World Journal of Laparoscopic Surgery

An Official Publication of the World Association of Laparoscopic Surgeons, UK

WJOLS

Also available online at
www.jaypeejournals.com
www.wjols.com

Access Online Resources

For more details, visit
www.wjols.com

Bibliographic Listings:
ProQuest, Scopus, Journals Factor, EBSCO,Genamics JournalSeek, Emcare, HINARI, Embase, J Gate, Google Scholar, Ulrich, CiteFactor, SIS, OAJI, MIAR, SIF, COSMOS, ESJI, SJIF, SJR, IIJIF, ICI

JAYPEE Jaypee Journals

REVIEW ARTICLE

Hysteroscopy and Assisted Reproductive Technology

Bamgbopa Tajudeen Kehinde

Nordica Fertility Center Lagos, Nigeria-106/108, Norman Williams Street, Ikoyi, Lagos, Nigeria

Abstract

Introduction: Hysteroscopy is an excellent instrument for evaluating the uterine characteristics in infertile women. It is the gold standard in the assessment of uterine anomalies today.

The aim: This review examines the two main applications of hysteroscopy in infertile patients who are candidates for assisted reproductive techniques: (1) In the evaluation the cervix, uterine cavity and rule out any pathology or lesions that could have been missed by hysterosalpingography or sonohysterography (2) Hysteroscopic surgery as treatment for uterine abnormalities in infertile patient going for assisted reproduction.

Methods: A literature search was conducted using Medline, Pubmed, Springer link and Highwire press. The following search terms were used: hysteroscopy, fertility, assisted reproduction, ART, IVF. Article were carefully selected and reviewed.

Results: There is a paucity of publications specifically on hysteroscopy use in ART, particularly from the third world. The Prevalence of uterine anomalies in women planned for ART is significant, necessitating a comprehensive assessment before ART treatment. Office hysteroscopy is a safe, effective and widely acceptable tool in the primary investigation of couple planned for ART. Hysteroscopic surgery is the mainstay of treatment of uterine anomalies in assisted reproduction and is a safe and effective alternative to laparoscopic salpingectomy in patients with hydrosalpinges.

Conclusion: The applications of hysteroscopy in assisted reproduction are still rapidly evolving. There are, however many areas of hysteroscopy in ART which require more research to enable the adoption of best practices in assisted reproduction.

Keywords: Hysteroscopy, assisted reproduction, infertility.

INTRODUCTION

Anomalies within the uterine cavity play an important role in fertility because they are capable of interfering with implantation. Adhesions, septa, polyps, submucous myomas, adenomyosis, endometritis, anomalies of the cervical canal, and lesions of the uterotubal junction are uterine disorders most often observed during investigation of and are implicated in infertility.[1] The proper diagnosis and treatment of these anomalies is vital to achieving success in assisted reproduction.

Hysterosalpingography can be used to evaluate tubal permeability but provides inadequate information about the uterine cavity (numerous false-positives and false-negatives) and pelvic ultrasound is especially helpful for diagnosing interstitial anomalies in the uterus.[1] Hysteroscopy, however, allows direct visualization of the uterine cavity, the endometrial mucus (and the cervical canal). The examination maybe practiced on an out-patient basis, without anesthesia, using appropriate small-caliber instruments and irrigation with physiological saline.[2] It may be necessary as a first line investigation because a significant percentage of patients have uterine pathology that may impair the success of fertility treatment.[3-5] Hysteroscopic treatment of these anomalies is also possible at the same time.[1,6]

The role of hysteroscopy in assisted reproduction has expanded over the years and the applications are still evolving. There is a growing consensus towards its use in the primary investigation of infertile women prior to *in vitro* Fertilization,[2,4,6] as well as in the management of hydrosalpinges in such patients, in place of laparoscopy.[7-9]

In this review, an attempt is made to examine the various applications of hysteroscopy in assisted reproduction in recent published literature, with particular focus on its use in primary assessment before IVF, assessment after repeat IVF failures as well as the uses of hysteroscopic surgery in assisted reproductive technology.

MATERIAL AND METHODS

A literature search was conducted using Medline, Pubmed , Springer link and Highwire press. The following search terms were used: Hysteroscopy, fertility, assisted reproduction, ART, IVF. In this review, ART include any form of assisted reproduction, including IVF/ICSI and ovarian stimulation with or without artificial insemination.

Abstracts had to be written in English and if the abstract was pertinent and relevant to the topic, the full article whether in English, German or French was sought. Other sources include Google using the same keywords and the websites of different organizations, such as ESHRE, IFFS, and FIGO, etc.

There were 1456 citations in total. Selected publications were screened for further references. Criteria for selection of

literature included; year of publication (publications more than 10 years old were largely ignored), types of study (preference for systematic reviews and randomized controlled studies), methods of analysis (statistical or nonstatistical) and Institution where studies were done (specialized fertility and endoscopic units).

FINDINGS AND DISCUSSION

Prevalence of Uterine Anomalies

The prevalence of uterine anomalies in patient undergoing IVF varies widely depending on the study population. A review by Bozdag et al revealed rates of 18-50% in patients undergoing IVF and 40-43% in patients with known IVF failures.[5] Hucke and colleagues in a review found 20% anomaly rates among infertile women.[6] Four prospective studies were reviewed with findings of 38% by Hinckley and Milki and 40.6% by Lorusso et al in pre-IVF treatment women while rates of 18% La Sala et al1998, and 45% Olivera et al, in women with recurrent implantation failure (RIF).[3,10-12] Endometrial polyps and uterine septum seem to be more frequent in our infertile patients than in the general population.[13]

The prevalence figures revealed from this review are quite significant and are a strong argument for a more extensive assessment of the uterine cavity as part of the primary assessment of patients planned for assisted reproduction.

Diagnostic Hysteroscopy: Pre-IVF Treatment and Post-IVF Failures

There is increasing use of diagnostic hysteroscopy be as part of routine investigation of infertile couple undergoing IVF.[6] The accepted practice in the past had been the review of uterine cavity by Hysterosalpingography with a resort to diagnostic hysteroscopy only after recurrent implantation failures (RIF). Pre-IVF hysteroscopy was done only when specifically indicate Economic considerations and lack of expertise is thought to contribute to the reluctance to use hysteroscopy as primary investigative tool.[2] A number of prospective studies, 2 RCTs and a systematic review were reviewed under this heading.

A prospective study of 1000 patients undergoing pre-IVF hysteroscopy by Campo et al revealed 62% had a normal uterine cavity.[3] Thirty-two percent had endometrial polyps. Other pathology included submucous fibroids (3%), intrauterine adhesions (3%), polypoid endometrium (0.9%), septum (0.5%) retained products of conception (0.3%), and bicornuate uterus (0.3%).[3]

DePlacido et al in a prospective series of 950 patients comparing minihysteroscope (n = 602) with 5 mm hysteroscope (n = 348) in an office setting. There was no difference in cavity finding in the two groups.[13] In the prospective series by Lorusso et al, 555 pre-IVF and 311 Post-IVF Failure patients had hysteroscopy followed by IVF cycle. The implantation and pregnancy rates were similar between the groups. Clinical outcomes in patients with repeated IVF failure who had hysteroscopy with no pathology compared with those who had pathology, did not show any statistical differences.[10]

Olivera et al and La Sala et al prospectively studied 55 and 100 post-IVF patient undergoing diagnostic hysteroscopy respectively. Of the 55 in the Olivera series, 25 (45%) had abnormalities which were treated.[12] Eighteen percent of patients in the La Sala series had uterine anomalies.[11]

In a randomized controlled study by Rama Raju and colleagues, 520 patient Pre-IVF patients were randomized into a hysteroscopy and a no- hysteroscopy group. Group I (n = 265) without office hysteroscopy. Group II (n = 255) had office hysteroscopy and was subclassified into group II a and group II b. Group II a (n = 160) had normal hysteroscopic findings whereas group II b (n = 95) had abnormal office hysteroscopy findings, which were corrected at the same time. There was no difference in the mean number of oocytes retrieved, fertilization rate, and number of embryos transferred among the patients in different groups. Statistically significant difference was observed in terms of clinical pregnancy rates between group I and group II a (26.2 and 44.44%, $P < 0.05$), and group I and group II b (26.2 and 39.55%, $P < 0.05$), respectively.[14]

Similarly, a RCT of Post-IVF failure patients were carried out by Demirol and Gurgan. Four hundred and twenty-one patients who had undergone two or more failed IVF-embryo transfer cycles were prospectively randomized into two groups. group I (n = 211) did not have office hysteroscopic evaluation, group II (n = 210) had office hysteroscopy. The patients who had normal hysteroscopic findings were included in group IIa (n = 154) and patients who had abnormal hysteroscopic findings were included in group IIb (n = 56). Intrauterine lesions diagnosed were operated during the office procedure. Fifty-six (26%) patients in group II had intrauterine pathologies and the treatment was performed at the same time. No difference existed in the mean number of oocyte retrieved, fertilization rate, and number of embryos transferred or first trimester abortion rates among the patients in groups. Clinical pregnancy rates in group I, group IIa and group IIb were 21.6%, 32.5% and 30.4% respectively. There was a significant difference in the clinical pregnancy rates between patients in group I and group IIa (21.6% and 32.5%, $P = 0.044$, respectively) and group I and group IIb (21.6% and 30.4%, $P = 0.044$, respectively). There was no significant difference in the clinical pregnancy rate of patients in groups IIa and IIb. Patients with normal hysterosalpingography but recurrent IVF-embryo transfer failure should be evaluated prior to commencing IVF-embryo transfer cycle to improve the clinical pregnancy rate.[15]

A systematic review of studies evaluating the influence of outpatient (office) hysteroscopy on the outcome of the subsequent IVF cycle was conducted by El Touchy.

All trials comparing the outcome of IVF treatment performed in patients who had outpatient hysteroscopy in the cycle preceding their IVF treatment with a control group in which hysteroscopy was not performed were included. The main outcome measure was pregnancy rate. In total, 1691 participants were included in two randomized (n = 941) and three non-randomized controlled studies (n = 750). The quality of the studies was variable. Meta-analyses of the results of five studies showed evidence of benefit from outpatient hysteroscopy in improving the pregnancy rate in the subsequent IVF cycle (pooled relative risk = 1.75, 95% CI 1.51-2.03). The evidence from randomized trials was consistent with that from non-randomized controlled studies.[16]

Thus, these studies along with the prevalence figures provide strong evidence for including diagnostic hysteroscopy as part of the primary investigation of infertile couple planned for assisted conception. Future robust randomized trials comparing outpatient hysteroscopy or minihysteroscopy with no intervention before IVF treatment would be a useful addition to further guide clinical practice.[16]

Office Hysteroscopy versus Conventional Hysteroscopy

Although diagnostic and operative laparoscopy are well-established in gynecology, diagnostic hysteroscopy is, however, not widely used in the office setting because of the discomfort produced by the procedure. Indeed, conventional hysteroscopy was more commonly practised and is performed under general anesthesia with a 4 mm optic with 5 mm external sheath, speculum and tenaculum to grasp and fix the uterus and it sometimes requires cervical dilatation. Since it seems invasive, traumatic and painful it is not very widely accepable.[4] Current evidence seems to weight heavily in favour of office hysteroscopy.

All of the prospective studies on diagnostic hysteroscopy in this review were done as office procedures in all cases or for most.[3,10,11,13-15] This implies the pre-eminence of office hysteroscopy in recent practice. Isaacson in a review, suggested that the under utilization of office diagnostic hysteroscopy denies many women a technique that is likely to keep them from more invasive and less useful procedures, such as diagnostic hysteroscopy and dilatation and curettage performed in the operating room under general anesthesia.[2]

The prospective series by DePlacido et al concluded that Office minihysteroscopy is a very effective diagnostic tool in an infertility work-up and is more widely accepted than traditional hysteroscopy.[13]

In the multicenter RCT by Rudi Campo et al, Patients were randomly assigned to undergo office diagnostic hysteroscopy either with 5.0 mm conventional instruments (n 5 240) or with 3.5 mm mini-instruments (n 5 240). Procedures were stratified according to patient parity and surgeon's previous experience. The indications for hysteroscopy were infertility in 219 cases (46%). The pain experienced during the procedure (0-10), the quality of visualization of the uterine cavity (0-3) and the complications were recorded. The examination was considered successful when the pain score was < 4, visualization score was >1 and no complication occurred. Less pain, better visualization and higher success rates were observed with mini-hysteroscopy ($P < 0.0001$, $P < 0.0001$ and $P < 0.0001$, respectively), in patients with vaginal deliveries ($P < 0.0001$, $P < 0.0001$ and $P < 0.0001$, respectively) and in procedures performed by experienced surgeons (P 5 0.02, P 5 NS and P 5 NS, respectively). The effects of patient parity and surgeon experience were no longer important when minihysteroscopy was used. They concluded that minihysteroscopy can be offered as a first line office diagnostic procedure.[4]

Hysteroscopic Surgery in Assisted Reproduction

Operative hysteroscopy has been accepted progressively as the best option for the treatment of intrauterine pathologies such as polyps, submucous myomas, septum and adhesions.[1,4,6] In this respect, hysteroscopic surgery has replaced conventional abdominal surgery. Surgical hysteroscopy is used to treat these anomalies and the patients receive general anesthesia. A high-frequency, low-voltage electric current is used, and glycine for irrigation when using unipolar electrosurgical sources. This procedure allows resection of submucous myomas and polyps and of septa and adhesions. Some groups use laser beams and irrigation by physiological saline for these treatments. Coagulation of a superficial focal spot of adenomyosis is not useful in infertility therapy.[1] There were not many publications addressing surgical hysteroscopy specifically in the assisted reproduction, most studies address it in the wider context of managing infertility.

Hysteroscopic Metroplasty for Uterine Septum

The aim of metroplasty is to restore a normal uterine anatomy to improve obstetrical outcomes in some uterine malformations. The hysteroscopic septoplasty cures the septate uterus. It is an effective procedure in the case of uterine septum with recurrent abortion losses. It probably improves the rate of live birth in women without obstetrical antecedent. For some authors, it could be considered at the time of the diagnosis and as first-line treatment in an assisted reproductive techniques (ART) program.[17]

Hysteroscopic resection of the septum improves fecundity of women with septate uterus and otherwise unexplained infertility. Patients with septate uterus and no other cause of sterility have a significantly higher probability of conceiving after removal of the septum than patients affected by idiopathic sterility.[18]

In a randomized prospective trial comparing 2 procedures for metroplasty: Resectoscopy with monopolar knife *versus* small-diameter hysteroscopy fitted with a versapoint device, one hundred-sixty patients with septate uterus and a history of recurrent abortion or primary infertility undergoing hysteroscopic metroplasty from 2001 to 2005. Hysteroscopic resection of the uterine septum performed with either a 26F resectoscope with unipolar knife (80 women, group A) or a 5 mm diameter hysteroscope with Versapoint device (80 women, group B). All patients were managed expectantly, with follow-up lasting 1 year. Operative parameters (operative time, fluid absorption, complications, need for second intervention) and reproductive outcome parameters (pregnancy, abortion, term and preterm delivery, modality of delivery, cervical cerclage) were measured. Operative time and fluid absorption were significantly greater in group A than in group B (23.4 +/– 5.7 *vs* 16.9 +/– 4.7 minutes and 486.4 +/– 170.0 *vs* 222.1 +/– 104.9 ml, respectively). The cumulative complication rate was significantly lower in group B than in group A. No difference in any of the reproductive parameters was observed between the 2 groups: Pregnancy and delivery rates were 70% and 81.6% in group A *vs* 76.9% and 84% in group B. Nine women (18.4%) from group B and 8 women (16%) from group B experienced spontaneous abortions. Most patients (54/82) delivered by cesarean section without differences according to the hysteroscopic technique used for metroplasty (65% in group A *vs* 67.7% in group B) or to the gestational age (65.1% of term and 68.7% of preterm deliveries).

The study concluded that small diameter hysteroscopy with bipolar electrode for the incision of uterine septum is as effective as resectoscopy with unipolar electrode regarding reproductive outcome and is associated with shorter operating time and lower complication rate.[19]

Hysteroscopic Surgery for Uterine Synechiae

Uterine synechiae precludes success in assisted reproductive techniques and so need to be diagnosed and treated. While sonohysterography and hysterosalpingography are useful as screening tests of intrauterine adhesions, hysteroscopy remains the mainstay of diagnosis.[1]

Hysteroscopy has also become the accepted optimum route of surgery, aimed at restoring the size and shape of the uterine cavity, normal endometrial function and increasing chances at IVF. Treatment options range from simple cervical dilatation in the case of cervical stenosis but an intact uterine cavity, to extensive adhesiolysis of dense intrauterine adhesions using scissors or electro or laser energy.

Magos in a review concluded that patients in whom the uterine fundus is completely obscured and those with a greatly narrowed, fibrotic cavity present the greatest therapeutic challenge. Several techniques have described for these difficult cases, but outcome is far worse than in patients with mild, endometrial-type adhesions.[20]

The review by Kodaman and Arici concluded that diagnosis and treatment of intrauterine adhesions are integral to the optimization of fertility outcomes and that favorable result in terms of pregnancy and live birth rates can be expected after hysteroscopic adhesiolysis. Postoperative mechanical distention of the endometrial cavity and hormonal treatment to facilitate endometrial regrowth appear to decrease the high-rate of adhesion reformation. Newer antiadhesive barriers may also prevent the recurrence of intrauterine adhesions. Endometrial development can remain stunted due to a scant amount of residual functioning endometrium and fibrosis. Potential pregnancy complications, especially placenta accreta, after the treatment of intrauterine adhesions should be anticipated and discussed with the patient.[21]

Hysteroscopic Management of Hydrosalpinges

It is well known that the success of assisted reproductive techniques, especially IVF, for patients with tubal pathologies such as hydrosalpinx is reduced by half compared with patients without hydrosalpinx.[22]

Theories explaining the mechanisms behind the impaired outcome of *in vitro* fertilization still focus on the hydrosalpingeal fluid. The negative effects of hydrosalpinx have generally been attributed largely to: (i) mechanical effects of fluid washing out uterine contents; (ii) embryo and gametotoxicity from toxic hydrosalpinx fluid; (iii) alterations in endometrial receptivity markers; or dwindled cross talk between embryoendometrium resulting in hindered implantation, and (iv) direct effect on endometrium, leading to intrauterine fluid formation. The underlying mechanism explaining reduced implantation and embryo development awaits further research.[23]

The pertinent question is to determine the best mode of treatment. Surgical treatment is generally advocated but a choice has to be made between salpingectomy and proximal tubal occlusion.

A cochrane database systematic review carried out by Johnson and colleagues to examine the efficacy of surgical intervention for tubal disease before IVF. Three randomized controlled trials involving 295 (or couples) were included in this review. The odds of ongoing pregnancy and live birth [Peto-odds ratio (OR) 2.13, 95% confidence interval (CI) 1.24 to 3.65] were increased with laparoscopic salpingectomy for hydrosalpinges prior to IVF. The odds of pregnancy were also increased (Peto-odds ratio (OR)1.75, 95% CI 1.07 to 2.86). There was no significant difference in the odds of ectopic pregnancy (Peto OR 0.42, 95% CI 0.08 to 2.14), miscarriage (Peto OR 0.49, 95% CI 0.16 to 1.52) or treatment complications (Peto OR 5.80, 95% CI 0.35 to 96.79). No data were available concerning the odds of multiple pregnancies.

The reviewers concluded that laparoscopic salpingectomy should be considered for all women with hydrosalpinges prior to IVF treatment.[24]

Kontoravdis et al in a prospective randomized study to evaluate and compare the clinical impact of proximal tubal occlusion and salpingectomy when performed before IVF in patients with hydrosalpinges, concluded that proximal tubal occlusion, when performed in women with unilateral or bilateral hydrosalpinges before their IVF treatment, represents a potentially beneficial surgical procedure, increasing significantly the chances for successful implantation and for clinical and ongoing pregnancy. Proximal tubal occlusion may be viewed as a valid alternative when salpingectomy is technically difficult or not feasible. One hundred fifteen patients with unilateral or bilateral hydrosalpinges, who were candidates for IVF treatment, had laparoscopic proximal tubal occlusion or laparoscopic salpingectomy, controlled ovarian stimulation, IVF, and embryo transfer. Patients who underwent proximal tubal occlusion before IVF demonstrated significantly increased implantation, clinical-pregnancy, and ongoing-pregnancy rates compared with those with no surgical intervention and demonstrated implantation, clinical-pregnancy, and ongoing-pregnancy rates comparable to those who underwent salpingectomy.[25]

There is now a preference for achieving proximal tubal occlusion via hysteroscopy. Darwish and El Saman carried out a prospective comparative study to determine whether hysteroscopic tubal occlusion will produce the same efficacy as laparoscopic tubal occlusion of functionless hydrosalpinx prior to IVF/ICSI. The study phase included 27 patients with uni- or bilateral functionless hydrosalpinges, who were randomly divided into 2 groups. Group A comprised 14 patients who were randomly allocated for laparoscopic occlusion. Group B included 13 patients scheduled for a hysteroscopic approach. Laparoscopic occlusion of the isthmic part of the fallopian tube was carried out using bipolar diathermy in 9 (64%) cases or clips in 3 (21.4%) cases in Group A. Roller ball electrode of the resectoscope was utilized for occlusion of the tubal ostium under local, spinal, or general anesthesia in group B. Second-look office hysteroscopy was performed in group B whenever possible. In both groups, hysterosalpingography or sonohysterography was carried out 1 month later to confirm tubal occlusion. The mean number of abdominal scars/patient was 1.4 and 1.5 in both groups, respectively. Unilateral functionless hydrosalpinx was encountered in 7 (50%) and 5 (38%) cases in both groups, respectively. In group A, the procedure was possible and successful in 10 cases (76.9%), while in group B, hysteroscopic access and occlusion were achieved in 12 (85.7%) and 9 (64.2%) cases, respectively. In group B, diagnostic hysteroscopy showed fine marginal adhesions in 2 cases (15%), and a small polyp in 1 case (7.7%). Hysteroscopic tubal occlusion showed shorter operative time (9+/– 2.8 *versus* 24+/– 4.8 minutes, p = 0.0001) and hospital stay (2+/– 1.8 *versus* 5+/– 1.1 hour, p = 0.0001). Second-look office hysteroscopy was performed in 8 cases in group B and revealed no significant corneal lesions at the site of hysteroscopic occlusion.[7]

This preliminary study demonstrates the feasibility of hysteroscopic tubal occlusion of functionless hydrosalpinx in all cases with acceptable efficacy. It has the advantage of adding a valuable evaluation of the endometrial cavity prior to IVF/ICSI. It should be an option for treatment protocol in cases of functionless hydrosalpinges.[7]

The recent introduction of the essure microinsert has added impetus to the drive for hysteroscopic management of hydrosalpinges.

Hiktari et al in a prospective case series of 5 women with unilateral or bilateral hydrosalpinges on transvaginal ultrasound, laparoscopy, or hysterosalpingogram who were planning further fertility therapy, concluded that hysteroscopic placement of the essure microinsert is a minimally invasive option for proximal tubal occlusion in patients requiring occlusion of hydrosalpinges before IVF and with contraindications to abdominal surgery. This technique may offer a safer alternative.[8]

Mijaytovic et al conducted a prospective, single-arm, clinical study to investigate the success rate of proximal tubal occlusion with essure devices in subfertile women with hydrosalpinges, and to observe the results of subsequent treatment with IVF. Ten women with uni- or bilateral hydrosalpinges prior to IVF were involved. In all patients laparoscopy was felt to be contraindicated. Hysteroscopic placement of essure devices was carried out in an office setting. All patients had successful placement of the essure devices without any complications. Proximal tubal occlusion was confirmed by hysterosalpingography in 9 out of 10 patients. A 40% ongoing pregnancy rate was achieved with 20% life births after one IVF cycle and/or frozen embryo transfer. They concluded that proximal occlusion of hydrosalpinges with essure devices before IVF is a successful treatment for patients with a contraindication for salpingectomy.[9]

Hysteroscopic Myomectomy for Submucous Fibroid

Uterine fibroids occur in 30% of women and are associated with a degree of subfertility and they interfere with infertility. But, the effect of fibroids on the outcome of assisted reproductive techniques specifically, has not been investigated extensively.

In a study by Hart et al, data were prospectively collected on 434 women undergoing IVF/ICSI in the assisted conception unit of an inner London teaching hospital. During the study period, 112 women with (study), and 322 women without (controls), intramural fibroids were treated. Patients were similar regarding the cause and duration of their infertility, number of previous treatments, and basal serum FSH concentration.

Women in the study group were on average 2 years older (36.4 *versus* 34.6 years; P < 0.01). There was no significant difference in the duration of ovarian stimulation or gonadotrophin requirement, number of follicles developed, oocytes collected, and embryos available for transfer or replaced. When analyzing only women with intramural fibroids of 5 cm in size (n = 106) pregnancy, implantation and ongoing pregnancy rates were significantly reduced: 23.3, 11.9 and 15.1 respectively compared with 34.1, 20.2 and 28.3% in the control group (P = 0.016, P = 0.018 and P = 0.003). The mean size of the largest fibroids was 2.3 cm (90% range 2.1 to 2.5 cm). Logistic regression analysis demonstrated that the presence of intramural fibroids was one of the significant variables affecting the chance of an ongoing pregnancy, even after controlling for the number of embryos available for replacement and increasing age, particularly age 40 years, odds ratio 0.46 (CI 0.24–0.88; P = 0.019). This study demonstrated that an intramural fibroid halves the chances of an ongoing pregnancy following assisted conception.[26]

Racknow and Arici, in a review in 2005 concluded that fibroid location, followed by size, is the most important factor determining the impact of fibroids on IVF outcomes. Any distortion of the endometrial cavity seriously affects IVF outcomes, and myomectomy is indicated in this situation. Myomectomy should also be considered for patients with large fibroids, and for patients with unexplained unsuccessful IVF cycles.[27]

Somigliana et al in their analysis concluded that available evidence also suggests that submucosal, intramural and subserosal fibroids interfere with fertility in decreasing order of importance. Physicians are advised to pursue a comprehensive and personalized approach clearly exposing the pros and cons of myomectomy to the patient, including the risks associated with fibroids during pregnancy on one hand, and those associated with surgery.[28]

Surrey and colleagues, in a prospective case-controlled study evaluated the impact of myomectomy on *in vitro* fertilization-embryo transfer (IVF-ET) and oocyte donation cycle outcome. Patients were grouped with submucosal leiomyomata resected hysteroscopically (group A: 15 oocyte donor recipients; group 1 = 31 IVF-ET patients) and those with intramural components or strictly intramural leiomyomata that distorted or impinged upon the endometrial cavity resected at laparotomy (group B = 26 oocyte donor recipients; group 2 = 29 IVF-ET patients). Precycle hysteroscopic or abdominal myomectomy were performed with subsequent fresh IVF-ET or oocyte donation. Results of controlled ovarian hyperstimulation as well as ongoing pregnancy and implantation rates were evaluated in comparison with contemporaneous patient groups without such lesions (group C = 552 oocyte donor recipients; group 3: 896 IVF-ET patients). The mean number and size of leiomyomata were significantly larger in patients who underwent abdominal myomectomy. However, neither ongoing pregnancy nor implantation rates were significantly different in comparison with controls among either oocyte donor recipients (group A: 86.7%, 57.8%; group B: 84.6%, 55.2%; group C: 77%, 49.1%). The findings were similar for those undergoing IVF-ET in comparison with controls (group 1: 61%, 24%; group 2: 52%, 26%; group 3: 53%, 23%). This study showed that precycle resection of appropriately selected clinically significant leiomyomata results in IVF-ET or oocyte donation cycle outcomes that are similar to controls.[29]

Kolankaya and Arici concluded in their review that myomas that compress the uterine cavity with an intramural portion and submucous myomas significantly reduce pregnancy rates, and should be removed before assisted reproductive techniques are used and that hysteroscopic myomectomy is the gold standard for the treatment of submucous myomas.[30]

In reviewing surgical technique employed at hysteroscopy, 2 publications were examined:

Attilio et al in a review of surgical techniques, confirmed that myomas that compress the uterine cavity with an intramural portion and submucous myomas significantly reduce pregnancy rates, and should be removed before assisted reproductive techniques are used and that hysteroscopic myomectomy is the gold standard for the treatment of submucous myomas. The choice of the technique mostly depends on the intramural extension of the fibroid, as well as on personal experience and available equipment. 'Resectoscopic slicing' still represents the 'gold standard' technique for treating fibroids G0, even if several other effective techniques including ablation by neodymium-yttrium-aluminum-garnet laser, morcellation and office myomectomy have been proposed. At present, the 'cold loop' technique seems to represent the best option as it allows a safe and complete removal of such fibroids in just one surgical procedure, while respecting the surrounding healthy myometrium.[31]

Touboul and colleagues tried to determine the rate of uterine synechiae after bipolar hysteroscopic myomectomy in patients suffering from infertility.[32] In a retrospective case series study, a group of 53 patients with primary (n = 30) and secondary (n = 23) infertility who underwent bipolar hysteroscopic resection of myomas between 2001 and 2006, and an outpatient hysteroscopy was performed 2 months after the fibroid resection. The formation of uterine Synechiae and pregnancy rates were collected from the patients' clinical notes. The submucosal myomas were intracavitary class 0 (n = 12), intramural class 1 (n = 19), and intramural class 2 (n = 22). The mean age of the women was 35.0 +/– 4.8 years. The mean myoma size was 25 +/– 11 mm. Postoperative office hysteroscopies revealed synechiae in four (7.5%) of 53 patients. Sixteen (32.7%) of the 49 patients not lost to follow-up conceived, and 12 (24.5%) of them delivered at term. Myoma size >/=3.5 cm and age <35 years were associated with a significantly higher pregnancy rate in univariate and multivariate analysis. They concluded

that the incidence of uterine synechiae after bipolar hysteroscopic resection of fibroids was 7.5%. This appears to be lower than that reported in previous studies using monopolar energy.[32]

Thus, bipolar hysteroscopic myomectomy may be a better option for infertile women. It must be said, however, that drawing clear guidelines for the management of fibroids in infertile women is difficult due to the lack of large randomized trials aimed at elucidating which patients may benefit from surgery.[32]

Hysteroscopic Management of Endometrial Polyps

There were very few studies addressing hysteroscopic polypectomy in assisted reproduction and there is no consensus about the management of patients diagnosed with endometrial polyp in IVF cycles.

Lass and colleagues at Bourn Hall Clinic Cambridge investigated the effect of endometrial polyps on pregnancy outcome in an *in vitro* fertilization (IVF) program. Endometrial polyps less than 2 cm in diameter were suspected by transvaginal ultrasound before oocyte recovery in 83 patients. Forty-nine women (Group I) had standard IVF-embryo transfer, while in 34 women (Group II) hysteroscopy and polypectomy were performed immediately following oocyte retrieval, the suitable embryos were all frozen, and the replacement cycle took place a few months later. Of the 32 hysteroscopies, a polyp was diagnosed in 24 cases (75%) and polypoid endometrium in another 5 patients (15.6%). An endometrial polyp was confirmed by histopathological examination in 14 women (58.3%). The pregnancy rate in group I was similar to the general pregnancy rate of our unit over the same period (22.4 *vs* 23.4%) but the miscarriage rate was higher (27.3 *vs* 10.7%, P = 0.08). In Group II, the pregnancy and miscarriage rates were similar to those of the frozen embryo cycles at Bourn Hall (30.4 and 14.3 *vs* 22.3 and 12.1%, respectively).Their conclusion was that small endometrial polyps, less than 2 cm, do not decrease the pregnancy rate, but there is a trend toward increased pregnancy loss. A policy of oocyte retrieval, polypectomy, freezing the embryos, and replacing them in the future might increase the "take-home baby" rate.[33]

Batioglu and Kavmak in a prospective series reported 6 patients with endometrial polyp (measuring < 2 cm) diagnosed by transvaginal ultrasonography performed on days 7 and 9 of the cycle in patients who underwent IVF. These six patients were treated by hysteroscopic polypectomy preceding oocyte retrieval under general anesthesia after informed consent was obtained. The cause of infertility was male factor in three patients, tubal factor in one, and two cases were unexplained. All patients had undergone ovulation induction and luteal support according to the long luteal protocol. As a result, in three cases pregnancy was achieved (one multiple and two singleton) and three cases were unsuccessful. One of the pregnant women gave birth at term, while the other two pregnancies are still ongoing. They concluded that, with no consensus regarding the management of patients diagnosed with endometrial polyp in IVF cycles. Cryopreservation, cycle cancellation and embryo transfer preceding polypectomy is the current management choice.[34]

Madani et al in a similar series studied nine patients who underwent assisted reproduction treatment cycles and were diagnosed with endometrial polyps less than 1.5 cm by transvaginal ultrasonography. Eight patients were treated by long protocol and one patient was the recipient of an egg donation cycle. In all patients, polyp resection was performed through hysteroscopic polypectomy. Polypectomy was done during ovarian stimulation in the standard treatment cycles, and during hormone replacement therapy in the recipient of the egg donation cycle. The interval between polyp resection and embryo transfer was 2-16 days. Four patients achieved pregnancy (two twins, two singletons), four patients were unsuccessful, and one pregnancy was a blighted ovum. All of the successful pregnancies were still ongoing. At time of publication. They concluded that if polypectomy before embryo transfer in an IVF cycle is proven to be safe, then embryos will be transferred without cycle cancellation. And that since this study included nine patients; further studies with more patients are required to confirm these findings.[35]

In a different scenario, Perez-Medina and colleagues carried out a prospective randomized study to determine whether hysteroscopic polypectomy before intrauterine insemination (IUI) achieved better pregnancy outcomes than no intervention. A total of 215 infertile women from the infertility unit of a university tertiary hospital with ultrasonographically diagnosed endometrial polyps (EP) undergoing IUI were randomly allocated to one of two pretreatment groups using an opaque envelope technique with assignment determined by a random number table. Hysteroscopic polypectomy was performed in the study group. Diagnostic hysteroscopy and polyp biopsy was performed in the control group. Total pregnancy rates and time for success in both groups after four IUI cycles were compared by means of contingency tables and life-table analysis. A total of 93 pregnancies occurred, 64 in the study group and 29 in the control group. Women in the study group had a better possibility of becoming pregnant after polypectomy, with a relative risk of 2.1 (95% confidence interval 1.5-2.9). Pregnancies in the study group were obtained before the first IUI in 65% of cases. Their conclusion is that hysteroscopic polypectomy before IUI is an effective measure.[36]

Implications for Sub Saharan Africa

Diagnostic and operative hysteroscopy are not used equally worldwide, neither is the practice of assisted reproductive techniques. There were no studies accessed on hysteroscopy

in assisted reproduction from SubSaharan Africa. However, infertility is a worldwide issue in reproductive health, more so in Africa. Negative consequences of childlessness are experienced to a greater degree in developing countries when compared with Western societies.[37] Bilateral tubal occlusion due to sexually transmitted diseases and pregnancy-related infections is the most common cause of infertility in developing countries, a condition that is potentially treatable with assisted reproductive technologies.[37]

In view of the World Health Organization's definition of health, the psychological and social consequences of infertility simply cannot be ignored. Prevention of infertility is difficult and does not help the couple seeking medical advice for infertility, whereas efficient treatment for infertility is time consuming, expensive and often unsuccessful.[38] New reproductive technologies are either unavailable or very costly in developing countries.[37] It is sadly obvious that, as in all developmental issues, Sub Saharan Africa is being left behind.

Strategies to tackle these short-comings would include optimizing the use of modern gynecological endoscopy where possible. Exhaustive infertility investigation can be conducted within the span of two couple-physician contacts, thereby responding to the couple's concern, avoiding loss of time and energy due to inappropriate therapies, and directing the subfertility treatment correctly from the start.[38]

Trained gynecologists can easily conduct this investigation even in developing countries with proper planning and allocation of resources. The investigation can be employed either with an emphasis on diagnosis alone (and then even under local anesthesia) or, if the necessary infrastructure is available, in combination with operative endoscopy under general anesthesia where indicated.[38]

Implementation of infertility care in low-resource settings include simplification of diagnostic and ART procedures, minimizing the complication rate of interventions, providing training-courses for health-care workers and incorporating infertility treatment into sexual and reproductive health-care programes.[37] The use of office hysteroscopy will also help to reduce cost and is more convenient for and acceptable to the patients.[2,4] There is also a need to stimulate and encourage research in those endoscopy and ART center in place Sub-Saharan Africa.

For the reasons of social justice, infertility treatment in developing countries requires greater attention at National and International levels.[37]

CONCLUSION

Hysteroscopy is efficacious as primary assessment in couples planned for ART. It is also the gold standard in the management of detected uterine anomalies. Office hysteroscopy is a safe and viable alternative to conventional hysteroscopy and should be encouraged even more so in low-resource settings in other to optimize patient preparation for assisted reproduction. The applications of hysteroscopy in assisted reproduction are still rapidly evolving. There are, however many areas of hysteroscopy in ART which require more research to enable the adoption of best practices in assisted reproduction.

REFERENCES

1. Merviel P, Mergui JL, Sananes S, Antoine JM, Salat-Baroux J, Uzan S: Role of hysteroscopy in the diagnosis and treatment of infertility. Presse Med Jul 2000;1;29(23):1302-10.
2. Isaacson K. Office hysteroscopy: A valuable but under-utilized technique. Curr Opin Obstet Gynecol Aug 2002;14(4):381-85.
3. Hinckley MD, Milki AA. 1000 office-based hysteroscopies prior to in vitro fertilization: Feasibility and findings. JSLS Apr-Jun 2004;8(2):103-07.
4. Rudi Campo, Carlos Roger Molinas, Luk Rombauts, Greet Mestdagh, Martin Lauwers, Paul Braekmans, Ivo Brosens, Yves Van Belle and Stephan Gordts: Prospective multicenter randomized controlled trial to evaluate factors influencing the success rate of office diagnostic hysteroscopy. Human Reproduction 2005;20(1):258-63.
5. Bozdag G, Aksan G, Esinler I, Yarali H. What is the role of office hysteroscopy in women with failed IVF cycles? Reprod Biomed Online Sep 2008;17(3):410-15.
6. Hucke J, De Bruyne F, Balan P. Hysteroscopy in infertility—diagnosis and treatment including falloposcopy. Contrib Gynecol Obstet 2000;20:13-20.
7. Darwish AM, El Saman AM. Is there a role for hysteroscopic tubal occlusion of functionless hydrosalpinges prior to IVF/ICSI in modern practiceActa Obstet Gynecol Scand. 2007;86(12):1484-89.
8. Hitkari JA, Singh SS, Shapiro HM, Leyland N. Essure treatment of hydrosalpinges. Fertil Steril Dec 2007;88(6):1663-66. Epub 2007 May 9.
9. Mijatovic V, Veersema S, Emanuel MH, Schats R, Hompes PG. Essure hysteroscopic tubal occlusion device for the treatment of hydrosalpinx prior to in vitro fertilization-embryo transfer in patients with a contraindication for laparoscopy. Fertil Steril Jan 2009 ;13.
10. Lorusso F, Ceci O, Bettocchi S, Lamanna G, Costantino A, Serrati G, Depalo R. Office hysteroscopy in an in vitro fertilization program. Gynecol Endocrinol Aug 2008;24(8):465-69.
11. La Sala GB, Montanari R, Dessanti L, Cigarini C, Sartori F. The role of diagnostic hysteroscopy and endometrial biopsy in assisted reproductive technologies. Fertil Steril Aug 1998;70(2):378-80.
12. Oliveira FG, Abdelmassih VG, Diamond MP, Dozortsev D, Nagy ZP, Abdelmassih R. Uterine cavity findings and hysteroscopic interventions in patients undergoing in vitro fertilization-embryo transfer who repeatedly cannot conceive. Fertil Steril Dec 2003;80(6):1371-75.
13. De Placido G, Clarizia R, Cadente C, Castaldo G, Romano C, Mollo A, Alviggi C, Conforti S. Compliance and diagnostic efficacy of mini-hysteroscopy versus traditional hysteroscopy in infertility investigationEur J Obstet Gynecol Reprod Biol Nov 2007;135(1):83-87. Epub 2007 May 3.

14. Rama Raju GA, Shashi Kumari G, Krishna KM, Prakash GJ, Madan K. Assessment of uterine cavity by hysteroscopy in assisted reproduction programme and its influence on pregnancy outcome. Arch Gynecol Obstet Jun 2006;274(3):160-64. Epub 2006 May 10.
15. Demirol A, Gurgan T. Effect of treatment of intrauterine pathologies with office hysteroscopy in patients with recurrent IVF failure. Reprod Biomed Online May 2004;8(5):590-94.
16. El-Toukhy T, Sunkara SK, Coomarasamy A, Grace J, Khalaf Y. Outpatient hysteroscopy and subsequent IVF cycle outcome: A systematic review and meta-analysis. Reprod Biomed Online May 2008;16(5):712-19.
17. Garbin O, Ziane A, Castaigne V, Rongières C. Do hysteroscopic metroplasties really improve really reproductive outcome? Gynecol Obstet Fertil Sep 2006;34(9):813-18. Epub 2006 Sep 7.
18. Mollo A, De Franciscis P, Colacurci N, Cobellis L, Perino A, Venezia R, Alviggi C, De Placido G. Hysteroscopic resection of the septum improves the pregnancy rate of women with unexplained infertility: A prospective controlled trial. Fertil Steril Jun 2009;91(6):2628-31.
19. Colacurci N, De Franciscis P, Mollo A, Litta P, Perino A, Cobellis L, De Placido G. Small-diameter hysteroscopy with Versapoint versus resectoscopy with a unipolar knife for the treatment of septate uterus: A prospective randomized study. J Minim Invasive Gynecol Sep-Oct 2007;14(5):622-27.
20. Magos A. Hysteroscopic treatment of Asherman's syndrome. Reprod Biomed Online 2002;4 Suppl 3:46-51.
21. Kodaman PH, Arici A. Intrauterine adhesions and fertility outcome: How to optimize success? Curr Opin Obstet Gynecol Jun 2007;19(3):207-14.
22. Ozmen B, Diedrich K, Al-Hasani S. Hydrosalpinx and IVF: Assessment of treatments implemented prior to IVF. Reprod Biomed Online Feb 2007;14(2):235-41.
23. Strandell A. Treatment of hydrosalpinx in the patient undergoing assisted reproduction. Curr Opin Obstet Gynecol. Aug 2007;19(4):360-65.
24. Johnson NP, Mak W, Sowter MC. Surgical treatment for tubal disease in women due to undergo in vitro fertilisation. Cochrane Database Syst Rev 2004;(3):CD002125.
25. Kontoravdis A, Makrakis E, Pantos K, Botsis D, Deligeoroglou E, Creatsas G. Proximal tubal occlusion and salpingectomy result in similar improvement in in vitro fertilization outcome in patients with hydrosalpinx. Fertil Steril Dec 2006;86(6):1642-49. Epub 2006 Oct 25.
26. Roger Hart, Yacoub Khalaf, Cheng-Toh Yeong, Paul Seed, Alison Taylor and Peter Braude: A prospective controlled study of the effect of intramural uterine fibroids on the outcome of assisted conception. Human Reproduction Nov 2001;16(11):2411-17.
27. Rackow BW, Arici A Fibroids and *in vitro* fertilization: Which comes first? Curr Opin Obstet Gynecol. Jun 2005;17(3):225-31.
28. E Somigliana, P Vercellini, R Daguati, R Pasin, O De Giorgi, PG Crosignani: Fibroids and female reproduction: A critical analysis of the evidence. Human Reproduction Update, Jun 2007;13(5):465-76.
29. Surrey ES, Minjarez DA, Stevens JM, Schoolcraft WB. Effect of myomectomy on the outcome of assisted reproductive technologies. Fertil Steril. May 2005;83(5):1473-79.
30. Kolankaya A, Arici A. Myomas and assisted reproductive technologies: When and how to act? Obstet Gynecol Clin North Am. Mar 2006 ;33(1):145-52.
31. Attilio Di Spiezio Sardo, Ivan Mazzon, Silvia Bramante, Stefano Bettocchi,Giuseppe Bifulco, Maurizio Guida and Carmine Nappi: Hysteroscopic myomectomy: A comprehensive review of surgical techniques. Human Reproduction Update 2008;14(2):101-19.
32. Touboul C, Fernandez H, Deffieux X, Berry R, Frydman R, Gervaise A. Uterine synechiae after bipolar hysteroscopic resection of submucosal myomas in patients with infertility. Fertil Steril. 2008 Oct 18. http://www.ncbi.nlm.nih.gov.
33. Lass A, Williams G, Abusheikha N, Brinsden P. The effect of endometrial polyps on outcomes of in vitro fertilization (IVF) cycles.J Assist Reprod Genet. Sep 1999;16(8):410-15.
34. Batioglu S, Kaymak O. Does hysteroscopic polypectomy without cycle cancellation affect IVF? Reprod Biomed Online. Jun 2005;10(6):767-69.
35. Madani T, Ghaffari F, Kiani K, Hosseini F. Hysteroscopic polypectomy without cycle cancellation in IVF cycles. Reprod Biomed Online. Mar 2009;18(3):412-15.
36. Tirso Pérez-Medina, José Bajo-Arenas, Francisco Salazar, Teresa Redondo, Luis Sanfrutos, Pilar Alvarez and Virginia Engels Endometrial polyps and their implication in the pregnancy rates of patients undergoing intrauterine insemination: A prospective, randomized study Human Reproduction 2005;20(6):1632-35.
37. Willem Ombelet, Ian Cooke, Silke Dyer, Gamal Serour and Paul Devroey Infertility and the provision of infertility medical services in developing countries Human Reproduction Update 2008;14(6):605-21.
38. Puttemans P, Ombelet W, Brosens I. Reflections on the way to conduct an investigation of subfertility. Hum Reprod. Oct 1995;10 (Suppl 1):80-89.

REVIEW ARTICLE

Practical Considerations for Common Duct Stone Clearance

Dennis L Sta Ana

Department of Surgery, Marikina Valley Medical Center, Sumulong ave, Marikina City-1800, Philippines

Abstract

Patients undergoing cholecystectomy have a 10 to 18% chance of common duct stone (CDS) being discovered during the procedure. With the advent of laparoscopy the generally successful open common bile duct exploration for the treatment of common duct stone has been largely replaced by endoscopic means. Lately however, endoscopic clearance is being challenged by a single stage laparoscopic common duct exploration. No clear consensus has been developed to delineate specific practice guidelines for each procedure. Even so, different variables such as patient variables, institutional limitations and technical considerations make the choice of the appropriate procedure a lot more confusing. It is the aim of this article review to find out practical options for the surgeons on the basis of established parameters for safe surgery as well circumstantial parameters that may be variably present in different hospital settings.The search strategy was to review literatures, abstracts, electronic databases, and bibliographies published from year 1999 until 2008 using different medical search engines. Results of this review showed two RCTs (n 378) comparing preoperative endoscopic clearance *vs* laparoscopic stone clearance and two smaller RCTs (n 166) which compared single stage laparoscopic stone clearance *vs* delayed endoscopic clearance. There was shorter length of stay in the laparoscopy arm in both studies but stone clearance rate, mortality and morbidity were not significantly different for all studies. Literatures that dealt with circumstantial parameters such as patient variables, institutional limitations and technical expertise, all showed positive significance for these parameters in predicting the success or failure of a procedure for common duct clearance.

Keywords: Common duct stones, cholecystitis, choledocholithiasis, ERCP, complications, laparoscopic choledochotomy, endoscopic surgery.

OBJECTIVES

The objectives of this review were to compare available data on four of the common procedures for CDS clearance. Procedures included were. (1) Open CBDE, (2) Preoperative ERCP, (3) Postoperative ERCP, and (4) Laparoscopic common bile duct clearance (LCBDC) based on success rate, mortality, morbidity, length of hospital stay, and cost. This review also aimed to find out how circumstantial parameters such as patient variable, institutional limitation and technical consideration would affect the decision making process for the treatment of CDS.

MATERIAL AND METHODS

A systematic literature search for relevant articles, abstracts, bibliographies and electronic data base using search engines such as Google, Springerlink, Highwire Press, and Medline. Thirty articles were chosen of which 4 randomised controlled trials and one systematic review were.

Accepted methods of treatment for common bile duct stone were evaluated for its outcome measures such as mortality, morbidity, success rate, duration of hospital stay and cost. No attempt was made to install one procedure as the best procedure for all types of scenario. Findings are presented based on available data gathered from the literature search.

Accepted methods of treatment for common duct stones are: (1) Open CBDE, (2) Preoperative, (3) Postoperative ERCP/ES, (4) Laparoscopic cholecystectomy with common duct clearance via transcystic route (LTCCBDE) or through a choledochotomy (LCBDE). Variables commonly used in the formulation of treatment strategy were chosen for analysis. This included articles dealing with institutional limitation, technical expertise and patient factors. These variables were then studied for its possible contribution in the choice of treatment modality.

INTRODUCTION

NIH consensus of 1993 replaced open cholecystectomy with Laparoscopic cholecystectomy as the procedure of choice for cholecystolithiasis. Gallstone, even if it is asymptomatic, has a 10-50% chance of complication within 20 years.[2] In patients who undergo cholecystectomy, 18% will be found to have choledocolithiasis.[3,4] With the dawning of the laparoscopic era, Endoscopic retrograde cholangio pancreatography (ERCP) became popular in common duct stone (CDS) removal.[5] In the beginning, it was a choice between open common bile duct exploration (CBDE) and endoscopic stone clearance (ERCP/ES) for CDS. With technical advances in laparoscopic removal of stone and the improvement in skills among laparoscopic surgeons, more and more used the single stage method of removing the CDS. It has now become important to compare laparoscopic and endoscopic approaches in the removal of common duct stones so that guidelines may be set.[10] At present, there are a lot of controversies in the management of CDS. To

add to this, standard algorithm, variations in laparoscopic skills, availability of proper equipment and cost differences in medical centers perpetuate the lack of consensus for this problem. The current practice option for CDS at the time of laparoscopic cholecystectomy (LC) are preoperative or postoperative ERCP/ES, intraoperative ERCP/ES, LTCCBDE, LCBDE and outright open CBDE. In the absence of official consensus, decision becomes dependent on the patient's medical fitness, technical skill of the surgeon, availability of equipment, availability of the endoscopic team and cost.

RESULTS AND DISCUSSION

The most contentious issue in the management of CDS is which between laparoscopic surgery and ERCP will be most beneficial to patients. Two RCTs conducted comparative studies on preoperative ERCP and laparoscopic CBDE using a total of 378 patients (Table 1).[6,7] Two smaller RCTs compared treatments of stones found during surgery using 166 randomized patients (Table 2).[8,9] Conversion rates for laparoscopic surgery were 7.4%,[7] implied 3.5%,[5] 2.4%[8] and 1.3%.[9] Combined success rates for laparoscopic *vs* endoscopic CBD stone clearance on an intention-to-treat basis were 88% *vs* 88% for the preoperative ERCP comparison. And for intraoperatively discovered CDS, there is 84% success rate for laparoscopic stone clearance as compared to 75% in the postoperative ERCP. Success rates for transcystic clearance is 81% and 85% choledochotomy.[6-9] Furthermore, the meta-analysis for laparoscopic stone clearance and both preoperative and postoperative ERCP showed no significant difference mortality, morbidity, success rate in ductal clearance, and hospital stay[11] except for the study of Rhodes[9] wherein the single stage approached was significantly shorter. It is noteworthy, however, that the endoscopy arm is an extraprocedure during the treatment process.

1. *Open CBDE:* In a systematic review by Martin DJ et al, 2006(11),open surgery result showed lower failure of treatment with fewer additional procedures. It also showed less mortality if compared with ERCP/CS.This procedure poses clear clear discomfort to the patient. In addition,the authors cautioned that the data are little dated and modern practice context must be kept in mind.
2. *Preoperative ERCP/ES*: ERCP has the ability to remove CDS in 90% of cases.[21] However, patients with clinical and biochemical suspicion of CDS, only 20-50% will be truly positive after ERCP. The patient, therefore, is unnecessarily exposed to complications of ERCP which runs to 5-20%[11-13] as well as delayed the treatment and resultant additional cost. On the other hand, in cases where there is high pretest probability of CDS and in the absence of expertise, this procedure becomes the most cost effective strategy.[1]
3. *ERCP/ES after LC*. In patients with CDS discovered during LC, endoscopic stone clearance may be performed in another day. Reason may be due to lack of expertise to do a single stage surgery or absence of an endoscopist. A focused study by Nathanson et al. 2005[8] comparing single stage laparoscopic choledochotomy and delayed ERCP/ES for patients with failed LTCCBDE, showed no significant difference in clearance rate, morbidity and length of hospital stay.
4. A. *LTCCBDE*: Transcystic common duct exploration using dormia basket, fogarty catheter affords the patient with CDS a single stage removal of the gallbladder and the common duct stone without t tube insertion. Success rate is about 80%.[15-17,14,18,19] In cases of failure a choice between LCBDE, Intraoperative endoscopic removal of stone or postoperative stone extraction may be made.
   B. *LCBDE*: A less attractive choice than LTCCBDE, it entails a choledochotomy to extract the CDS. It demands excellent skills and more operative time than the other surgical options. Success rate ranges from 50 to 97%.[14,15,20]

Complications for ERCP

1. ERCP/ES complication
2. Pancreatitis (8%)
3. Bleeding (3%)
4. Perforation (1.5%)
5. Cholangitis (2%)
6. Recurrent stones (8%)
7. Stenosis (8%).

List of Complications for Laparoscopic Cholecystectomy

1. Wound infection (7.5%)
2. Bleeding (0.5%)
3. Abscess (0.15%)
4. Postoperative bile leak (0.75%)
5. Pulmonary embolism (0.5%)
6. Pneumonia, pulmonary(0.2%)
7. Urinary (0.2%)
8. Cardiac (0.2%)
9. Retained stones (0.2%).

Patient Selection

Age seems to be important in predicting the incidence of CDS. Under the age of 60, patients with gallstones have 8 to 15% chance of concomitant CDS and in patients over 60 years, concomitant CDS is 15 to 60%.[1]

Atherosclerotic heart disease is not an absolute contra-indication in laparoscopic CDS clearance.[22-24] Circumstantial factor such as inadequate expertise in laparoscopic procedure may result in prolonged surgery with prolonged pneumoperitonium thereby possibly increasing the intracranial pressure (ICP). Prolonged pneumoperitoneum in the background of increased ICP is a contraindication for laparoscopy[23-25] hence clinical situation dictates preoperative stone extraction or the use of open CBDE to remove the CDS.

CDS in the background of acute cholecystitis is seen in 3 to 25% of patients.[26] When considering LTCCBDE, the surgeon

must anticipate possible friable cystic duct, increase bleeding or a distorted anatomy. Presence of these inflammatory changes makes the surgery hazardous to the patient[27,28] hence open technique or postoperative endoscopic clearance must be in mind.

Morphology of the stone is very important to consider when choosing the optimum procedure. Proximal stone is less amenable to LTCCBDE. Large stone may not pass through the cystic duct. CDS larger than 9 mm are hard to remove via transcystic route.

Institutional Limitations

In the treatment of CDS, the hospital considers the availability of a good team of laparoscopic surgeons, presence of expert endoscopist and cost-effectiveness of the procedure. As compared to cholecystectomy, the presence of CDS significantly increases the mortality, morbidity and cost of treatment of the patients. The choice of doing a single stage LTCCBDE shortens hospital stay, lower cost, and lower mortality and morbidity when compared to LC with second stage ERCP/ES.[27]

In the absence of laparoscopic skill or equipment, LC with postoperative ERCP/ES may be the proper procedure to use.

Technical Expertise

In advance medical centers, a complete choice of operative and nonoperative management of CDS stone may be used.

Operative management includes transcystic CBDE, flouroscopic wirebasket retrieval, ampullary balloon dilatation, Lap CBDE, antergrade transcystic sphincterotomy, and open CBDE all of which presents their own advantages and disadvantages. Nonoperative management includes ERCP/ES, Percutaneous transhepatic stone removal, and observation. When all of the armamentarium for the treatment of CDS are present in the institution, decision is hinged on the analysis of established parameters.

CONCLUSION

Based on analyzed data from the literature search, open CBDE is still a valid procedure in the era of laparoscopy when the intended procedure is open cholecystectomy or if the medical condition precludes the use of laparoscopy. CDS when discovered during the course of LC is treated best with LTCCBDE. If the surgeon fails in the transcystic approach, either LCBDE, Intraoperative or postoperative ERCP/ES may be carried out.

There are varying circumstances that may affect the choice of procedure for CDS.[29] Surgeons may best serve their patients if parameters other than that used in standardized treatment are considered in choosing the best option for the patient.

REFERENCES

1. Consensus Development Panel. Gallstones and laparoscopic cholecystectomy. (National Institutes of Health Consensus Development Panel on Gallstone and Laparoscopic Cholecystectomy). JAMA 1993;269(8):1018-24.
2. Ko CW and Lee SP. Epidemiology and natural history of common bileduct stones and prediction of disease. Review. Gastrointestinal Endoscopy 2002;56(6 Suppl):S165-69. [MEDLINE: 1247261]
3. Lezoche E, Paganini AM. Technical considerations and laparoscopicbile duct exploration: transcystic and choledochotomy. Seminars in Surgery 2000;7(4):262-78.
4. Soltan et al. A simple scoring system for predicting bileduct stones in patients with cholelithiasis. Journal of Gastrointestinal Surgery 2001;5(4):434-37.
5. Fletcher D R. Changes in the practice of biliary surgery and ERCPduring the introduction of laparoscopic cholecystectomy to Australia: Their possible significance. Australian and New Zealand Journal of Surgery 1994;64(2):75-80.
6. Sgourakis G, Karaliotas K. Laparoscopic common bile ductexploration and cholecystectomy versus endoscopic stone extractionand laparoscopic cholecystectomy for choledocholithiasis. Aprospective randomized study. Minerva Chir 2002;57:467-74.
7. Cuschieri A, et al. EAES multicenter prospective randomized trial comparing two-stage vssingle-stage management of patients with gallstone disease andductal calculi. Surg Endosc 1999;13:952-957.
8. Nathanson LK, et al. Postoperative ERCP versus laparoscopic choledochotomy for clearance of selectedbile duct calculi: A randomized trial. Ann Surg 2005;242:188-92.
9. Rhodes M, et al. Laparoscopicexploration of the common bile duct: Lessons learned from 129 consecutive cases. Br J Surg 1995;82:666-68.
10. Martin DJ, et al Surgical versus endoscopic treatment of bile duct stones. Cochrane Database Syst Rev. Apr 2006;19:CD003327.
11. Cisek PI, Greaney GC. The role of endoscopic retrograde cholangiopancreatography with laparoscopic cholecystectomy in the management of choledocholithiasis. Am Surg 1994;60:772-76.
12. Graham SM, et al. Laparoscopic cholecystectomy and common bile duct stones. The utility of planned perioperative endoscopic retrograde cholangiography and sphincterotomy: Experience with 63 patients. Ann Surg 1993;218:61-67.
13. Jung LU, et al. Laparoscopic cholecystectomy and intraoperative ERCP. Surg Rounds 1996;19:406-12.
14. Fiore NF, et al. An analysis of perioperative cholangiography in one thousand laparoscopic cholecystectomies.Surgery 1997;122: 817-21.
15. Berthou JC, Drouard F, Charbonneau P, Moussaier K 1998.
16. Evaluation of laparoscopic management of common bile ductstones in 220 patients. Surg Endosc 12:16-22.
17. Carroll BJ, Fallas MJ, Phillips EH. Laparoscopic transcysticcholedochoscopy. Surg 1994;8:310-14.
18. Carroll BJ, Phillips EH, Dayakhovsky L. Laparoscopic choledoscopy: An effective approach to the common bile duct. J Laparoendosc Surg 1992;2:15-21.

19. Philips EH, Liberman M, Carroll BJ, Fallas MJ, Rosenthal RJ, et al. Bile duct stones in the laparoscopic era. Is preoperative sphincterotomy necessary? Arch Surg 1995;130:880-85.
20. Vracko J, Wiechel KL. How often might a transcystic-ductstone extraction be feasible? Surg Endosc 1998;12:12-15.
21. Paganini AM, Lezoche E. Follow-up of 161 unselected-consecutive patients treated laparoscopically for common bile duct stones. Surg Endosc 1998;12:23-29.
22. Carroll BJ, et al. Laparoscopic cholecystectomy in critically ill cardiac patients. Am Surg 1993;59:783.
23. Milas M, et al. Management of biliary tract stones in heart transplant patients. Ann Surg 1996;223:L747.
24. Irgau L, et al. Elective intraoperative intracranial pressure monitoring during laparoscopic cholecystectomy. Arch Surg 1995;130:1011.
25. Josephs LG, et al. Diagnostic laparoscopy increases intracranial pressure. J Trauma 1993;36:815.
26. Rosenthal RJ, et al. Intracranial pressure: Effects of pneumoperitoneumin a large animal model. Surg Endosc 1997;11:376.
27. Rattner DW, et al. Factors associated with successful laparoscopic cholecystectomy for acute cholecystitis. Ann Surg 1993;217:233.
28. Zucker KA, Flowers JL, Bailey RW, Graham SM, Buell J, Imbembo AL. Laparoscopic management of acute cholecystitis. Am J Surg 1993;165:508.
29. Lieberman MA, et al. Management of choledocholithiasis during pregnancy: A newprotocol in the laparoscopic era. J Laparoendosc. Surg 1995;5:399.

REVIEW ARTICLE

Common Bile Duct Injuries During Laparoscopic Cholecystectomy

BV Sridhar Varma

General Surgeon and Endoscopist, Neela Nursing Home, Bhadrachalam, Khammam, Andhra Pradesh, India

Abstract

Iatrogenic common bile duct injuries are the worst complication of laparoscopic cholecystectomy. The goal of this study is to increase awareness of the problem and educate surgeons about the consequences and proper management of these injuries. Cholecystectomy is the most common gastrointestinal operation performed. Laparoscopic cholecystectomy was first performed by Erich Muhe in 1985 in Germany. In 1987 laparoscopically complete removal of GB was performed by Mourat in Lyon, France. The widespread acceptance of laparoscopic cholecystectomy was based on anticipated reduction in postoperative pain, minimal tissue injury intraoperatively and early return to work. It has now become a gold standard for the treatment for GB stone in experience and safe hand.

Many articles source that soon after introduction, how it became clear that laparoscopic cholecystectomy was associated with unique complication of higher rate of CBD injures compared with open cholecystectomy. Highest rates of CBD injuries where reported in early 1990s when laparoscopic cholecystectomy was introduced, suggesting a learning curve effect. In a review by Strasburg et al and Roslyl et al, the incidence of billiary injuries during open cholecystectomy was found 0.2-0.3%. The review by Strasburg et al in 1995 of more than 124000 laparoscopic cholecystectomies reported in literature found the incidence of major bile duct injuries to be 0.5%. Even as the surgeon passed through learning curve and has reached "steady-state" and there has been no significant improvement in the incidence of billiary duct injuries. The impact of major CBD injuries is staggering to both the patient and health care system.

Keywords: CBD injury, laparoscopic cholecystectomy, complication of laparoscopy.

INTRODUCTION

Article study shows that about 95% bile injuries are minor and were irrelevant to patients out come and only 5% were major and almost always required a technologically demanding and expensive operative reconstruction of billiary tree. Inspitet of proper diagnosis and treatment of major bile duct injuries mortality rate was found to be10-12%.

As noted by WHO in 1947 health is not limited to absence of disease, fulfill of physical, mental, and social well-being, therefore the extent to which a procedure and disease process impact the physical, psychologies and social aspect of patient life and filling of well-being. Therefore to truly access a patient out come after CBD injury one must not measure the usual objective clinical outcome, but also evaluate the patients subjective health related quality of life.

In most of study it was found health related quality of life and time to returned to work among the patients who had CBD injuries during laparoscopic cholecystectomy and under went treatment at secondary and tertiary center, out comes were compared with those under went uncomplicated laparoscopic cholecystectomy.

MATERIAL AND METHOD

A literature search was performed using Google, Yahoo, Springer link, Highwire press and the following search terms were used. Iatrogenic bile duct injuries, common bileduct injuries during laparoscopic cholecystectomy, postcholecystectomy complication, long-term detrimental effect of bilduct injuries. The 15 no of quality citations reviewed were selected for these reviews.

The criteria for selection was the following:

1. At least 40 cases should be included the study especially for complicated cases.
2. Method of analysis: Retrospective analysis.
3. Type of procedure: Laparoscopic cholecystectomy using four port.
4. The institution were the procedure was practice (preference for those specialist for laparoscopic surgery).
5. Laparoscopic cholecystectomy practice: In all studies laparoscopy.
6. Cholecystectomy was performed with a standard technique using four ports.
7. Creation of pneumoperitoneum with CO_2.
8. Insertion of port followed by diagnostic laparoscopic.
9. Holding the funduss by assistant through four ports.
10. Dissections of visceral peritoneum.
11. Dissections of Calot's triangle and homeostasis maintain by using various type of energized instrument.
12. Clipping and division of cystic duct and artery.
13. Dissection of GB from liver bad.
14. Extraction of GB and any spilled stone.
15. Irrigation of suction of operating field.
16. Final diagnosis laparoscopy.
17. Removal of instrument with complete exist of CO_2.
18. Closure of wound.

DISCUSSION

In the recent past laparoscopic cholecystectomy is the gold standard of gall stone diseases, though the impact of CBD injuries staggering to both patients and health care system. After reviewing the many articles through internet. I found the so many cases of injuries and the proper management in time can decrease the serious complication and mortality. There are many factor in laparoscopic cholecystectomy regarding increase risk of CBD injury:

1. Misinterpretation of anatomy 70%.
2. Anatomical variation of Calot's triangle.
3. Risk factor.
4. Technical errors.
5. Surgeon operates on image rather than reality.
6. Anatomical variation and misinterpretation of anatomy.
7. GB is the organ having one of the most variable anatomy like.
8. Low union with common hepatic duct.
9. High union with common hepatic duct.
10. Adherent to common hepatic duct.
11. Cystic duct absent are very short.
12. Anterior spiral joining common hepatic duct left side.
13. Posterior spiral joining common hepatic duct left side.
14. Intrahepatic GB.
15. Aberrant cystic duct.

Surgeons operate on image rather than reality. Visual psychological studies show that laparoscopic surgeon works on snap interpretation by brain, and success or disasters depend on whether snaps are right or wrong. Snap interpretation will be wrong if there is eye balldegradation. Lack of initial identification and memory of the structure to the points of absolute certainty, i.e. relative anatomy. Though recall the anatomical variation of Calot's triangle but it is more important to remember the relative anatomy to minimize the risk of CBD injury. Though so many articles published regarding preoperative cholangiography regarding the CBD injury like: David R Flum , Thomas Koepsell, Patrik Hegarty, et al. Arch Surg 2001:136:1287-92 claiming some decrease risk of CBD injury but in my opinion it is not much helpful because surgeon works on relative anatomy rather than absolute anatomy. A little bit advantage of chalcographic is compensated by the injury to cystic duct during processor and increase operative time of processor and little risk of injury during procedure itself. Though preoperative cholangiography is helpful in diagnosis of stones in billary duct and to treat them in same time.Therefore now, days it is matter of choice from center to center to do the intraoperative cholangiography. In the same way the high resolution ultrasound preoperatively is not much helpful because it is not of much help in interpretating the billary channel. It can only interpretate bile duct dilatation and any stone or debris in spite of cost and specialty involving.

After the introduction of laparoscopic cholecystecomy in the late decade of 1980, the field of general surgery was revolutionized. After the study of the many articles about laparoscopic cholecystectomy and bile duct injuries, it was found that laparoscopic cholecystectomy had many benefits to patient's like less pain, less blood loss during operation, decreased hospital stay and earlier return to normal activities. Inspite of these benefits unfortunately the data of many studies show a higher incidence of CBD injuries when compared with open cholecystectomy (atleast 0.4 to 0.5% *vs* 0.1 to 0.2% respectively). After review of many articles about CBD injuries regarding risk factor of injuries their proper management and long-term detrimental effect of bile duct injury on health and quality of life, it is still a gold standard for treatment of symptomatic gallstone disease uncomplicated gallbladder diseases like mucocoele, empyma, cholesterosis, porcelain GB, adenomatous polyp of GB.

RISK FACTOR

Many studies show that the risk factor increases the chance of CBD injury. Many studies like a/population base study of 152776 cholestomoty in sweet disk by Anne Waugh, MD, PhD, Magnus Nilsson, MD, PhD, show that old age, male sex, increase the risk of CBD injuries. In the same group the injuries were three times more, when performed in acute cholecystis compared to elective and even more risk in acute to chronic cholecystitic when GB is inflamed and fibrosed.

TECHNICAL ERRORS

All the articles like Strasbarg et al in 1995 of more than 124000 Laparoscopic cholecystotomies reported that high rate of billary injury was due in part of learning curve effect, as surgeonpassed through learning curve have reached, steady-state, there has been no significant in the improvement of incident of billary duct injuries. Major associations have established specific guide lines to avoid this dreaded complication in 1991 Hunter noted that bill duct injury in laparoscopic cholecystectomy appear to more common in US (0.5 to 2.7%) than in Europe 0.33%. He observed that American teaching stressed cephalic (towards the right shoulder) traction of the infundibulum in GB tenting the CBD in risking its miss identification. European teaching stressed the lateral retraction places the cystic duct at right angle to CBD reducing the likely hood of miss identification.

After studying many articles regarding CBD injury in recommendation of guide line for clinical application in laparoscopy cholecystectomy by many associations like society of American gastrointestinal endoscopic surgeons, it is found that:

1. Try to memorize the initial anatomy of Calot's triangle surgeon should concern more about relative anatomy than initial anatomy.
2. Surgeon must clearly identify the cystic duct at its junction with GB.
3. A large distended GB should be aspirated and lifted rather than grasped.
4. The surgeon should retract the GB infoundibulm laterally rather than in cephalic direction and avoid force fully pulling up of GB can cause tenting of CBD.
5. The surgeon should meticulously dissect the cyst duct and cyst artery.

6. The surgeon should limit the use of all energy sources and prefer pledged dissection near the CBD and recognized that they can cause occult injury.
7. Use suction and irrigation frequently.
8. The surgeon should not hesitate to convert to an open operation for technical difficulties, anatomy uncertainties or anatomical anomalies.
9. The surgeon need to see all structure clearly before dividing any ductal structure.
10. Peroperative cholangioraphy may be a little helpful to avoid bill duct injury, but it is quite helpful to diagnose bill duct injury at the same time allowing first appropriate treatment at the same time.
11. Surgeon should prefer extracorporeal knotting as mass legation just below the GB.
12. Neck in cases of difficult dissection of cyst duct and artery.

BILE DUCT

Biliary tree is the whole network of various size ducts branching through liver path is as follows:

Bilicalculi – Canals of hering – Interlobular bile duct – Intra-hepatic bile duct – Right and left hepatic bile duct merge to form – Common hepatic duct and join cystic duct form – Common bile duct (join pancreatic duct) form ampulla of vater and enters the second part of duodenum.

The Bismuth classification for bile duct injury is:
Type I – CHD stump > 2 cm.

Type II – CHD stump < 2 cm.

Type III – Hilar right and left duct injury with confluence intact.

Type IV – Hilar separation of right and left duct.

Type V – Injury to aberrant right duct ± CBD injury.

In 1995 Strasberg and Soper modified the Bismuth classification of bile duct injury.

1. Type A – Bile leak from a minor duct still in continuity with the common bile duct.
   These leaks occur at the cystic duct or from the liver bed.
2. Type B – Occlusion of part of the biliary tree. Usually the result of an injury to an aberrant right hepatic duct. In 2% of patients, the cystic duct enters a right hepatic duct rather than the common bile duct–Common hepatic duct junction. The aberrant duct may be a segmental duct, a sectoral duct (the right anterior or posterior duct), or even
3. Type C – Bile leak from duct not in communication with common bile duct.
   Usually diagnosed in early postoperative period as an intraperitoneal bile collection.
4. Type D – Lateral injury to extrahepatic bile ducts. May involve the common bile duct, common hepatic duct, or the right or left bile duct.
5. Type E – Circumferential injury of major bile ducts. This type of injury causes separation of hepatic parenchyma from the lower ducts and duodenum. May be treated by percutaneous or endoscopic techniques depending on length of stenosis or if.

Classification of Biliary Duct Injuries

If complication recognized intraoperatively:

1. For high complete transaction Roux-en-y hepatojejuno-stomy.
2. For lower complete injuries – Primary suture repair over T tube.
3. Long end of T-Tube most not be exteriorized from same side for partial injuries insertion of T-tube and Roux-en-y serosal patch.
   Strategy to handle complication recognized postoperatively Ultrasound + ERCP + MRCP + PTC.

After the detecting the injury or other complication due to bile duct injury, after resuscitation the patient, is treated with fluid + electrolytes + systemic antibiotic.

Patient should be reffered to appropriate center like: secondary or tertiary center for further management accordingly The principal of treatment is to re-establish a pressure gradient that will favour the follow of bile into the duodenum not outside the leak side like:

1. Conservative treatment and billiary drainage for 6 weeks by ERCP stent- insertion.
   Or PTBD if endoscopic stent application is not possible.
2. Some times internal stenting with or without sphincterotomy is effective in treatment of small leaks.
3. A retrospective study by De Palana, et al in 2002 showed that sphincterotomy alone was highly effective in producing closure of bile fistulas by reducing endobilliary pressure.
4. After several weeks, reconstative surgery like Roux-en-y cholecystectomy or hepato jejunostomy should be performed if necessary.

CONCLUSION

The principal difference form surgeon's perspective between laparoscopy and open cholecystectomy is the lack of three dimensional views of structures to be manipulated. During laparoscopy procedure a surgeon is guided by a two dimensional image seen on a television and screen depth perception is affected. That required higher level of coordination and patience. After diagnosing the CBD injury during operation it should be repaired with appropriate method either open or laparoscopically. If diagnosed in postoperative period then it should be always managed in secondary or tertiarycenter with the operate methods with fully skilled surgeon. Inspite of a little more risk of bile duct injury. Laparoscopic cholecystectomy is still the gold standard of method for GB stone diseases due to other benefits over open cholecystectomy. After taking care of possibilities of CBD injury, early diagnosis and proper management, laparoscopic cholecystectomy is still the gold standard for GB stone diseases.

BIBLIOGRAPHY

1. Adamsen S, Hansen Oh, Funch- Jensen P, Schulze S, stage JG, Ware P. Bile duct injury during laparoscopic Cholecystectomy: A prospective nationwide series. J Am Coll Surg 1997;184:571-78.
2. Archer Sb, Brown DW, Smith CD, Branum GD, Hunter JG. Bile duct injury during laparoscopic Cholecystectomy: Results a national survey. Ann Surg 2001;234:549-58.
3. Boerma D, Rauws EA, Keulemans YC, et al. Impaired quality of life 5 years after bile duct injury during laparoscopic Cholecystectomy: A prospective analysis. Ann Surg 2001;234:750-57.
4. Calvete J, Sabater L, Camps B, et al. Bile duct injury during laparoscopic Cholecystectomy: Myth or reality the learning curve? Surg Endosc 2000;14: 608-11.
5. Caroll BJ, Birth M, Phillips EH. Common bile duct injuries during laparoscopic. Cholecystectomy that result in litigation. Surg Endosc 1998;12:310-14.
6. Chen XR, Lou D, Li Sh, et al. Avoiding serious complication in laparoscopic. Cholecystectomy –lessons learned from an experience of 2428 cases. Ann Acad Med Singapore 1996;25:635-39.
7. Cox Mr, Wilson TG, Jeans PL, et al. Minimizing the risk of bile duct injury at laparoscopic Cholecystectomy. World J Surg 1994;18:422-27.
8. Fletcher Dr Hobbs MS, Tan P, et al. Complication of Cholecystectomy: Risks of the laparoscopic approach and protective effects of operative cholangiography: A population-based study. Am Surg 1999;229;449-57.
9. Flowers JL, Zucker KA, Graham SM, et al. Laparoscopic cholangiography: Result and indicatina. Ann Surg 1992;215:209-16.
10. Gouma DJ, Go PM Bile duct injury during laparoscopic and congenital Cholecystectomy. J Am Coll Surg 1994;178:229-33.
11. Hawasli A. Does routine cystic duct cholangiogram during laparoscopic. Cholecystectomy prevent common bile duct injury? Surg Laparosc Endosc 1993;3:290-95.
12. Huang CS, Lein HH, Tai FC, Wu Ch. Long-term results of major bile duct injury associated with laparoscopic Cholecystectomy. Surg Endosc 2003;17:1362-67.
13. Hunter JG, Avoidance of bile duct injury during laparoscopic Cholecystectomy. Am J Surg 1991;162:71-76.
14. Kullman E, Borch K, Lindstrom E, et al. Value of routine intraopeartive cholangiography in detecting aberrant bile ducts and bile duct injuries during laparoscopic Cholecystectomy. Br J Surg 1996; 83:171-75.
15. Lorimer JW, Fairfull-Smith RJ. Intraopeartive cholangiography during laparoscopic Cholecystectomy.
16. MacFadyen BV Jr. Vecchio R, Ricardo AE, Mathis CR. Bile duct injury after laparoscopic Cholecystectomy: The United States experience. Surg Endosc 1998;12:315-21.
17. Melton Gb, Lilemoe KD, Cameron JL, Saute PA, Coleman J, et al. Major bile duct injuries associated with laparoscopic Cholecystectomy: Effect of surgical repair on quality of lie. Ann Surg 2002;235:888-95.
18. Perissat J. Laparoscopic Cholecystectomy: The European experience. Am J Surg 1993;165:444-49.
19. Prof Dr RK Mishra. Essentials of laparoscopy New Delhi, M/s all Medical Publisher 2005.
20. Prof Dr RK Mishra. Textbook of practical laparoscopic surgery New Delhi, Jaypee Brothers Medical Publisher 2008. Jordan AB; Hospital charges for laparoscopic and open Cholecystectomy (letter), JAMA 226(24).
21. Raute M, Podlech P, Jaschke W, et al. Mangement of bile duct injuries and strictures following Cholecystectomy. World Surg 1993;17:914-18.
22. Richardson MC, Bell G, Fullarton GM, West of Scotland Laparoscopic Cholecystectomy Audit Group. Incidence and nature of bile duct injuries following laparoscopic Cholecystectomy: An audit of 5913 cases. Br J Surg 1996;83:1356-60.
23. Roslyn JJ, Binns GS, Hughes EF, Sauders-Kirkwood K, Zinner MJ, Cates JA. Open Cholecystectomoy: A contemporary analysis of 42,474 patients. Ann Surg 1993;218:129-37.
24. Sabharwal AJ, Minford EJ, et al. Laparoscopic cholangiography: A prospective study. Br J Surg 1998;85:624-26.
25. Schol FP, Go PM, Gouma DJ. Outcome of 49 repairs of bile duct injuries after laparoscopic. World J Surg 19:753-57.
26. Strasberg SM, Herti M, Soper NJ. An analysis of the Problem of billiary injury during laparoscopic Cholecystectomy. J Am Coll Srug 1995;180:101-1255.
27. Targarona EM, Marco C, Balague C, et al. How, when, and why bile duct injury occurs: A comparison between open and laparoscopic Cholecystectomy. Surg Endosc 1998;12:322-26.
28. Taylor B. Common bile duct injury during laparoscopic Cholecystectomy in Onatrio: Does ICD-9 Coding indicate true incidence? CMAJ 1998;158:481-85.
29. Windsor JA, Pong J. Laparoscopic billiary injury: More than a learning curve problem. Aust N Z J A Surg 1998;68:186-89.
30. Woods MS, Traverso WL, Kozarek RA, et al. Characteristics of biliary tract complication during laparoscopic Cholecystectomy: A multi-institutional study. A J Surg 1994;167:237-34.
31. Wright KD, Wellwood JM. Bile duct injury during laparoscopic Cholecystectomy without operative cholangiography. Br J Surg 1998;85:191-94.
32. Wudel LJ Jr, Wright JK, Pinson CW, et al. Bile duct injury following laparoscopic Cholecystectomy: A cause for continued concern. Am Surg 2001;67:557-63.

Roscopic Cholecystectomy. Br J Surg 1996;83:171-75.

REVIEW ARTICLE

Open versus Laparoscopic Adrenalectomy for Multiple Adrenal Disorders

Malikendra Patel

Laparoscopic Surgeon and Endoscopist, Ipsaa Endoscopy Center, Khandwa, Madhya Pradesh, India

Abstract

In this review article, twelve articles were reviewed from 1998-march 2009 and analyzed, treatment and management of different adrenal surgical problems were reviewed including pheochromocytoma, functional adenoma, adrenal cortical carcinoma, adrenal metastasis and primary adrenal malignancies. The studies were taken from Journal of clinical endocrinology and metabolism, annals of surgical oncology, Google, Springerlink, The Hongkong medical diary, ANZ journal of surgery. Evaluation of the safety of laparoscopic adrenalectomy in comparison open treatment was done.

Conclusion: Laparoscopic adrenalectomy should be the treatment of choice for all benign and certain malignant adrenal tumors. Laparoscopic resection of large adrenal tumors needs experienced surgeons in open and advanced laparoscopic surgery.

Keywords: Adrenalectomy, functional adenoma, adrenal cortical carcinoma, adrenal metastasis, pheochromacytoma, open *versus* laparoscopic surgery.

INTRODUCTION

Adrenal masses are one of the most prevalent of all human tumors. The prevalence of adrenal masses approaches 3% in middle age, and increases to as much as 7% in the elderly. [1] It is anticipated that the management of adrenal masses will be a growing clinical challenge in our aging society because of its high prevalence in the elderly and the increased use of abdominal imaging studies.

A. Functional Adenoma

If history or physical examination of a patient with a unilateral adrenal mass shows signs and symptoms suggestive of glucocorticoid, mineralocorticoid, adrenal sex hormone that is confirmed biochemically, adrenalectomy is often considered the treatment of choice. In the absence of clinical symptoms; treatment decisions for patients with biochemical evidence of cortisol hypersecretion present a vexing problem. While adrenalectomy has been demonstrated to correct biochemical abnormalities, its effect on long-term outcome and quality of life is unknown. Either adrenalectomy or careful observation has been suggested as a treatment option.

B. Pheochromocytoma

Pheochromocytoma is among the most life-threatening endocrine diseases, particularly if it remains undiagnosed. Patients even with "silent" pheochromocytomas are at risk for a hypertensive crisis and should undergo adrenalectomy.

C. Adrenocortical Carcinoma

In patients with nonfunctioning adrenal masses, distinguishing between malignant and benign primary adrenal tumors guides subsequent management. Variables to consider are the size of the lesion, its imaging characteristics, and its growth rate. Traditionally, the size of the lesion has been considered to be the major determinant of the presence of a malignant tumor. More than 60% of the adrenal masses less than 4 cm are benign adenomas, while less than 2% represent primary adrenocortical carcinomas. In contrast, the risk for carcinoma increases to 25% in lesions that are greater than 6 cm, while benignadenomas account for less than 15%. Therefore, the generally accepted recommendation is to excise lesions that are larger than 6 cm. Lesions that are less than 4 cm and are defined as low risk by imaging criteria are unlikely to have malignant potential and are generallynot resected. For lesions between 4 cm and 6 cm, either close follow-up or adrenalectomy is considered a reasonable approach. Adrenalectomy should be strongly considered if the imaging findings suggest that the lesion is not an adenoma.

D. Metastases

The adrenal glands are frequent sites for metastases from many cancers. Lymphoma and carcinoma of the lung and breast account for a large proportion of adrenal metastases. Other primary cancers include melanoma, leukemia, and kidney and ovarian carcinoma. In a review of 1000 consecutive autopsies of patients with carcinoma, the adrenal glands were involved in 27% of the cases.[4] The incidence of adrenal metastases in patients with breast and lung cancer is approximately 39 and 35%, respectively. [4,5] Among cancer patients, 50-75% of clinically in apparent adrenal masses are metastases.[6] There is no established clinical benefit to be derived form adrenalectomy in those patients who are diagnosed with a metastasis from a known primary neoplasm. Nevertheless; long-term survival has

been reported in selected patients, after resection of isolated adrenal metastases.[7] Since then, many series have confirmed that when metastasis is isolated to the adrenal gland, adrenalectomy by open or laparoscopic approach can achieve long-term survival.[8]

E. Others

Generally, myelolipoma and adrenal cyst are benign lesions that require no therapy. Larger, symptomatic or rapidly growing tumors are treated with adrenalectomy, which is usually curative. Infections, especially tuberculosis and histoplasmosis, can also manifest themselves as an adrenal mass. Surgery may be indicated if medical treatment is ineffective.

OBJECTIVE

The aims of this study is evaluating the efficacy, safety and outcome of laparoscopic adrenalectomy for all adrenal benign and malignant tumors in comparison with open surgery, and also determine the risk factors which influence the outcome to identify those patients that are not good candidates for laparoscopic approach.

MATERIAL AND METHODS

A literature search was performed using search engine Google, High Wire Press, Springer Link and library facility available at laparoscopic hospital. Journal of clinical endocrinology and Metabolism. The Hongkong medical diary and ANZ journal of surgery.

TREATMENT

Surgical treatment is the only option. Preoperatively in all patients with preoperative signs and symptoms of catecholamine excess, alpha-adrenergic blockade was started 10 days to 2 weeks before surgery. For patients with tachycardia, beta-blockade was added. Patients with alpha blockade-induced orthostatic hypotension were treated with oral and/or intravenous volume loading during the 24 to 48 hours prior to surgery. Patients were infused with 1 to 2 L of crystalloid solution for intravascular volume expansion in the preoperative holding area. It is wise to have all patients an arterial line and 2 large-bore peripheral intravenous lines or a central venous line placed prior to the induction of general anesthesia.

SURGICAL TECHNIQUE

The adrenalectomies can be performed laparoscopically through a lateral decubitus or supine transperitoneal approach, or lateral retroperitoneal approach.[1,2] Briefly, a diagnostic laparoscopy was performed at the beginning of each procedure to rule out local tumor invasion or diffuse metastatic spread. The lateral decubitus transperitoneal approach; which is the most popular; starts with three subcostal ports (5-12 mm) allowed for the introduction of a 30° laparoscope and 2 working instruments. During right adrenalectomies, a fourth 5 mm port was placed in a subxyphoid position for liver retraction. Occasionally during left adrenalectomies, a fourth port was added below the tip of the left twelfth rib to provide blunt retraction of the kidney and/or adrenal gland. This technique was particularly useful for larger tumors, which often encroached upon the vascular hilum of the kidney, making exposure of the adrenal vein difficult. Early ligation and division of the adrenal vein was carried out prior to gland manipulation and dissection when possible.

For right adrenalectomies, the right hepatic lobe was completely mobilized to provide adequate visualization and safe access to the vena cava and adrenal vein. The triangular ligament was incised to the level of the diaphragm. The retroperitoneum was then opened longitudinally along the medial aspect of the adrenal gland, and immediately adjacent to the lateral edge of the liver, until the vena cava was clearly identified.

Development of the plane between the inferior vena cava and the medial margin of the gland was performed to expose the right adrenal vein. Early dissection and mobilization of the inferior retroperitoneal attachments to the tumor increased gland mobility and made venous control considerably safer.

On the left, the splenic flexure was mobilized to allow access to the splenorenal ligament. The retroperitoneal plane superficial to gerota fascia was developed to the level of the diaphragm, allowing for medial rotation of the spleen and the pancreatic tail. A complete medial rotation of adjacent structures was critical to provide adequate exposure of the adrenal gland and vein. Gerota fascia was incised medial to the superior pole of the kidney to provide access to the left adrenal vein and the adrenal gland. The vein was then ligated and divided at its confluence with the left renal vein.

On either side, the borders of the adrenal gland were first identified and then dissected away from the retroperitoneum, using periadrenal fat as a "handle". The larger glands, especially those greater than 5 cm, were most often resected with periadrenal fat, exposing the psoas muscle from the renal hilum cephalad to the diaphragm. The gland was never grasped to avoid hemodynamic liability, troublesome bleeding, or tumor disruption. Large adrenal veins, typically those greater than 7 mm in width, were divided with an endovascular stapler. Specimens were placed into an impervious extraction bag prior to morcellation (if necessary) and removal. The peritoneum and fascia at the trocar sites were closed endoscopically.

POSTOPERATIVE CARE

Crystalloid fluid challenge to treat postoperative hypotension. NG-tubes as indicated. Clear liquids can be given on the same night after surgery. Patients were discharged 3-5 days. Follow-up in OPD at 7 to 10 days and another at 3 to 4 weeks postoperatively, and subsequently as needed. Long-term follow-up included frequent blood pressure monitoring for the first year, then yearly thereafter. Urinary metanephrine levels are followed annually for a period of 5 years.

COMPLICATIONS

The advent of laparoscopy for advanced surgical procedures has given rise to specific risks of intraoperative complications. Complications being reported in the literature included tissue injury (liver, spleen, pancreas, kidney, duodenum and colon), vascular injury (hepatic artery, splenic artery, venal cava and adrenal veins), and major hemorrhage. Postoperative complications such as hematoma, infection and port-site herniation have also been reported. The overall complication rates reported in various literatures, including the local one, were around 4%, and the mortality was less than 1%.[2,11-13] The conversion rate was around 4-5% for various approaches of laparoscopic adrenalectomy. In most cases, the reason for conversion was bleeding, difficult dissection, or intraoperatively suspected malignancy.

OUTCOME AND ANALYSIS

Compared with those who underwent a standard open approach, patients undergoing a laparoscopic adrenalectomy have demonstrated decreased perioperative morbidity, shorter hospitalization, and faster functional recovery.[3-4]

DISCUSSION

Surgical treatment offers the cure for all adrenal tumors (benign or malignant). Despite the improvements in perioperative medical management, anesthesia, and surgical techniques, adrenalectomy for adrenal tumors carries morbidity rates as high as 40% and perioperative mortality rates of 2 to 4%.[5] Fears of cardiovascular instability due of excessive catecholamine release caused by the pneumoperitoneum and/or laparoscopic dissection have urged concerns over the role of laparoscopy in adrenalectomy. Continuous invasive monitoring and pharmacologic intervention by an experienced anesthesia team are necessary to avoid substantial cardiovascular instability. The surgeon must avoid excessive tumor manipulation, which can result in catecholamine release. Tumor manipulation has been shown to be the most important intraoperative factor for catecholamine release during both open and laparoscopic adrenal resections.[6-8] Fernandez-Cruz et al[9] demonstrated that mean plasma norepinephrine and epinephrine increased 13.7 and 34.2-fold during open tumor manipulation.

Thompson and associates[25] performed a matched case-control study comparing 50 patients having open adrenalectomy to 56 patients having adrenalectomy through a posterior approach. They found that LA, compared to OA, was significantly associated with shorter hospital stay, less postoperative narcotic use, more rapid return to normal activity, increased patient satisfaction, and less late morbidity. However, the laparoscopic procedure was associated, with longer operating room time and higher cost. Similar results have been reported by Prinz[26] and by Brunt et al,[27] who found that LA had distinct advantages compared to OA. Laparoscopic tumor manipulation was associated with a significantly diminished increase in plasma catecholamine levels (norepinephrine, 8.6-fold; epinephrine, 17.4-fold).[24] Rocha et al[6] also reported that such hormonal release occurs despite an early adrenal vein ligation, likely due to the extensive vascularity of pheochromocytomas. Careful adrenal dissection, using periadrenal fat as a handle, with minimization of direct manipulation or compression of the gland itself, is critical to avoid catecholamine release. Intra-abdominal insufflation during laparoscopic pheochromocytoma excision may alone cause an increase in serum catecholamines.[6-10]

This stimulus may be via either a direct tumor compression or a change in tumor perfusion. The pneumoperitoneum with CO_2 may lead to hypercapnia and acidosis, which, in turn, are known stimuli of catecholamine secretion and hypertension.[6-11] Rocha et al found a more than 10-fold elevation in catecholamines during abdominal insufflation to 12 mm Hg with CO_2, with about 50% of patients experiencing hypertensive episodes.[6] As a result, helium has been suggested as an alternate insufflation agent to eliminate the deleterious effects of CO_2 during laparoscopic adrenalectomies for adrenal tumors. In a prospective evaluation of 11 patients undergoing helium insufflation during laparoscopic pheochromocytoma resection, the authors demonstrated that its use avoided significant intraoperative hypercarbia or acidosis and provided greater intraoperative hemodynamic stability.[7] Interestingly, though, there were no differences between the CO_2 and the helium insufflation groups in either serum catecholamine surges or overall surgical outcomes.[7] When compared with other indications for adrenalectomy, laparoscopic resection of adrenal tumors, results in longer operative times, higher complication rates, and longer hospitalization. With growing experience using advanced laparoscopic techniques, conversion rates have decreased from 22 to 0-4%.[12-14] The "learning curve" may play a significant role in improving the efficiency and safety of advanced laparoscopic procedures. Extreme care must be exercised to avoid intraoperative capsular disruptions and possible iatrogenic pheochromocytomatosis. Li et al[15] reported 3 cases of pheochromocytoma recurrence 3 to 4 years after initial laparoscopic resection and possible tumor spillage. As a result, many investigators have suggested that laparoscopy be avoided for pheochromocytomas larger that 7 to 8 cm.[12-17] Conversion to an open procedure is warranted, however, when laparoscopic dissection cannot be performed safely or a complete resection cannot be performed without undue trauma to the gland.

It has been agreed by several authors that a posterior retroperitoneal LA is preferable to an anterior LA, especially inpatients who have either bilateral adrenal tumors, prior toextensive abdominal procedures with resultant adhesions and scar tissue formation, or pre-existing cardiopulmonary disease.[18,19] Posterior LA is not indicated in patients with large adrenal tumors. The absolute contraindications for laparoscopic adrenalectomy include primary or metastatic invasive adrenal malignancies because extensive *en bloc* surgery and node dissection will be necessary. As well as coagulopathy, which can't be controlled preoperatively. Size of the tumor correlates with malignant potential. Weight greater than 100 gm or size

equal to 6 cm is highly suggestive of malignancy[20,21] Laparoscopy is a limited approach to the adrenal, requiring manipulation of the gland to remove it. In patients with cancer,wide resection of the gland with contiguous structures provides the best chance for cure.[22]

The lateral transperitoneal approach is preferred over the retroperitoneal approach because of improved working space and gland visualization.[23] The resected gland is removed from the port site in an occlusive bag to decrease peritoneal implantation and port site recurrence.

The question is not weather laparoscopic adrenalectomy foradrenal tumors should be done or not, but by whom should it be performed. A surgeon who is very proficient laparoscopically and significantly knowledgeable about adrenal anatomy may be able to perform this operation in a hospital that offers an appropriate level of anesthesia and ICU care.

CONCLUSION

laparoscopic resection of bening adrenal tumors can be performed safely with a short hospital stay and few complications; minimally invasive adrenalectomy for large tumors has historically been controversial. Lesions larger than 6 cm are associated with longer operative times than smaller lesions, but they are not associated with greater blood loss, higher rates of intraoperative hemodynamic instability, or longer hospital stay.

REFERENCES

1. Heniford BT, Arca MJ, Walsh RM, Gill IS. Laparoscopic adrenalectomy for cancer. Semin Surg Oncol 1999;16:293-06.
2. Gagner M, Pomp A, Heniford BT, et al. Laparoscopic adrenalectomy: Lessons learned from 100 consecutive procedures. Ann Surg 1997;226:238-46; discussion 246-47.
3. Brunt LM. The positive impact of laparoscopic adrenalectomy on complications of adrenal surgery. Surg Endosc 2002;16:252-57.
4. Jacobs JK, Goldstein RE, Geer RJ. Laparoscopic adrenalectomy: A new standard of care. Ann Surg 1997;225:495-01; discussion 501-02.
5. Werbel SS, Ober KP. Pheochromocytoma: Update on diagnosis, localization, and management. Med Clin North Am 1995;79:131-53.
6. Flavio Rocha M, Faramarzi-Roques R, Tauzin-Fin P, et al. Laparoscopic surgery for pheochromocytoma. Eur Urol 2004;45:226-32.
7. Fernandez-Cruz L, Saenz A, Taura P, et al. Helium and carbon dioxide pneumoperitoneum in patients with pheochromocytoma undergoing laparoscopic adrenalectomy. World J Surg 1998;22:1250-55.
8. Marty J, Desmonts JM, Chalaux G, et al. Hypertensive responses during operation for phaeochromocytoma: A study of plasma catecholamine and haemodynamic changes. Eur J Anaesthesiol 1985;2:257-64.
9. Fernandez-Cruz L, Taura P, Saenz A, et al. Laparoscopic approach to pheochromocytoma: Hemodynamic changes and catecholamine secretion. World J Surg 1996;20:762-68; discussion 768.
10. de La Chapelle A, Deghmani M, Dureuil B. Peritoneal insufflation can be a critical moment in the laparoscopic surgery of pheochromocytoma. Ann Fr Anesth Reanim. 1998;17:1184-85.
11. Rose CE Jr, Althaus JA, Kaiser DL, et al. Acute hypoxemia and hypercapnia: Increase in plasma catecholamines in conscious dogs. Am J Physiol 1983;245:H924-29.
12. Cheah WK, Clark OH, Horn JK, et al. Laparoscopic adrenalectomy for pheochromocytoma. World J Surg 2002;26:1048-51.
13. Kercher KW, Park A, Matthews BD, et al. Laparoscopic adrenalectomy for pheochromocytoma. Surg Endosc. 2002;16:100-02.
14. Kim AW, Quiros RM, Maxhimer JB, et al. Outcome of laparoscopic adrenalectomy for pheochromocytomas vs aldosteronomas. Arch Surg 2004;139:526-29; discussion 529-31.
15. Li ML, Fitzgerald PA, Price DC, et al. Iatrogenic pheochromocytomatosis: A previously unreported result of laparoscopic adrenalectomy. Surgery 2001;130:1072-77.
16. Inabnet WB, Pitre J, Bernard D, et al. Comparison of the hemodynamic parameters of open and laparoscopic adrenalectomy for pheochromocytoma. World J Surg 2000;24:574-78.
17. Staren ED, Prinz RA. Adrenalectomy in the era of laparoscopy. Surgery 1996;120:706-709; discussion 710-11.
18. Walz MK, Peitgen K, Hoermann R, Giebler RM, Mann K, Eigler FW. Posterior regroperitoneoscopy as a new minimally invasive approach for adrenalectomy: Results of 30 adrenalectomies in 27 patients. Word J Surg 1996;20:769-74.
19. Bonjer HJ, Lange JF, Kazemier G, deHerder WW, Steyerberg EW, Bruining HA. Comparison of three techniques for adrenalectomy. Br J Surg 1997;84:679-83.
20. Ross NS, Aron DC. Hormonal evaluation of a patient with an incidentally discovered adrenal mass. N Engl J Med 1990;323:1401-07.
21. Page DL, DeLellis RA, Hough AJ. Tumors of the adrenal. In: HartmannWH, Cowan WR (Eds). Atlas of Tumor Pathology. Washington Armed Forces Institute of Pathology 1986;1-06.
22. Soper NJ, Brunt LM, Kerbl K. Laparoscopic general surgery, 1994.
23. Duh QY, Siperstein AE, Clark OH, et al. Laparoscopic adrenalectomy:Comparison of the lateral and posterior approaches. Arch Surg 1996;131:870-76.
24. Gagner M, Lacroix A, Bolte E. Laparoscopic adrenalectomy in Cushing's syndrome and pheochromocytoma. N Engl J Med 1992;327:1033.
25. Thompson GB, Grant CS, van Heerden J, et al. Laparoscopic versus open posterior adrenalectomy: A case-control study of 100 patients. Surg 1997;6:132-36.
26. Prinz RA. A comparison of laparoscopic and open adrenalectomies. Arch Surg 1995;130:489-94.
27. Brunt LM, Doherty GM, Norton JA, Soper NJ, Quasebarth MA, et al. Laparoscopic adrenalectomy compared to open adrenalectomy for benignadrenal neoplasms. J Am Coll Surg 1996;183:1-10.

REVIEW ARTICLE

Laparoscopic Radical Hysterectomy versus Open Radical Hysterectomy for Carcinoma Cervix Stage 1

SB Naval

Consultant, Obstetrician and Gynecologist, Naval Hospital and IVF Center, Jalgaon-425001, Maharashtra, India

Abstract

The present review has considered good number of studies involving fair large number of patients operated with both modalities for carcinoma cervix stage 1. Minor differences in the operative techniques are ignored. Overall operation time for laparoscopic procedures was required more. Incidence of intraoperative complication was also higher in addition to inherent complications related to pneumoperitoneum. However, results in terms of disease free survival between the groups were comparable.

Advantages pertaining to reduced hospital stay and better cosmesis with laparoscopic modality at present do not outweigh the higher incidence of intraoperative complication than that in open radical hysterectomy group.

Keywords: Radical hysterectomy, stage 1 cancer cervix, laparoscopy.

INTRODUCTION

In Indian population cervical cancer is in the first position amongst cancers of reproductive organs. Even in the patients where detection of disease is not very late the easy and fully satisfactory modality of treatment still is been searched. Advent of modern technology has made available laparoscopic mode. It is worthwhile to find whether the laparoscopic radical hysterectomy with pelvic and para-aortic lymadenectomy is a better option.

METHODOLOGY

Scope of review of published articles on this subject was made available through the search into Google, Highwire Press, Yahoo, and Surgical Endoscopy journals.

REVIEW ARTICLES

In a study at the university of Puerto Rico nineteen women underwent laparoscopic radical hysterectomy or laparoscopically assisted vaginal radical hysterectomy, with pelvic node dissection and para-aortic node dissection when indicated. One procedure was converted to laparotomy due to equipment failure, two minor postoperative complications. The second was incisional bleeding, which was controlled with sutures applied using a local anesthetic, there have been no incidents of recurrence.[1]

Study of patients treated by laparoscopic-assisted radical vaginal hysterectomy (LARVH) with time-matched radical abdominal hysterectomy (RAH) controls at our center. Records of all patients with FIGO stage IA/IB cervical cancer undergoing radical surgery was studied.

Results: Between November 1996 to December 2003,71 and 205 patients have undergone LARVH and RAH, respectively, for FIGO stage IA/IB carcinoma of the cervix. Both groups were similar with respect to age and Quetelet index. All laparoscopic procedures were completed successfully with no conversions to laparotomy. Intraoperative morbidity characteristics analyzed (LARVH *vs* RAH) were blood loss 300 ml *vs* 500 ml ($P < 0.001$), operative time 3.5 hours *vs* 2.5 hours ($P < 0.001$), and intraoperative complications 13% *vs* 4% ($P < 0.03$). Intraoperative complications in the LARVH group included: cystotomy (7), ureteric injury (1), and bowel injury.[1] There was no difference in transfusion rates. There was no difference between postoperative infectious and noninfectious complications (LARVH *vs* RAH), 9% *vs* 5% and 5% *vs* 2%, respectively. The median time to normal urine residual was 10 days *vs* 5 days ($P < 0.001$), and the median length of hospital stay was 1 day *vs* 5 days ($P < 0.001$). After a median follow-up of 17 and 21 months, there have been 4 recurrences in the LARVH group and 13 in the RAH ($P = NS$). The overall 2 years recurrence-free survival was 94% and 94% in the LARVH and RAH groups, respectively ($P = NS$). The major benefits are less intraoperative blood loss and shorter hospital stay. It is a safe procedure with low overall morbidity and complication rates. However, at present, LARVH is associated with an increase in intraoperative complications, and patients may have an increased time to return to normal bladder function.[2]

STUDY DESIGN–1

Seventy-eight consecutive patients with stage IA[2] and IB cervical cancer with at least 3 years of follow-up consented to

undergo this surgical procedure with argon beam coagulation and endoscopic staplers. Sixty-eight patients had squamous cell carcinomas; 8 patients had adenocarcinomas, and 2 patients had adenosquamous carcinomas of the cervix.

Results: All but 5 surgical procedures were completed laparoscopically. The average operative time was 205 minutes (range, 150-430 minutes). The average blood loss was 225 mL (range, 50-700 mL). One patient (1.3%) had transfusion. Operative cystotomies occurred for 3 patients: 2 cystotomies were repaired laparoscopically, and 1 cystotomy required laparotomy. One patient underwent laparotomy because of equipment failure, and another patient underwent laparotomy to pass a ureteral stent. Two other patients underwent laparotomy to control bleeding sites. All surgical margins were macroscopically negative, but 3 patients had microscopically positive and/or close surgical margins. One patient had a ureterovaginal fistula. There have been 4 documented recurrences (5.1%), with a minimum of 3 years of follow-up.[3]

STUDY DESIGN–2

A type III radical hysterectomy with bilateral aortic and pelvic lymph node dissection was separated into eight component parts: (1) right and left aortic lymphadenectomy, (2) right and left pelvic lymphadenectomy, (3) development of the paravesical and pararectal spaces, (4) ureteral dissection, (5) ligation and dissection of the uterine artery, (6) development of the vesicouterine and rectovaginal spaces, (7) resection of the parametria, and (8) resection of the upper vagina. The adequacy of the component parts was determined and documented on video.

Results: Complete aortic and pelvic lymphadenectomy and a type III radical hysterectomy were performed by operative laparoscopy.

Conclusion: A complete pelvic and aortic lymphadenectomy and type III radical hysterectomy were performed laparoscopically. This approach could potentially decrease morbidity historically associated with radical hysterectomy and lymphadenectomy performed either abdominally or vaginally. Only prospective randomized trails will allow for the evaluation of potential benefits associated with this surgical technique.[4]

Fourteen cases of radical hysterectomy with bilateral pelvic and common iliac lymphadenectomy for a stage IB squamous carcinoma of the cervix. To date fourteen of these procedures have been performed with few complications. The complications encountered thus far include narrowing of a right ureter detected by an intravenous pyelogram obtained on postoperative day 10 and a small vesicovaginal fistula. The narrowed right ureter had a retrograde stent placed as a precaution. It would appear that laparoscopic radical hysterectomy in selected patients offers significant advantages in terms of hospitalization, incision size, and wound, pulmonary, and intestinal complications. In addition to the clinical advantages, laparoscopic radical hysterectomy appears to be more cost effective than traditional laparotomy.[5]

In laparoscopy-assisted radical vaginal hysterectomy, laparoscopy is used to develop the paravesical and pararectal spaces. The cardinal ligament is isolated and cut after bipolar coagulation to the level of the deep uterine vein. By the vaginal approach, the ureters are identified before their entry into the bladder pillar. The uterine vessels are pulled down until their laparoscopically coagulated ends become visible. After incision of the vesicocervical reflection, the uterine fundus is grasped and developed (Döderlein maneuver). The lower cardinal and uterosacral ligaments are exposed by pulling the cervix and fundus uteri to the contralateral side. The cardinal and uterosacral ligaments are dissected and ligated, and the specimen is removed. We combined laparoscopic lymphadenectomy with radical vaginal hysterectomy in 33 women with cervical cancer. The mean operating time was 80 minutes for the vaginal phase and 215 minutes for the laparoscopic phase, including para-aortic and pelvic lymphadenectomy and preparation of the cardinal ligaments. Blood transfusions were necessary in four women. Three patients sustained injury to the bladder, one patient to the left ureter, and another patient to the left internal iliac vein. Repair was achieved at primary surgery for all intraoperative complications. No fistula was observed. The patients had fully recuperated after a mean of 28 days. The laparoscopy-assisted Schauta-Stoeckel approach may prove to be a safe alternative to conventional radical abdominal hysterectomy.[6]

A vaginal or a laparoscopic approach in radical surgery for cervical carcinoma has been proposed. A pilot study of eight cases shows that an oncologic surgeon familiarized with these techniques is able to take advantage of the benefits of both routes in the same patient: Laparoscopic surgery is adapted to lymph node dissection, section of the origin of the uterine artery, and dissection of the ureter under direct vision; vaginal surgery allows a precise incision of the vaginal cuff. Both routes may be used for the section of parameters, but we propose the use of the vaginal route. The combination of vaginal and laparoscopic surgery spares the pain and discomfort of both laparotomy and perineotomy.[7]

The clinical usefulness of laparoscopic pelvic and para-aortic lymphadenectomy for staging and therapy of gynecological cancer was analyzed prospectively.

Method: Laparoscopic para-aortic and pelvic lymphadenectomy was performed in 150 patients with cervical (n = 96), endometrial (n = 41), or ovarian cancer (n = 13). Lymphadenectomy was combined with laparoscopically assisted vaginal radical hysterectomy in 70 patients, with laparoscopically assisted vaginal hysterectomy and/or bilateral salpingo-oophorectomy and/or appendectomy and/or omentectomy in 24 patients, with trachelectomy in 2 patients, and with laparoscopic radical hysterectomy in 2 patients; lymphadenectomy alone was performed in 52 patients. Right-sided para-aortic lymphadenectomy extended to the level of the right ovarian vein; left-sided dissection reached the level of the inferior mesenteric artery. In ovarian tumors, dissection was extended

to the level of the renal vessels; in addition, the ovarian vessels were removed with the surrounding tissue. Peri- and postoperative data were collected prospectively to monitor progress of surgical performance.

Results: Mean operative time was 36 minutes (15-105 minutes) for right-sided para-aortic and 24 minutes (12-49 minutes) for left-sided para-aortic lymphadenectomy; bilateral pelvic lymphadenectomy took 64 minutes (44-110 minutes). On average 26.8 (10-56) pelvic lymph nodes and 7.3 (0-19) para-aortic lymph nodes were sampled. Major vessels were injured in 7 patients of which 4 patients required laparotomy. Patients undergoing lymphadenectomy alone were admitted for 3.2 days on average.[8]

STUDY DESIGN–3

The surgical-anatomic principles of radical vaginal surgery and the techniques of three increasingly extended vaginal hysterectomies are illustrated. Possible indications are pointed out on the basis of our personal experience from previously published retrospective studies.

Results: Class I extended vaginal hysterectomy allows the "en bloc" dissection of the uterus along with the upper third of vagina and both the adnexa. The parametria are not removed. This procedure has proved to be of value for treatment of stage I endometrial cancer. In the class II extended vaginal hysterectomy the distal tract of the anterior and posterior parametria are preserved, whereas the cardinal ligament is entirely removed. This operation has shown promising results for treatment of stage IB-IIA cervical cancer of small volume while reducing the incidence of bladder and rectal dysfunctions. The class III procedure includes the complete removal of the parametria (anterior, lateral, and posterior). This operation has been shown to provide a high rate of cure for stage IB-IIA cervical cancer.[9]

In 57 consecutive patients with stage Ia to IIb cervical cancer, laparoscopic radical hysterectomy and lymphadenectomy were performed. Forty-eight patients had squamous cell carcinomas, 7 patients had adenocarcinomas, and 2 patients had adenosquamous carcinomas of the cervix.

Results: All but 2 surgical procedures were completed laparoscopically. The average operative time was 186 minutes (150-320 minutes). The average blood loss was 168 ml (120-700 ml). Average numbers of pelvic and para-aortic lymph nodes removed were 18.6 (12-23) and 8.2 (6-12), respectively. Eight patients (14.0%) had positive lymph nodes. All surgical margins were macroscopically negative. Operative cystotomies occurred in 2 patients and one patient with venous injuries were repaired laparoscopically. Two other patients underwent laparotomy to control bleeding or repair ascending colon. After surgery, patients passed gas in 2.3 days and self-voided in 10.2 days on average. Follow-up has been provided every 3 months. There have been 3 cases of recurrences, one patient uncontrolled, and one patient ureteral constriction. Three patients have retention of urine.[10]

Between August 1994 and September 2003, pelvic and/or para-aortic transperitoneal laparoscopic lymphadenectomy was performed in 650 patients at the Department of Gynecology of the Friedrich-Schiller University of Jena. Retrospective and prospective data collection and evaluation of videotapes were possible in 606 patients. Laparoscopic lymphadenectomy was part of the following surgical procedures: Staging laparoscopy in patients with advanced cervical cancer (n = 133) or early ovarian cancer (n = 44), trachelectomy in patients with early cervical cancer (n = 42), laparoscopic-assisted radical vaginal hysterectomy in patients with cervical cancer (n = 221), laparoscopy before exenteration in patients with pelvic recurrence (n = 20), laparoscopic-assisted vaginal hysterectomy or laparoscopic-assisted radical vaginal hysterectomy in patients with endometrial cancer (n = 112), and operative procedures for other indications (n = 34).

Results: After a learning period of approximately 20 procedures, a constant number of pelvic lymph nodes (16.9-21.9) was removed over the years. Pelvic lymphadenectomy took 28 minutes, and parametric lymphadenectomy took 18 minutes for each side. The number of removed para-aortic lymph nodes increased continuously over the years from 5.5 to 18.5. Right-sided para-aortic, left-sided inframesenteric and left-sided infrarenal lymphadenectomy took an average of 36, 28, and 62 minutes, respectively. The number of removed lymph nodes was independent from the body mass index of the patient. Duration of pelvic lymphadenectomy was independent of body mass index, but right-sided para-aortic lymphadenectomy lasted significantly longer in obese women (35 *vs* 41 minutes, P = 0.011). The overall complication rate was 8.7% with 2.9% intraoperative (vessel or bowel injury) and 5.8% postoperative complications. No major intraoperative complication was encountered during the last 5 years of the study.

Conclusion: By transperitoneal laparoscopic lymphadenectomy, an adequate number of lymph nodes can be removed in an adequate time and independent from body mass index. The complication rate is low and can be minimized by standardization of the procedure.[11]

Between January 1991 and March 1994, 70 patients with cervical cancer were treated by radical abdominal hysterectomy, and between August 1994 and May 1999, 70 patients with cervical cancer were treated by laparoscopically assisted radical vaginal hysterectomy. Data from both the abdominal group and the laparoscopic-vaginal group were obtained retrospectively.

Results: The mean duration of surgery was significantly longer for the laparoscopic-vaginal approach than for the abdominal approach (292.9 *vs* 209.9 minutes). Significantly more pelvic lymph nodes were removed by laparoscopy (27 *vs* 10.7). Blood loss and transfusion rates were significantly lower in the laparoscopic-vaginal group. Intraoperative complications were seen more often during laparoscopic-vaginal surgery ($p < 0.05$). Early postoperative complications occurred significantly more

Table 1: Comparison between laparoscopic radical hysterectomy

	Year	Type of operation	Number of patients	Time taken for surgery (min)	Blood loss (ml)	Conversion to abdominal surgery	Hospital stay (days)	Vascular injuries	Bowel injuries
Ref1	1993	Laparoscopic	19	–	–	1	–	–	–
Ref2	2003	Laparoscopic	71	210	300	–	1	–	1
Ref2	2003	Abdominal	205	150	500	–	5	–	–
Ref3	2002	Laparoscopic	78	205	225	5	–	2	–
Ref4	1996	Laparoscopic	–	–	–	–	–	2	–
Ref5	1994	Laparoscopic	14	–	–	–	–	–	–
Ref6	1996	Laparoscopic	33	295	–	–	–	1	–
Ref7	1993	Laparoscopic	8	–	–	–	–	–	–
Ref 8	1998	Laparoscopic	150	–	–	–	–	–	–
Ref 9	1996	Vaginal	–	–	–	–	–	–	–
Ref 10	2003	Laparoscopic	57	186	168	2	–	2	1
Ref11	1994	Laparoscopic	650	–	–	–	–	–	–
Ref12	2001	Laparoscopic	70	293	–	–	11.4	–	–
Ref 12	2001	Abdominal	70	310	–	–	22.9	–	–
Ref13	2003	Laparoscopic	200	–	–	–	–	–	–
Ref14	2008	Laparoscopic	200	205-344	293	14(7%)	–	–	–
Ref 15	2006	Laparoscopic	317	–	–	4	12	7	1
Ref16	2008	Laparoscopic	295	162	230	5	–	7	3
Ref17	2004	Abdominal	–	–	–	–	10.3	1	1
Ref18	1967	Abdominal	204	–	–	–	–	–	–
Ref19	1990	Abdominal	44	–	–	–	–	–	–
Ref20	1997	Abdominal	302	–	–	–	–	11	–

frequently after the abdominal approach. The mean duration of hospital stay was significantly shorter for patients treated by laparoscopic-vaginal surgery (11.4 *vs* 22.8 days).[12]

Between August 1994 and June 2002, 200 patients with cervical cancer (TNM stage 1a1, L1 n = 6, 1a2 n = 21, 1b1 n = 89, 1b2 n = 26, 2a n = 11, 2b n = 45, 3a n = 1, 4 n = 1; squamous cell carcinoma 76.5%, adenocarcinoma 23.5%) were treated with LARVH (type II n = 102, type III n = 98) (Table 1).

Results: Para-aortic lymphadenectomy was performed in 170 (85%) patients and pelvic lymphadenectomy was performed in all 200 patients. In 26 (13%) patients positive lymph nodes were found. Major intraoperative injuries occurred in 6% of patients. Postoperative complications occurred in 8% of patients. Incidence of complications decreased significantly when comparing the first half with the second half of patients. After a median follow-up time of 40 months, overall 5-year survival could be projected to 83%; 18.5% of patients experienced recurrence with 35% exclusively extrapelvic and 11% of patients died of recurrence. Independent prognostic factors for recurrence-free survival were tumor stage, lymph node status, and combined involvement of lymphovascular and angiovascular space. In the absence of these risk factors projected 5-year survival was 98%.

Conclusion: Patients with tumor < 4 cm, negative lymph nodes, and the absence of the combination of angio- and lymphovascular space involvement can be identified by laparoscopic staging and are ideal candidates for LARVH.[13]

SUMMARY OF RESULTS

	Laparoscopic RH	Open RH
Number of patients	862	825
Time taken for operation	186-344 minutes	150-310 minutes
Blood loss	225-344 ml	400-500 ml
Conversion: Lap to open	1.5-25%	–
Hospital stay	5-12 days	10-23 days
Vascular injury	3-5%	0-1%
Bowel injury	1.5-2%	0-1%
Bladder injury	3.5-10%	1-1.34%
Ureteric injury	2%	2%
Postoperative Infective morbidity	5-7%	5-20%
Hypercarbia	0.5-1%	—
Bowel fistula	0.5-0.75%	—
Urinary fistulas	2-3%	1%
Disease free survival	83-94.9%	75.6-94%

DISCUSSION

Looking at the comparative analysis shown in Table 2 the laparoscopic radical hysterectomy with lymphadenectomy has

Table 2: Complication rate laparoscopic versus open radical hysterectomy

	Bladder injuries	*Ureteric injury*	*Hypercarbia*	*Postoperative fever/abscess/ infection*	*Urinary fistula*	*Other post-operative complications*	*Two years disease free survival rate(%)*
Ref1	–	–	–	1	–	1	100
Ref2	7	1	–	9	–	5	94
Ref2	–	–	–	5	–	2	94
Ref3	3	–	–	–	1	–	94.9
Ref4	3	–	–	–	–	–	–
Ref5	–	1	–	–	1	–	–
Ref6	3	1	–	–	–	–	–
Ref7	–	–	–	–	–	–	–
Ref8	–	–	–	–	–	–	–
Ref9	–	–	–	–	–	–	–
Ref10	2	1	–	–	–	4	97
Ref11	–	–	–	–	–	–	–
Ref12	–	–	–	–	–	–	–
Ref12	–	–	–	–	–	–	–
Ref 13	–	–	–	–	–	8	83
Ref 14	–	–	–	22	–	–	–
Ref 15	5	–	1	–	10	6	–
Ref 16	5	1	1	–	12	19	83.7
Ref 17	–	–	–	–	–	40%	75.5
Ref 18	–	–	–	–	–	–	83
Ref19	–	3	–	8	–	3	83
Ref 20	2	–	–	30%	3.5%	4%	–

comparable outcome except that it takes more operative time and chances of intraoperative major complications are higher. It requires extraordinary surgical skills. The laparoscopic modality gives better performance of lymphadenectomy and hence yields marginally better disease free survival.

CONCLUSION

At present the laparoscopic approach for cervical cancer stage 1 is though not better but fairly comparable to conventional modality. The advent of robotic and with growing skill of surgeons this modality will bring about better results with fewer complications.

REFERENCES

1. Nezhat CR, Nezhat FR, Burrell MO, Ramirez CE, Welander C, et al. Gynecol Surg. Laparoscopic radical hysterectomy and laparoscopically assisted vaginal radical hysterectomy with pelvic and para-aortic node dissection Summer 1993;9(2):105-20.
2. Steed H, Rosen B, Murphy J, Laframboise S, De Petrillo D, et al. Gynecol Oncol. A comparison of laparascopic-assisted radical vaginal hysterectomy and radical abdominal hysterectomy in the treatment of cervical cancer Jun 2004;93(3):588-93.
3. Spirtos NM, Eisenkop SM, Schlaerth JB, Ballon SC. Am J Obstet Gynecol. Laparoscopic radical hysterectomy (type III) with aortic and pelvic lymphadenectomy in patients with stage I cervical cancer: Surgical morbidity and intermediate follow-up Aug 2002;187(2):340-48.
4. Spirtos NM, Schlaerth JB, Kimball RE, Leiphart VM, Ballon SC. Am J Obstet Gynecol. Laparoscopic radical hysterectomy (type III) with aortic and pelvic lymphadenectomy. Jun 1996;174(6):1763-67; discussion 1767-68.
5. Sedlacek TV, Campion MJ, Hutchins RA, Reich H.J Am Assoc Gynecol Laparosc. Laparoscopic Radical Hysterectomy: A Preliminary Report Aug 1994;1(4, Part 2):S32.
6. Schneider A, Possover M, Kamprath S, Endisch U, Krause N, Nöschel H. Obstet Gynecol. Laparoscopy-assisted radical vaginal hysterectomy modified according to Schauta-Stoeckel Dec 1996;88(6):1057-60.
7. Querleu D. Gynecol Oncol. Laparoscopically assisted radical vaginal hysterectomy Nov 1993;51(2):248-54.
8. Possover M, Krause N, Plaul K, Kühne-Heid R, Schneider A. Gynecol Oncol. Laparoscopic para-aortic and pelvic lymphadenectomy: Experience with 150 patients and review of the literature Oct 1998;71(1):19-28.
9. Massi G, Savino L, Susini T. Am J Obstet Gynecol. Three classes of radical vaginal hysterectomy for treatment of endometrial and cervical cancer Dec 1996;175(6):1576-85.
10. Zhonghua Fu Chan Ke Za Zhi. Clinical evaluation of laparoscopic radical hysterectomy with pelvic and para-aortic lymphadenectomy in patients with cervical cancer Jul 2003;38(7):409-11.

11. Köhler C, Klemm P, Schau A, Possover M, Krause N, Tozzi R, Schneider A.Gynecol Oncol. Introduction of transperitoneal lymphadenectomy in a gynecologic oncology center: Analysis of 650 laparoscopic pelvic and/or para-aortic transperitoneal lymphadenectomies Oct 2004;95(1):52-61.
12. Malur S, Possover M, Schneider A. Surg Endosc. Laparoscopically assisted radical vaginal versus radical abdominal hysterectomy type II in patients with cervical cancer Mar 2001;15(3):289-92. Epub 2000 Dec 12.
13. Hertel H, Köhler C, Michels W, Possover M, Tozzi R, Schneider A. Gynecol Oncol. Laparoscopic-assisted radical vaginal hysterectomy (LARVH): Prospective evaluation of 200 patients with cervical cancer Sep 2003;90(3):505-11.
14. Dr Chukwunwendu Anthony Okonkwo Review Article On Total Laparoscopic Radical Hysterectomy Versus Radical Abdominal Hysterectomy.
(http:/www.laparoscopyhospital.com/radical_hysterectomy_versus_radical_abnominal_hysterectomy.html)
15. H Xu, Y Chen, Y Li, Q Zhang, D Wang, Z Liang Surg Endosc. Complications of laparoscopic radical hysterectomy and lymphadenectomy for invasive cervical cancer: Experience based on 317 procedures 2007;21:960-64.
16. Yong Chen, Huichen Xu, Yuyan Li, Dan Wang, Junnan Li, et al. The Outcome of Laparoscopic Radical Hysterectomy and Lymphadenectomy for Cervical Cancer: A Prospective Analysis of 295 Patients Annals of Surgical Oncology 15(10):284.
17. Kanate Thanagumtorn,Charoen Vipupinyo Survival of FIGO Stage 1 b1 Cervical Cancer Patients treated with radical hysterectomy and pelvic lymphadenectomy. Bulletin of Department of Medical Services, Thailand March 2004;29(3).
18. The Surgical Treatment of Cancer of The Cervix: Stage I And JJ*Vol. 102, No. I , M.1).Presented at the Forty-ninth Annual Meeting of the American Radium Society, Toronto, Ontario, Canada, May 1967;29-31.
19. N McClure, J Price, E B Bond. Radical hysterectomy for stage 1 cervical carcinoma in Northern Ireland. A five year review The Ulster Medical Journal, October 1990;59(2):183-86.
20. B Croamziplialinca Jtoiounrns aol fo rfa Mdiceadli chayls atenrde cBtoiomloygical Research. Complications of surgical treatment of cervical carcinoma FS Abrão, RC Breitbarg, AT Oliveira and FA Vasconcelos 1997;30:29-33.

REVIEW ARTICLE

Different Port Closure Techniques in Laparoscopy Surgery

[1]Majid A Hamood, [2]RK Mishra

[1]Department of Surgery, Hilla Teaching Hospital, PO Box 294, Babil, Hilla, Iraq

[2]Department of Surgery, Laparoscopy Hospital, New Delhi, India

Abstract

Introduction: Any new surgical procedure, face a new technical challenges, although minimally invasive surgery cause evident reduction of the pain to the patient postoperatively, with better cosmesis, but with time, new challenges appears.

One of challenges is port closure techniques, in order to prevent the trocar site hernias and other complications .

Aims: The aim of this study to review and list different techniques used for closure of the trocar sites.

Methods: A literature search was performed for articles and text books dealing with techniques of closure. The author searched this subject using Medline and the search engine Google, Springerlink and High wire Press. The following search term were used; port site closure techniques. Review, All articles reporting techniques with their references were reviewed with some text books.

Results: in this literature review we described many techniques in addition to classical closure using curved needles, including Grice needle, Maciol-needles, endoclose device.

Carter-Thomason device, Tahoe ligature device, Endo-Judge device, exit puncture closure device, Owsley retractor, spinal cord needles, dual hemostat, Veress needle loop technique,suture carrier, Riverdin and Deschamps needles, and Gore-Tex closure device. Semm's emergency needle with adistal eyelet; the modified Veress needle with a slit made in the retractable brunt tip; dental awl with aneye; prolene 2/0 on a straight needle aided by a Veress needle; a straight needle armed with suture; Auto stitch (United States Surgical), a modified Veress needle bearing a crochet hook at the tip. Foley catheter threaded through the port hole forthe elevation of fascial edge upon traction; fish-hook needle improvised out of a hypodermic needle by bending it 180°; Grooved director; U-shaped purse-string suture placed in the fascia around the port hole .

Conclusion: Although there are different techniques used to close the trocar site, all of them are effective in closing the defect in the fascial layers of the abdominal wall, two main groups of techniques were found.

Keywords: Port closure, techniques, complication, laparoscopy surgery.

INTRODUCTION

Around 200 years ago, endoscopy was first started with the help of tin tube at the end of which candle was placed to provide the illumination.[1] The modern area of laparoscopy started in 1966 with the development of Hopkin's-Rod system.[2] The introduction of any surgical procedure brings with it new technical challenges. Because laparoscopy offers patients a reduction in pain and better cosmesis, it is being used more frequently today. Laparoscopy allows for more intricate procedures to be performed, but larger ports are required to execute such complex surgeries.[1] Along with larger ports come larger abdominal incisions and thus an increase in the possibility of complications following surgery.[3] These complications can include incisional bowel herniation as well as small bowel obstruction.[4,5] The closure of laparoscopic trocar sites is helpful in reducing such complications. In 1968, Fear[6,7] was the first to report ventral hernia at a trocar site after laparoscopy. Trocar complications occur in approximately 1 to 6% of patients.[8-16] Herniation associated with laparoscopic trocar sites can occur with incisions as small as 3 mm.[17] It is recommended that all 10 and 12 mm trocar sites in adults and all 5 mm port sites in children be closed, incorporating the peritoneum into the fascial closure.[10,18-20] Standard suture techniques can be difficult and frustrating, often involving blind closure of the fascial defect. A number of techniques and devices have been developed to facilitate this fascial closure.

METHOD

Selected papers were screened for further references. Criteria for selection of literature were the number of cases (excluded if less than 20), methods of analysis (statical or nonstatical), operative procedure (only universally accepted procedures were selected) and the institution where the study was done (specialized institution for laparoscopic surgery). Textbooks of laparoscopic surgery also were reviewed.

RESULTS

Port closure techniques could be classified from a technical point of view into two groups:

1st group: With laparoscopic visualization (Must be seen through telescope).

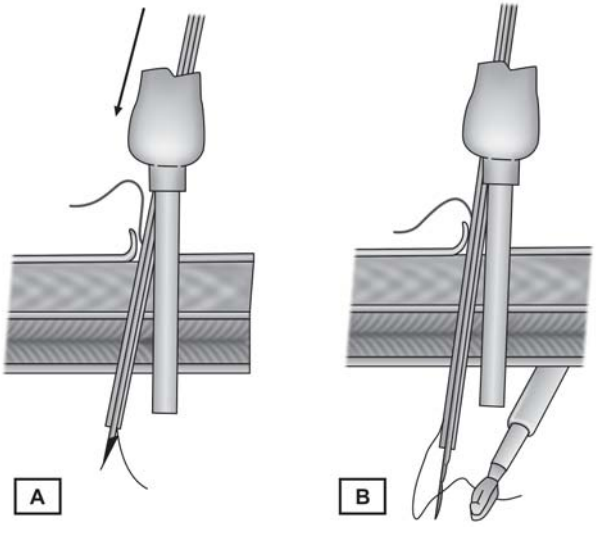
2nd group: Without laparoscopic visualization (must be seen by surgeon, no telescope).

FIRST GROUP

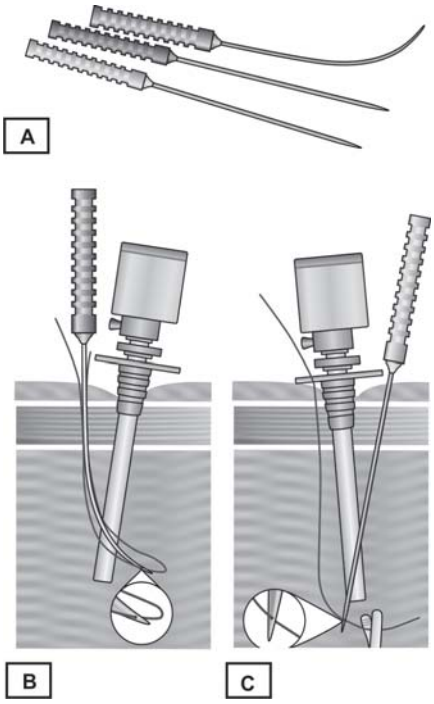
The manipulation of this group is performed from inside the abdomen under direct visualization, the maximum safety in avoiding visceral injuries. These techniques include Maciol needles, the Grice needle, catheter or spinal needles, the endoclose device, and the Gor-Tex device, Reverdin, Deschamps needles, Semm's emergency needle with adistal eyelet; the modified Veress needle with a slitmade in the retractable brunt tip; dental awl with aneye; prolene 2/0 on a straight needle aided by a Veress needle; a straight needle armed with suture;Autostitch (United states surgical), a modified Veress needle bearing a crochet hook at the tip, veress needle loop technique.[29]

*Grice needle*s Used by Stringer et al,[16] A Grice needle (Figs 1A and B) was inserted at an angle along the side of a lateral trocar. Under direct laparoscopic visualization, the needle was placed through both the peritoneum and the fascia. Within the abdomen, the suture was grasped and removed from the Grice needle with a grasper inserted from the opposite trocar. The Grice needle then was removed and reinserted opposite the previous puncture, again at an angle along the trocar. The suture was regrasped with the Grice needle and pulled out of the abdomen. After complete removal of the trocar, the suture was tied under direct laparoscopic visualization.

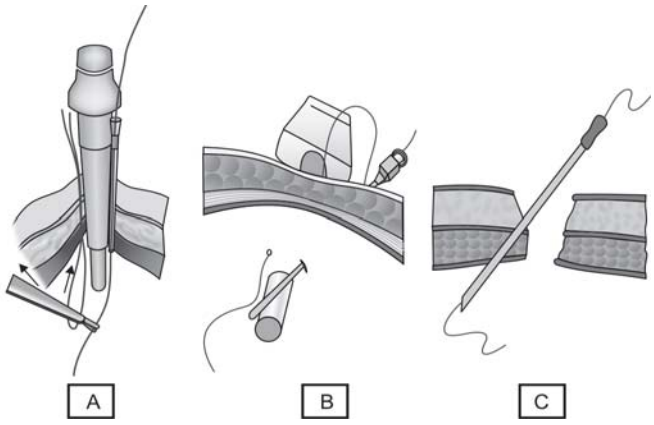
Maciol needles. Contarini[6] reported using Maciol needles (Core Dynamics, Inc. Jacksonville, FL, USA, Maciol needles (Fig. 2A) are a set of three needles: Two black handled introducers, one straight and one curved, and a golden-handle retriever. The introducer needle (needle with an eye) is used to pass the suture through the abdominal wall into the peritoneal cavity from the subcutaneous tissue (Fig. 2B). The retriever needle (needle with a barb) is next passed into the abdomen on the opposite side of the defect to retrieve the suture, then pulled back through the tissue (Fig. 2C). The procedure is performed under direct laparoscopic visualization before trocar withdrawal and does not require any enlargement of the skin incision.



Figs 1A and B: Grice needle



Figs 2A to C: (A) Maciol suture needle set (B and C) Maciol needles



Figs 3A to C: Vein catheter, spinal cord needle, and angiocath needle

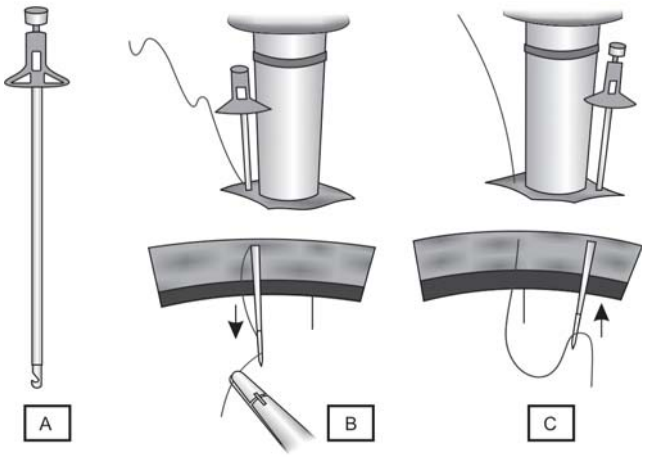
Vein catheter, angiocath needle, and spinal cord needle. Nadler et al.[22] used a venous catheter (Fig. 3A). direct laparoscopic visualization to secure the abdominal wall fascia and peritoneum, (Fig. 3B). A continuously running nonabsorbable 0-polypropylene suture is inserted through a 15 gauge needle, which penetrates all subcutaneous layers including the fascia, going around the umbilical opening at a 45 degree angle to create a purse string. The needle penetrates the fascia at a distance of 0.5 to 1 cm from the trocar site. After the first insertion of the needle, an endograsp forceps is used to pull the free suture edge into the abdomen Then the needle, still

holding the suture, is reinserted at the next point and, with the use of the forceps, the free intra-abdominal edge of the suture is locked through the loop that has been created. This maneuver is repeated another three times until the purse string is fashioned. In the final step, the suture edge, which is pulled by the last loop, and the needle are withdrawn outside the abdomen near the site of first needle insertion, and both edges of the suture are tied up onto the fascia, angiocath needle to perform the same closure technique (Fig. 3C). The large 10 mm trocar is removed, and the pneumoperitoneum is maintained in all abdominal trocar wounds 10 mm or larger simply by placement of a gloved finger over the top of the wound. A 14 gauge angiocath needle with the sheath removed is preloaded with a 50 cm length of 0- braided polyglactin suture. The angiocath and suture are inserted through all fascia layers on one side of the laparoscopic wound with laparoscopic visualization. Carefully, the needle and suture are placed in the exact middle of one side of the trocar wound. The surgeon or surgical assistant grasps the suture through a previously made 5 mm port. The needle is removed, and the suture is pulled a short distance (10-15 cm) into the abdominal cavity. A 5 mm grasping instrument is inserted directly through the subxiphoid or any large trocar wound, and the suture is grasped. The 5 mm grasping instrument and suture are removed from the abdominal cavity. The four steps are repeated by passing another preloaded angiocath needle and suture through the midpoint of the other side of the trocar wound. The suture is brought out through the same trocar hole. The ends of the suture are tied together with several square knots. The knot is reduced into the peritoneal cavity by pulling on one or both ends of the tied suture. The knot may be removed by pulling it through the fascia, thereby leaving a single strand of suture for closure of the fascia. The fascia is then closed, and the suture is tied under direct vision through the laparoscope.[23]

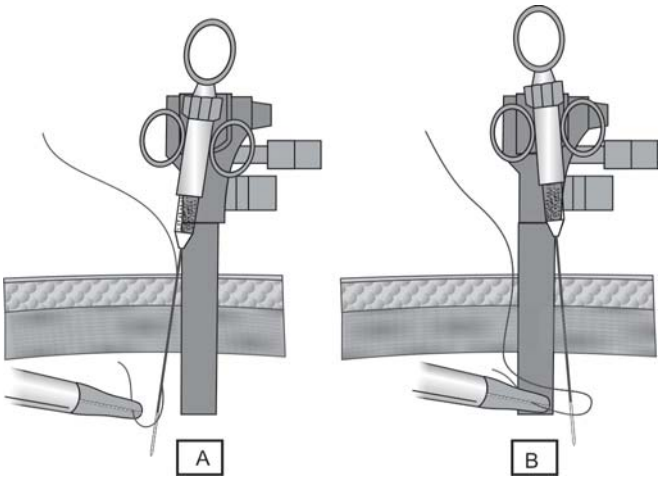
Endoclose suture device. This is a disposable endoclose device (Tyco Auto Suture International, Inc. Norwalk, CT, USA) with a spring-loaded suture carrier (Fig. 4A) is loaded with a 0-absorbable suture and introduced into the abdomen between the edge of the skin and the port.The suture is released and dropped in the abdominal cavity, after which the device is removed (Fig. 4B). The spring-loaded suture carrier is then passed through the fascia and peritoneum 180° degree from the original insertion site between the skin incision and the port. With the assistance of a 5 mm grasping forceps through a secondary port, the suture is reloaded onto the opened notch in the endoclose needle (Fig. 4C). The device and suture are brought out of the abdomen. The port is removed, and the suture is tied to approximate the fascia and peritoneum.[23,24]

THE GORE-TEX SUTURE PASSER

Chapman[25] used the Gore-Tex suture passer (WL Gore and Associates, Phoenix, AZ, USA), which is a reusable trocar closure device. With the trocar still in place and the abdomen



Figs 4A to C: Endoclose suture device



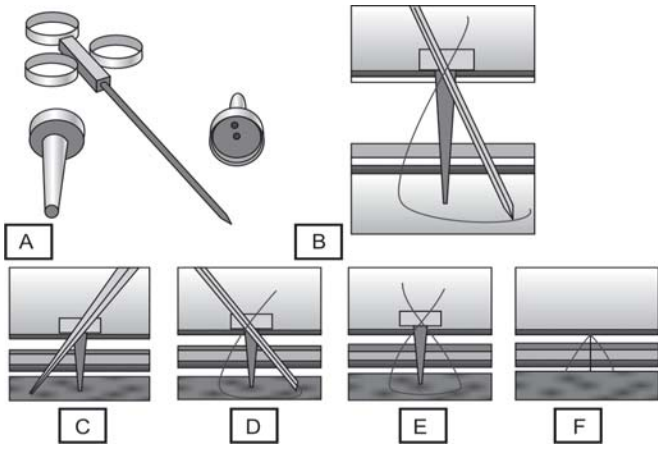
Figs 5A and B: The Gore-Tex suture passer

distended by the pneumoperitoneum, the laparoscope is used to view the trocar site to be closed. The end of the trocar should still be visible within the peritoneal cavity.

The suture is loaded into the Gore-Tex Suture Passer, then passed through the subcutaneous tissue and fascia on one side of the trocar (Fig. 5A). The suture is released from the passer by pushing down on the handle, then grasped intraperitoneally with a blunt grasper. The suture passer is then removed and inserted through the subcutaneous space and fascia on the opposite side of the trocar. The suture is placed back in the jaw of the suture passer and locked into position by pulling back on the handle (Fig. 5B). The suture is then removed by pulling the passer out. Next, the trocar may be removed and the suture tied down.

CARTER-THOMASON DEVICE

The Carter-Thomason close-sure system (Inlet Medical, Inc., Eden Prairie, MN, USA) is of two parts (Figs 6A and B): The Pilot guide and the Carter-Thomason suture passer. Closure of the port incision requires four easy steps: (1) use the suture

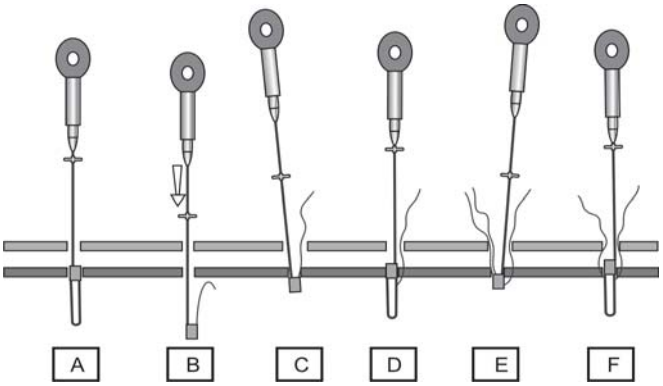


Figs 6A to F: Carter-Thomason device

passer to push suture material through the Pilot guide, fascia, muscle, and peritoneum into the abdomen, then drop the suture and remove the suture passer) (Fig. 6C), (2) push the suture passer through the opposite side of the pilot guide and pick up the suture (Fig. 6D), (3)pull the suture up through the peritoneum, muscle, fascia, and guide (Fig. 6E), and (4) remove the Pilot guide and tie (Fig. 6F). Designed specifically for bariatric and obese patients. The suture passer and Pilot guides have been lengthened to reach through the peritoneum in the larger patient to provide full-thickness closure in this at-risk group.[23]

ENDO-JUDGE DEVICE

The Endo-Judge wound closure device (Figs 7A to F), a 14 gauge hollow J-shaped needle that serves as a carrier for suture material and adevice for performing the fascial closure. The suture is mounted on a reel at the proximal end of the device and fed to the hollow needle until it is delivered out the needle tip. The plastic oval shield (olive) at the J-portion of the needle maintains pneumoperitoneum and prevents injury to underlying structures. Reverdin and Deschamps needle can also be used same way to close the port (Figs 13A and B). It is controlled by asliding ring located on the shaft of the instrument. The device should be used under direct visualization. The Endo-Judge is



Figs 7A to F: Endo-Judge device

passed into the abdomen until the olive is visible below the peritoneum. The instrument is then positioned in a plane perpendicular to the trocar incision to expose the needle and pass it through the peritoneum and fascia until it exits the skin incision.The end of the suture is grasped and tagged with ahemostat. The needle is dropped back into the olive, and the instrument is rotated 180°. The olive is again dropped to expose the needle, which is again passed through the peritoneum and fascia. After removal of the Endo-Judge, the suture is tied, creating a secure, airtight fascial and peritoneal closure.

The *2 mm trocar technique*. Reardon et al.[24] A 2 mm trocar and sleeve are introduced adjacent to the port whose entry site will be closed. A monofilamentheavy-gauge suture with the needle removed is passed through the lumen of the 2 mm sleeve. The 2 mm sleeve is then removed over the suture, after which the 2 mm trocar and sleeve are reintroduced through the opposing fascial edge 180° from the original insertion site. The trocar is removed, and a 2 mm grasper is passed through the sleeve and used to retrieve the intra-abdominal end of the suture.

THE 5 mm TROCAR TECHNIQUE

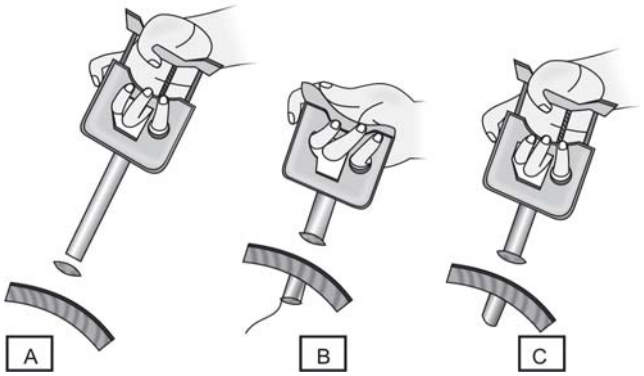
Rastogi and Dy[25] developed a simple technique using the regular curved needle and sutures for closure of peritoneal and rectus sheath defects at the port site. Using a 5 mm telescope, they inspect the defect from the inside, and then pass a hemostat through the incision. Under direct telescopic vision, the peritoneum and rectus sheath are grasped at both the upper and lower edges and pulled through the incision,facilitating the passage of the needle. Chatzipapaset et al.[9] developed a similar closure technique using standard sutures with straight needles, a 5 mm laparoscopic grasper, and a 4 mm hysteroscope.

TAHOE SURGICAL INSTRUMENT LIGATURE DEVICE

It is disposable. Initially, the laparoscopic cannula is removed. A 0-absorbable suture is placed into the hollow delivery Tahoe needle without extension beyond the distal end of the needle (Fig. 8A). The device is introduced into the abdomen after the needles are first inserted through the two holes on an introduction disk. The needle tips are then guided to pierce the fascia on either side of the port site. The lock is released, and the handle is depressed until the metal retrieval loop is extended and encompasses the tip and distal shaft of the delivery needle. The suture is fed into the delivery needle until it lies several inches beyond the distal end of the delivery needle and through the retrieval loop (Fig. 8B). The handle is released, allowing the retrieval loop to retract, thereby securing the suture in the closed metal loop. The entire device is withdrawn from the abdomen (Fig. 8C), thus delivering the tow ends of the suture onto the abdominal wall. The suture is tied, approximating the peritoneum and fascia.[24]

EXIT DISPOSABLE PUNCTURE CLOSURE DEVICE

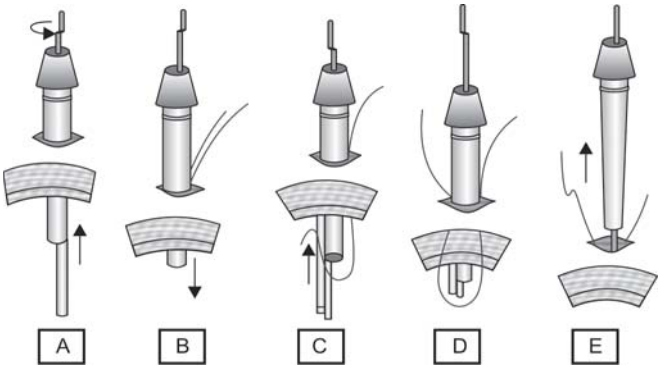
A 10 mm instrument with arecessed right-angle needle that can be exposed by rotating a dial at the top of the instrument. The



Figs 8A to C: Tahoe surgical instrument ligature device

device is introduced through the 12 mm laparoscopic port. When laparoscopically visualized in the abdomen, the right-angle needle assembly is rotated to the open position, thereby exposing the needle carrier (Fig. 9A). The device is then pulled back up through the port, thereby drawing the needle up through the peritoneum and fascia between the skin and the port. The skin is pulled away from the tip of the needle to avoid puncture of the skin. When the needle is seen coming through the subcutaneous fat, a 0-absorbable suture is loaded through the hole in the needle (Fig. 9B). The needle and suture, along with the entire device, are pushed back down through the port into the abdomen,thereby passing the suture down through the fascial and peritoneal layers. The exit device is then rotated 180° to the opposite side of the port (Fig. 9C), and the needle carrying the suture is again delivered through the fascia and peritoneum. The needle is identified in the subcutaneous tissue, and the suture is pulled from the tip of the needle (Fig. 9D). The device is returned back in to the abdomen; the needle is closed; and the closed device is removed through the port (Fig. 9E). The port is removed, and the suture is tied, securing the peritoneum and fascia.[24]

Veress needle loop technique; used by RK Mishra, making a loop by passing nylon suture to veress needle and tied it, then loadge the vicryl suture to the tip of veress needle, then push the veress needle with the loop, through the abdominal wall, with out piercing the skin, 3 mm away from the trocar site, then remove the veress, leaving the vicryl in side, by putting your finger on the vicryl, grasp the vicryl by grasper, and pass it to the other side of the trocar, to push it in side the veress loop, after piercing the abdominal wall, leaving the skin,and then remove the trocar, and close the wall by knotting (Figs 14A to N).



Figs 9A to E: Exit disposable puncture closure device

SECOND GROUP

Port closure should be performed under direct visualization of the surgeon, which requires good insufflation of the abdomen. When desufflation is performed, a tactile sense should be used to close the port. These techniques are applicable during insufflation or after desufflation. These techniques include the suture carrier, the dual hemostat technique, the Lowsley retractor, application of bioabsorbable hernia plug in trocar sites.[28] Preliminary placement of fascial stay sutures above and below the prospective trocar site; Foley catheter threaded through the port hole for the elevation of fascial edge upon traction; fish-hook needle improvised out of a hypodermic needle by bending it 180°; Grooved director; U-shaped purse-string suture placed in the fascia around the port hole.[21]

SUTURE CARRIER

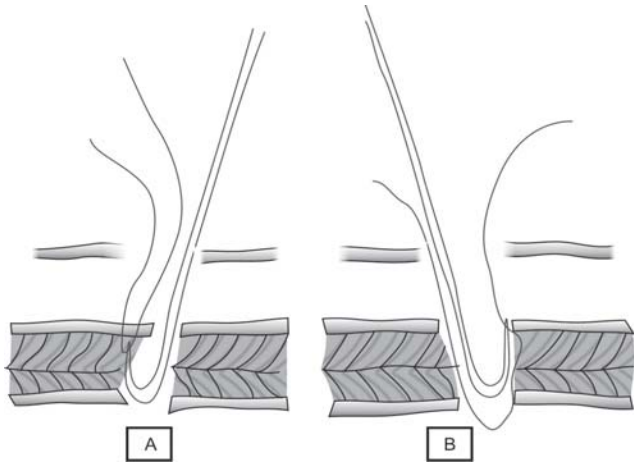
Jorge et al[26] and Li and Chung developed a hook suture carrier (Figs 10A and B) for closure of trocar wounds, making use of the vertical rather than the horizontal space. The suture carrier is a hook suture carrier modified from a simple hook retractor with an eye drilled into the tip through which suture material can be threaded. The handle is 24 cm long, and the size of the hook approximates the size of the general closure needle (CT needle; Ethicon, Somerville, NJ, USA). To begin closure, the fascial edge is lifted vertically with a hook retractor, and the suture carrier is partially inserted into the wound to catch the peritoneum and fascia under direct vision, piercing it from the undersurface (Fig. 10A). A suture (such as 0-polypropylene) is threaded into the exposed eye of the carrier and brought beneath the fascia. This same suture is then carried to the opposite edge of the wound using the carrier, executing a stitch from inside out. After the suture is disengaged from the carrier, a simple stitch is accomplished with the knot on the surface when tied (Fig. 10B).

DUAL-HEMOSTAT TECHNIQUE

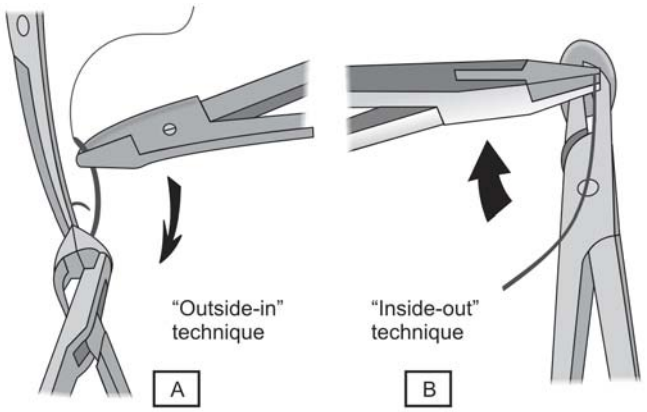
Spalding et al[27] reported the dual-hemostat technique (Figs 11A and B), which is very simple, using two hemostats and a needle driver with suture and needle. The first hemostat is placed into the wound, after which the tips are spread open and the fascia is lifted up away from the underlying abdominal viscera. The second hemostat is used to retract the overlying subcutaneous tissue. Then the suture needle is driven through the fascia to exits between the splayed tips. The procedure is repeated at the opposite side of the wound.

LOWSLEY RETRACTOR WITH HAND CLOSURE

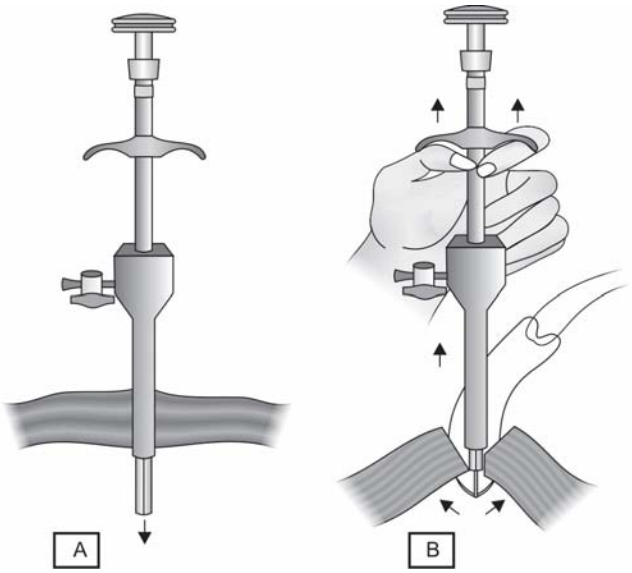
This technique uses the straight Lowsley retractor (Circon ACMI, Stanford, CT, USA), a regular needle driver, and a



Figs 10A and B: Suture carrier



Figs 11A and B: Dual-hemostat technique



Figs 12A and B: Lowsley retractor with hand closure

Figs 13A and B: Reverdin and Deschamps needle

0-absorbable suture on a curved needle.[13] The closed straight Lowsley retractor is passed through the 12 mm port and into the peritoneal cavity (Fig. 12A). The blades of the Lowsley retractor are next opened maximally to 180°. The port then is removed from the abdomen along the shaft of the Lowsley retractor, leaving only the retractor in the wound. The retractor and the port are pulled upward. The fascia is tented toward the skin surface and exposed. A standard hand-sutured closure with 0-absorbable suture then is performed (Fig. 12B).[23]

PORT PLUG TECHNIQUE

In this technique using the bioabsorbable hernia plug hernin in trocar site,the device was implanted in the umbilical trocar (10 mm) implantation of the bioabsorbable hernia plug device by the safe port possible in all cases.[28]

DISCUSSION

The port site hernias are found with incidence of 0.23% at the 10 mm port site and 1.9% at the 12 mm port site. This incidence markedly increases to 6.3% for obese patients with a body mass index (BMI) greater than 30.[10, 12,14] This incisional hernia at a trocar site after laparoscopy may arise from failure to reapproximate fascial wound edges ,infection, premature suture disruption, a bulge at a previous port site should immediately raise suspicion.[23]

Hernia at trocar ports is classified into three types:

1. The early-onset type (i.e., occurring immediately after the operation, with small-bowel obstruction (especially Richter hernia) frequently developing, (2) the late-onset type (i.e., occurring several months after the operation, mostly with local abdominal bulging and no small-bowel obstruction developing [laparocele]), and (3) and the special type (i.e., indicating protrusion of the intestine and/or omentum).[20] The Richter hernia usually presents days later, and the patients experience a delay in diagnosis due to persistence of bowel function leading to significant morbidity.This complication of minimally invasive surgery is rare, but

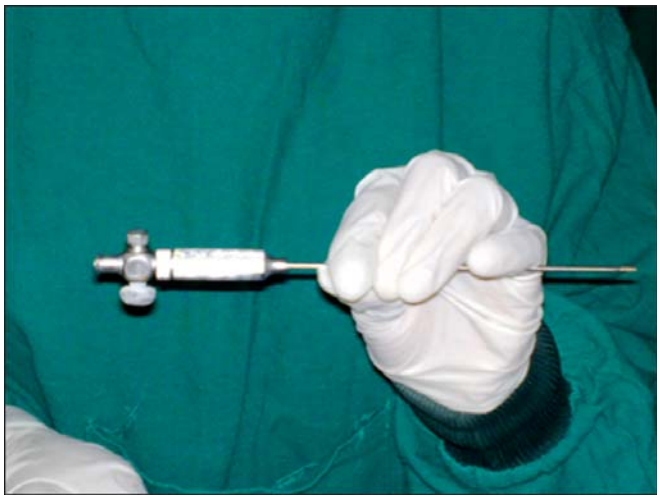


Fig. 14A

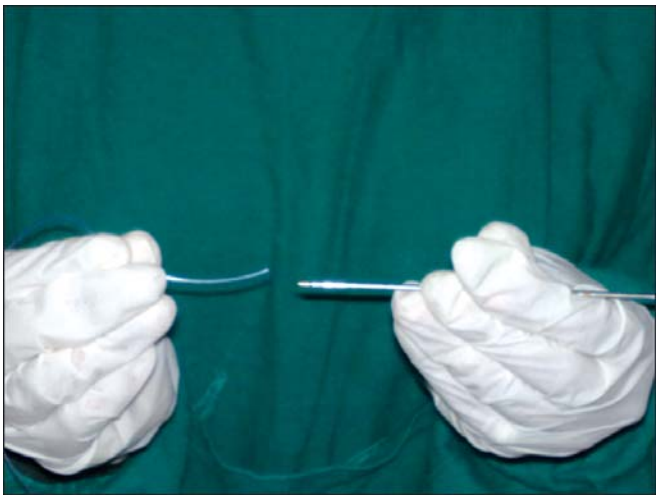


Fig. 14D

Fig. 14B

Fig. 14E

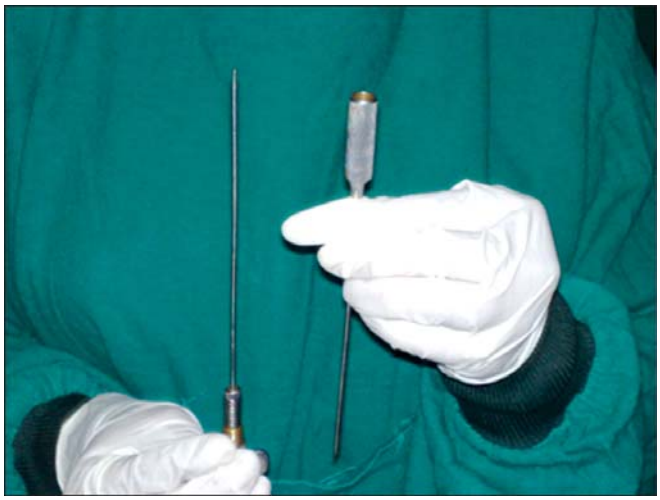


Fig. 14C

Fig. 14F

Fig. 14: Contd...

Contd...

Fig. 14G

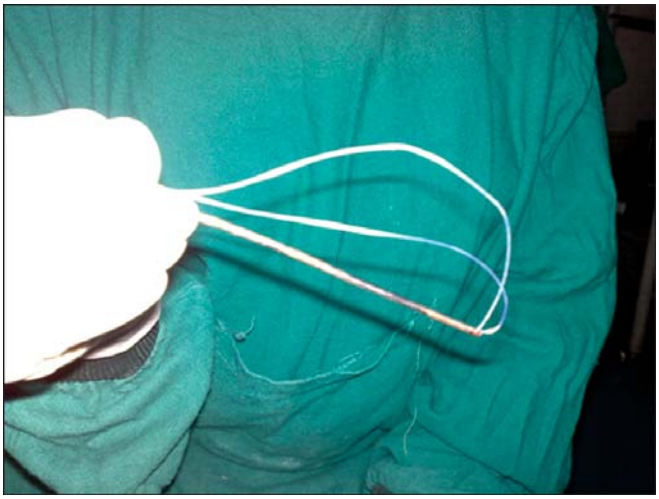


Fig. 14J

Fig. 14H

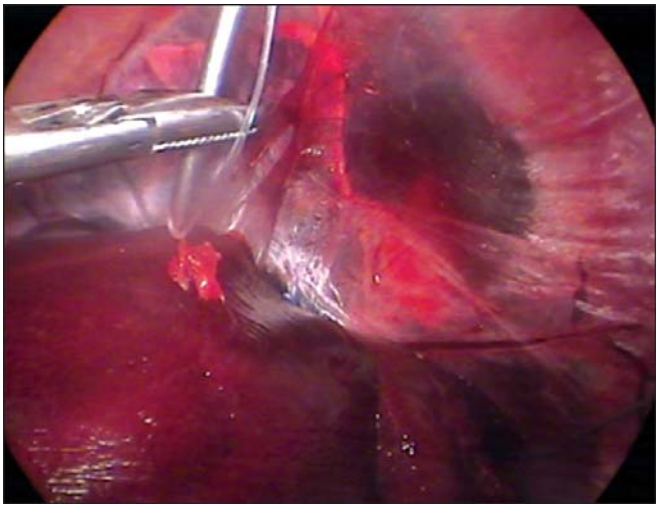


Fig. 14K

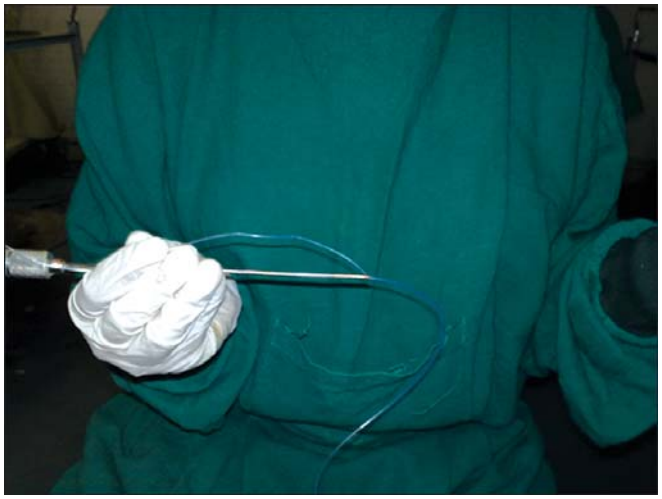


Fig. 14I

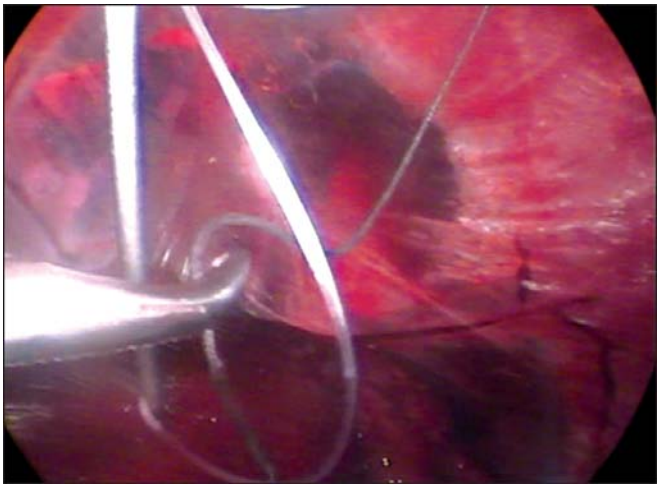


Fig. 14L

Fig. 14: Contd...

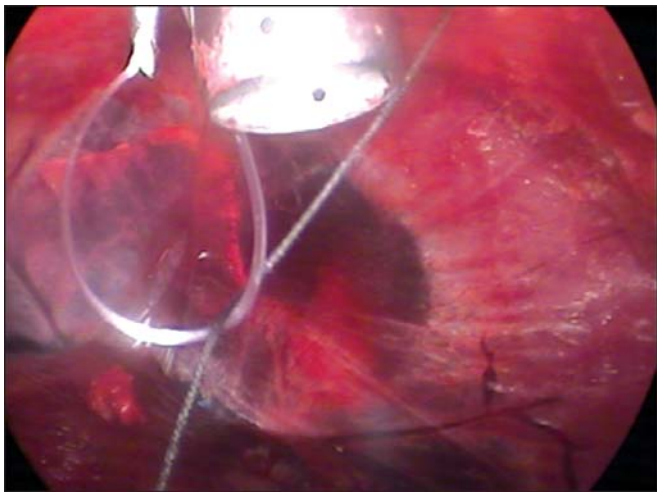


Fig. 14M

Fig. 14N

Figs 14A to N: Veress needle technique for port closure

potentially dangerous. The usual presentation involves crampy abdominal pain with nausea and vomiting. Treatment is by reduction of the bowel that is incarcerated, followed by repair of the fascial defect. Although some authors advocate open repair or local exploration combined with laparoscopy, the laparoscopic approach is acceptable treatment at the time of diagnosis, as long as the incarcerated bowel is not compromised or frankly ischemic.[30] The following risk factors for the development of trocar-site hernias have been identified: The trocar diameter, the trocar design, pre-existing fascial defects, and some operation and patient-related factors.[11] Many authors believe that inserting the 10 mm lateral trocar in an oblique fashion or as a Z-tract will reduce hernia formation by putting the external and internal fascias at different levels,[8-31] so It is recommended that all 10 and 12 mm trocar must be closed. The development of nonbladed obturators with integrated stability sleeves allows for creation of a muscle-splitting dilated laparoscopic port site with minimal abdominal wall defects after removal of trocar sleeves,[32,33] may play a role. There is a debate concerning 5 mm trocar fasciaclosure, especially in children.[27] Some authors insist that all laparoscopic puncture wounds, even those smaller than 10 mm, should be closed at the fascial level in infants. Kulacoglu, [34] Reardon et al,[25] and Nezhat et al[15] agree that it may not be necessary to recommend routine closure of all 5 mm port sites. However, when such a port has been used for active manipulation during a long operation, closure of the fascia should be considered to avoid hernia, port closure with the maintenance of the pneumoperitoneum during closure keeps the anterior abdominal wall away from the bowel, reducing the likelihood of iatrogenic injury. It also provides easy assessment of adequate closure by the acquisition of a "gas-tight" seal and allows the potential for intraperitoneal inspection of the closed port site via remaining lateral ports, further ensuring that the bowel is not implicated in the repair, and that homeostasis has been achieved,[35] at the end the perfiction of the clouser technique have proliferated and improvements are continuously being made. Practising surgeon should be congnisant of the full range of techniques while familiarizing themselves with the useful ones deemed simple, safe and effective.[36]

The comparisons among these techniques are beyond the aim of this illustrative review, applying a tighter closure of the skin incision may control the leak of the ascetic fluid in patient with ascitis, but for a short-time. The tight closure of fascia will prevent ascitic fluid leak.[6] For closure of the skin, transcutaneous closure with absorbable material seems to be the most suitable technique.[37]

REFERENCES

1. Knyrm K, Serdlitz H,Vakil H, et al. Prespectives in electronic endoscopy, past present and future of fibres and CC ds in medical endoscopy 1990;22 (suppl) 2-8.
2. Iqbal saleem-minimal access surgery the port site complications. Technology today July-sept 2003;10:3.
3. Earle DB. A simple and inexpensive technique for closing trocar sites and grasping sutures. J Laparoendosc Adv Surg Techni 1999;9:81-85.
4. Brody F, Rehm J, Ponsky J, Holzman M. A reliable and efficient technique for laparoscopic needle positioning. Surg Endosc 1999;13:1053-54.
5. Felix EL, Harbertson N, Vartanian S. Laparoscopic hernioplasty: Significant complications. Surg Endosc 1999;13:321-22.
6. Contarini O. Complication of trocar wounds. In: Meinero M, Melotti G, Mouret Ph (Eds). Laparoscopic surgery. Masson SP A, Milano, Italy 1994;38-44.
7. Elashry OM, Nakada SY, Wolf Jr JS, Figenshau RS, McDougall RV, Clayman RV. Comparative clinical study of port-closure techniques following laparoscopic surgery. J Am Coll Surg 1996;183:335-44.

8. Eltabbakh GH. Small bowel obstruction secondary to herniation through a 5 mm laparoscopic trocar site following laparoscopic lymphadenectomy. Eur J Gynaecol Oncol 1999;20:275-76.
9. Chatzipapas IK, Hart RJ, Magos A. Simple technique for rectus sheath closure after laparoscopic surgery using straight needles, with review of the literature. J Laparoendosc Adv Surg Tech A 1999;9:205-09.
10. Di Lorenzo N, Coscarella G, Lirosi F, Gaspari A. Port-site closure: A new problem, an old device. JSLS 2002;6(2):181-83.
11. Holzinger F, Klaiber C. Trocar-site hernias: A rare but potentially dangerous complication of laparoscopic surgery. Chirurg 2002;73:899-904.
12. Kadar N, Reich H, Liu CY, Manko GF, Gimpelson R. Incisional hernias after major laparoscopic gynecologic procedures. Am J Obstet Gynecol 1993;168:1493-95.
13. Krug F, Herold A, Wenk H, Bruch HP. Incisional hernias after laparoscopic interventions. Chirurg 1995;66:419-23.
14. Montz FJ, Holschneider CH, Munro MG. Incisional hernia following laparoscopy: A survey of the American Association of Gynecologic Laparoscopists. Obstet Gynecol 1994;84: 881-84.
15. Nezhat C, Nezhat F, Seidman DS, Nezhat C. Incisional hernias after operative laparoscopy. J Laparoendosc Adv Surg Tech A 1997;7:111-15.
16. Stringer NH, Levy ES, Kezmoh MP, Walker J, Abramovitz S, et al. New closure technique for lateral operative laparoscopic trocar sites: A report of 80 closures. Surg Endosc 1995;9:838-40.
17. Tonouchi H, Ohmori Y, Kobayashi M, Kusunoki M. Trocar site hernia. Arch Surg 2004;139:1248-56.
18. Azurin DJ, Go LS, Arroyo LR, Kirkland ML. Trocar-site herniation following laparoscopic cholecystectomy and the significance of an incidental preexisting umbilical hernia. Am Surg 1995;61:718-20.
19. Matthews BD, Heniford BT, Sing RF. Preperitoneal Richter hernia after a laparoscopic gastric bypass. Surg Laparosc Endosc Percutan Tech 2001;11:47-49.
20. Majeski J, Anthony E. An improved, inexpensive, quick,and easily learned technique for closure of all large abdominal trocar wounds after laparoscopic procedures. J Am Coll Surg 2002;194:391-93.
21. WT Ng. A full review of port-closure techniques Surg Endosc 2007;21:1895-97.
22. Nadler RB, McDougall E, Bullock AD, Ludwig MA, Brunt LM. Fascial closure of laparoscopic port sites: A new technique. Urology 1995;45:1046-48.
23. 1. Shaher Z (2007) Port closure techniques. Surg Endosc DOI:10.1007/s00464-006-9095-6, February 8, 2007.
24. Elashry O, Nakada SY, Stuart Wolf J, Sherburne Figenshau R, McDougall EM, Clayman RV. Comparative clinical study of port-closure techniques following laparoscopic surgery. J Am Coll Surg 1996;183:335-44.
25. Chapman WH III. Trocar-site closure: A new and easy technique. J Laparoendosc Adv Surg Tech A 1999;9: 499-502.
26. Jorge C, Carlos M, Alejandro W. A simple and safe technique for closure of trocar wounds using a new instrument. Surg Laparosc Endosc 1996;6:392-93.
27. Spalding SC, Ponsky TA, Oristian E. A new dual-hemostat technique to facilitate the closure of small laparoscopic trocar incisions. Surg Endosc 2002;17:164-65.
28. Calose Moreno, et al. Prevention of trocar site hernias Surgical Innovation 2008;15(2):100-04.
29. Textbook of Practical laparoscopic surgery. Dr RK Mishra (2nd edn) Jaypee publication.
30. Boughey JC, Nottingham JM, Walls AC. Richter_s hernia in the laparoscopic era: Four case reports and review of the literature. Surg Laparosc Endosc Percutan Tech 2003;13:55-58.
31. Hogdall C, Roosen JU. Incarcerated hernia following laparoscopy. Acta Obstet Gynecol Scand 1987;66:735-36.
32. Leibl BJ, Schmedt CG, Schwarz J, Kraft K, Bittner R. Laparoscopic surgery complications associated with trocar tip design: Review of literature and own results. J Laparoendosc Adv Surg Tech A 1999;9:135-40.
33. Liu CD, McFadden DW. Laparoscopic port sites do notrequire fascial closure when nonbladed trocars are used. Am Surg 2000;66: 853-54.
34. Kulacoglu IH. Comment. J Laparoendosc Adv Surg Tech A 2000;10:227-28.
35. Durkin DJ, Horner J. Further modification of the dual hemostat port closure technique. Surg Endosc 2005;19:1002.
36. Ng Wai -Tat, Luk. Hung-Review of techniques for port closure Surgical practice August 2007;11(3):115-20.
37. Buchweitz O, Wulfing P, Kiesel L. A prospective randomized trial of closing laparoscopic wounds by transcutaneous vs subcuticular suture or adhesive papertape. Surg Endosc 2005;19:148-51.

REVIEW ARTICLE

Avoiding of Nontherapeutic Laparotomies in Blunt Abdominal Trauma with Aid of Laparoscopy

Majid Yaas Khudhair

Department of Surgery, Hilla Teaching General Hospital, Babylon, Iraq

Abstract

Introduction: As there is particular danger that an injury to the diaphragm or intestines be overlooked. The decision in favor of surgery or nonoperative conservative treatment in abdominal trauma requires a precise diagnosis that is not always possible with imaging techniques. Owing to this circumstance, the indications for exploratory laparotomy should be generous with laparoscopy up to 41% of exploratory nontherapeutic laparotomies could be, or could have been, avoided.

Methods: Only in stable blunt abdominal trauma patients. A diagnostic laparoscopy with therapeutic option should only be attempted. three trocars are used and the exploration of the abdomen is systematic, beginning with the right upper quadrant and continuing clockwise injuries to the diaphragm. Small lacerations of the intestines and mesentery can be detected and sutured endoscopically parenchymal organs Injuries can be sealed with tissue adhesive and collagen tamponade to prevent further bleeding.

Results: The number of unnecessary laparotomies and the related morbidity can be reduced with routine use of laparoscopy, because it sensitivity reached 90-100% in abdominal trauma.

Conclusions: In stable blunt trauma patient minimally invasive surgery has become established as a useful tool. The future holds exciting scope for this field of surgery through innovative development in computer technology and robotic systems. The advantages are reduction of morbidity, shortening of hospitalization and cost-effectiveness.

Aims and objectives: The aim of this review is to show the benefits and risks of laparoscopy in blunt trauma patients.

The benefits: The main benefits of laparoscopy are that it can reduce the rate of nontherapeutic and negative laparotomies,identify diaphragmatic injuries accurately, and in some cases provide a therapeutic option. It should be emphasized that the use of laparoscopy as a diagnostic ortherapeutic method in patients with trauma is reserved only for hemodynamically stable patients. It should be kept in mind that laparoscopy has limitations in the diagnosis of hollow visceral injury. Laparoscopy can detect and repair diaphragmatic injuries and exclude the risk of nontherapeutic laparotomy due to a nonbleeding injury of the spleen or liver. Further advantages are reduced morbidity, shortened hospital stay, and lower cost.

The risks: (1) Overlooking of injuries, mainly involving the intestinal tract and so delaying their treatment, leading in turn to considerably increased morbidity; (2) Laparoscopy-specific complications, such as vascular and intestinal injuries; (3) Gas embolism.

Missed injuries are the most common of these three problems and probably pose the most serious risk, though the literature data are very unclear on this. While some authors find that laparoscopy is inadequate for detecting intestinal injuries.[3,4] Even a very experienced surgeon should not hesitate to convert to open technique if there is any uncertainty.[9] Minimally invasive surgery has become established as a useful tool in the management of trauma. The future holds exciting scope for this field of surgery through innovative developments in computer technology and robotic systems.

Material and methods: A literatures search was performed using Medline and the Search engine google, Springerlink and Highwire press. The following search terms were used: Laparoscopy, blunt trauma, diagnosis of abdominal trauma. Hundreds of literatures and papers published discussing this subject. The most recent selected. The selected papers were screened for farther references. Criteria for selection were the number of cases (excluded if less than 20), methods of analysis, operative procedure (universally accepted procedures were selected), and the institution where the study done.

Keywords: Laparoscopy, trauma, abdominal trauma, diagnosis of abdominal trauma.

INTRODUCTION

Laparoscopy has come to play an increasing role in the last 15 years to come into use as diagnostic and therapeutic methods in visceral trauma. In most industrialized countries, trauma is the most common cause of death in the younger population below the age of 50. About one-half of the deaths take place within minutes at the site of the accident; these are usually severe head and cardiovascular injuries. Thirty percent of the deaths occur within a few hours of the injury and the remaining 20% after days to weeks due to infections and multiorgan failure. In the second group, in which victims die within a few hours' conservative estimates indicate that some 20-30% of them could be saved with timely diagnosis and proper treatment. Laparoscopy has come to play an increasing role in this concept. It is primarily a diagnostic measure, but when feasible, also be

applied therapeutically in patients who have no obvious indications for emergency surgery for intra-abdominal injury still poses a significant clinical challenge, in spite of several diagnostic methods are available for evaluation of trauma patients. The management of trauma patients should avoid delay, provide prompt diagnosis and appropriate treatment, and avoid complications.

DISCUSSION

Information's from history and clinical examination can provide us clue to the extent of organ injuries and bleeding. After that, there are two radiological examinations that owing to technological developments in the last two decades, have come to provide high-quality information. These are sonography and computer tomography (CT), both of which can be applied quickly and efficiently to trauma patients, whereby hemodynamic stability is a prerequisite for a CT general or trauma surgeons can perform sonography in emergency room.

The focused assessment for the sonographic examination of the trauma patient (FAST) protocol is intended to determine the presence of free fluid in the abdominal cavity and assess its quantity and location.[5] It is noninvasive and nonstressful and can be repeated as necessary. With portable equipment, ultrasonography can be performed in emergency cases simultaneously with ongoing resuscitation without sedation, and it can also be done at the bedside without moving the patient. Rozycki et al[6] achieved a sensitivity of 83.3% and specifity of 99.7% in 1540 patients with blunt and penetrating injuries.

CT scan is noninvasive and can provide valuable supplemental information on the size, number, and extent of pathological changes. The findings can be determined very precisely and reproducibly. CT has 97% sensitivity, 98% specificity, and 98% accuracy for peritoneal violation.[10] In detecting bowel injury, CT has an overall sensitivity of 94% and 96% in detecting mesenteric injury.[11] Both sonography and CT show a weakness in diagnosing injuries to the diaphragm: Mihos et al.[1,16,17] achieved a correct preoperative diagnosis in only 26% of 65 patients with a diaphragmatic injury, and in 74%, the diagnosis was made during operation. With these high quality methods, there is still a degree of diagnostic uncertainty with blunt abdominal trauma, especially when the gastrointestinal tract and pancreas are involved.[12-15] This uncertainty justify for exploratory laparotomies undertaken to avoid overlooked injuries. A considerable number of these laparotomies is unnecessary or nontherapeutic and has corresponding morbidity to avoid overlooked injuries. A considerable number of these laparotomies are unnecessary or nontherapeutic and have corresponding morbidity. The literature shows that a variety of laparoscopic techniques are applicable to patients with abdominal trauma with good results. In a review by Villavicencio and Aucar, in two prospective studies screening laparoscopy for blunt trauma reported sensitivity of 90 to 100%, specificity of 86 to 100%, and accuracy of 88 to 100%.[2] In nine prospective series, screening laparoscopy for penetrating trauma reported sensitivity of 85 to 100%, specificity of 73 to 100% and accuracy of 80 to 100% with 2 procedure-related complications among 543 patients.[2] Diagnostic laparoscopy for blunt trauma reported sensitivity of 100%, specificity of 91%, and accuracy of 96%; for penetrating trauma, sensitivity of 80 to 100%, specificity of 38 to 86%, and accuracy of 54 to 89%.[2] Missed injuries with screening laparoscopy were 0.4% (6 of 1708 patients) and laparoscopy-related complications were 1.3% (22 of 1672 patients).[2] Laparoscopy can prevent laparotomy in 63% of patients with a variety of injuries.[2] The laparoscopic approach avoids a negative laparotomy in 23-54% of stab wound and blunt abdominal trauma patients.[9] Laparoscopy is cost-effective when compared with negative laparotomy.[8]

HOW TO PERFORM LAPAROSCOPY IN TRAUMA?

With three trocar the abdominal exploration can be perfomed in systemic manner.

The first access is achieved with open technique using 10 mm trocar at the umbilicus. Gas for the pneumoperitoneum should be insufflated slowly and carefully. After a preliminary inspection of the entire abdominal cavity, two further trocars are introduced on the right and left sides at the level of the navel and somewhat lateral to the medioclavicular line. These working trocars have a diameter of 5-10 mm . The abdomen is explored systematically, beginning with the right upper quadrant and proceeding clockwise. After a first fast survey, the exploration continues in the same order for a second time. This time, blood is vacuumed off into a cell-saver device and the liver, including the subphrenic surface and the visceral fascia, is explored. It is advantageous during this phase of the operation to have the table in the anti-Trendelenburg position to shift the abdominal organs caudally. In the supine position, the spleen is covered by the greater omentum and is not immediately visible. After the anterior wall of the stomach was inspected, the omentum is shifted caudally and the spleen is lifted from its bed with a blunt instrument. While the liver and spleen are being examined, the diaphragm can also be inspected. Even the most remote parts of the diaphragm can be explored more adequately by laparoscopy when compared with the open technique.

After the upper abdominal organs, the left flank with the left flexure, descending colon and sigmoid are examined for injuries down to the left lower quadrant. Then the operating table is brought into the Trendelenburg position for examination of the rectum, Douglas space, and urinary bladder and, in women, the internal genital organs. The examination is continued in the right lower quadrant with the cecum and right hemicolon. The omentum is shifted cranially so that the small intestine can be examined.

Using two atraumatic grasping forceps, the small intestine is followed from the ileocecal region in the oral direction to the duodenal-jejunal flexure. Exploration of the duodenum, posterior

gastric wall, and pancreas is only indicated when injury to these organs is suspected. It is justified when there are hematomas or thrombi adherent on these organs and/or on the basis of a CT image. Treatment depends on the equipment available in the respective hospital and the surgeon's personal experience.

CONCLUSION

In stable blunt trauma patient minimally invasive surgery has become established as a useful tool. The future holds exciting scope for this field of surgery through innovative development in computer technology and robotic systems. The advantages are reduction of morbidity, shortening of hospitalization and cost-effectiveness.

REFERENCES

1. Mihos P, Potaris K, Gakidis J, Paraskevopoulos J, Varvatsoulis P, et al. Traumatic rupture of the diaphragm: Experience with 65 patients. Injury 2003;34:169-72.
2. Villavicencio RT, Aucar JA. Analysis of laparoscopy in trauma. J Am Coll Surg 1999;189:11-20.
3. Ivatury RR, Simon RJ, Stahl WM. A critical evaluation of laparoscopy in penetrating abdominal trauma. J Trauma 1993;34:822-28.
4. Livingstone DH, Tortella BJ, Blackwood J, Machiedo GW, Rush BF. The role of laparoscopy in abdominal trauma. J Trauma 1992;33:471-75.
5. Ballard RB, Rozycki GS, Newman PG, Cubillos JE, Salomone JP, et al. An algorithm to reduce the incidence of false-negative FAST examinations in patients at high risk for occult injury. J Am Coll Surg 1999;189: 145-51.
6. Rozycki GS, Ballard RB, Feliciano DV, Schmidt JA, Pennington SD. Surgeon-performed ultrasound for the assessment of truncal injuries: Lessons learned from 1540 patients. Ann Surg 1998;228:557-67.
7. Uranüs S, Pfeifer J. Nonoperative treatment of blunt splenic injury. World J Surg 2001;5:1405-07.
8. Smith RS, Fry WR, Morabito DJ, Koehler RH, Organ CHJr. Therapeutic laparoscopy in trauma. Am J Surg 1995;170:632-36.
9. Chol YB, Lim KS. Therapeutic laparoscopy forabdominal trauma. Surg Endosc 2003;17:421-27.
10. Shanmuganathan K, Mirvis SE, Chiu WC, Killeen KL, Hogan GJF, et al. Penetrating torso trauma: Triple-contrast helical CT in peritoneal violation and organ injury – A prospective study in 200 patients. Radiology 2004;231:775-84.
11. Killeen KL, Shanmuganathan K, Poletti PA, Cooper C, Mirvis SE. Helical computed tomography of boweland mesenteric injuries. J Trauma 2001;51:26-36.
12. Hata M, Murao Y, Konobu T, Okuchi K, Nakajima Y. "Laparoscopic treatment for peripheral pancreatic duct injury after blunt abdominal trauma: Report of a case" Surg Today 2002;32:659-62.
13. Higashitani K, Kondo T, Sato Y, Takayasu T, Mori R, Ohshima T. "Complete transection of the pancreas due to a single stamping injury: A case report" Int J Legal Med 2001;115:72-75.
14. Lucas, CE. "Diagnosis and treatment of pancreatic and duodenal injury" Surg Clin North, Am 1977;57:49-65.
15. Mayer JM, Tomaczek R, Rau B, Gebhard F, Beger HG. "Pancreatic injury in severe trauma: Early diagnosis and therapy improve the outcome" Dig Surg 2002;19:291-99.
16. Tyburski JG, Dente CJ, Wilson RF, Shanti C, Steffes CP, Carlin A. "Infectious complications following duodenal and/or pancreatic trauma" Am Surg 2001;67:227-30.
17. Zimmermann T, Henneking K, Kelm C, Padberg W, Schwemmle, K. "Pankreaspseudozysten nach stumpfen Bauchtraumata" Langenbecks Arch Chir 1993;378:102-05.

REVIEW ARTICLE

Laparoscopic versus Intraoperative Ultrasound in the Diagnostic of Liver Tumors

María A Matamoros

Director of the Hepatobiliary and Liver Transplant Center, Caja Costarricense del Seguro Social, San José, Costa Rica

Abstract

Introduction: Intraoperative ultrasound has become the gold standard complementary study to surgical decision making in liver surgery. In this review are analyze different variables to identified if laparoscopy ultrasound findings are equal or better than intraoperative ultrasound.

Methods: A literature search was performed using Medline and Highwire Press data base. The following search terms were use: "laparoscopic ultrasonography", "intraoperative ultrasonography" and "liver tumors". 447 citations found in total. Criteria for selection of literature were number of cases (excluded if less than 20), Ultrasonography studies IOU and LU of different types of tumors: neuroendorcrine, HCC and colon metastasis were included, and method of analysis (statistical or nonstatistical).

Results: The variables analyze in the studies selected were as follows: Method of patients selection, operative technique, operating time, irresectability, postoperative morbidity, number of new tumors missed by IOU or LIOU, surgical plan changed after IOU or LIUO and Hospital stay. Patient's selection was based in patient having any type of liver tumor. Operative technique was performed in cases of IOU by conventional laparotomy, and in laparoscopy cases were use mainly 2 subcostal ports and the umbilical port. Operating time was estimated surgical prolongation of 30 minutes in the laparoscopy cases. Morbidity was lower in LIOU cases than in IOU. Lesions missed by LIOU and IOU, both methods showed a higher sensitivity in finding small lesions than other complementary diagnostic studies. Hospital stay was considerable shorter in LIOU.

Conclusions: Laparoscopy ultrasound has demonstrated to be very useful in diagnostic of liver tumor lesions. Therefore, there is big room for the LIOU improved in diagnostic liver tumors. New and improved LIOU probes would very soon allow similar findings than IOU. Targeting laparoscopy to patients at high risk for unresectable disease requires consideration to avoid unnecessary laparotomy.

Aim and objectives: The aim of this study is to compare the effectiveness of laparoscopic ultrasonography (LU) *versus* the open intraoperative ultrasonography.
The following parameters were evaluated for both IOU and LIOU:

1. Method of patients selection.
2. Operative technique.
3. Operating time.
4. Intraoperative and postoperative complications.
5. Postoperative morbidity.
6. Number of new tumors missed by IOU or LIOU.
7. Surgical plan changed after IOU or LIUO.
8. Hospital stay.

Material and methods: A literature search was performed using Medline and Highwire Press data base. The following search terms were use: "laparoscopic ultrasonography", "intraoperative ultrasonography" and "liver tumors". 447 citations found in total. Selected papers were screened for further references. Criteria for selection of literature were number of cases (excluded if less than 20), Ultrasonography studies IOU and LU of different types of tumors: Neuroendocrine, HCC and colon metastasis were included, and method of analysis (statistical or nonstatistical).

Keywords: Laparoscopic ultrasound, diagnostic laparoscopy, laparoscopic tumor resection, laparoscopy for cancers.

INTRODUCTION

Intraoperative ultrasonography (IOU) has become the gold standard tool in liver surgery. Patients diagnosed with colon cancer approximately one fifth have occult metastases at the time of the presentation. It has been demonstrated the sensibility of IOU in diagnosed liver tumors is high. IOU in combination with other radiological studies prior the surgery improved the diagnosed of the liver lesions. Nowadays IOU is use to perform tumor staging, metastatic survey, and guidance for whole organ or split liver and metastasectomy, metastatic survey, intrahepatic biliary tree and vascular structures evaluation. Laparoscopy ultrasound is not always available as it is the IOU probes because not all the ultrasound scanners have adequate their probes to use in laparoscopy. Since it became available, some centers started to switch form the IOU to laparoscopy ultrasonography. The development of dedicated linear array probes improve the feasibility to have a good image and better contact with the liver surface. Before, transluminal probes were used through

laparoscopic probes making the procedure very cumbersome and had bad image quality of 1.4 cm depth.[1]

A good laparoscopy probe might have less than 10 mm to be able to introduce in a 10 mm laparoscopy port. Ideally, the length of the probe should be 35-50 cm to access adequately the abdominal cavity. The IOU probes generally come in 5-10 MHz. Actually majority of this LS probes come in 5-10 MHz as it is in IOU. The 5-10 MHz probes allow a penetration depth of 4-10 cm. And the LS come with a flexible tip to maximize it capability to scan difficult angles of abdominal organs.

Regarding the technique of the IOU is use the regular bilateral subcostal approach used for liver surgery. The most common technique of laparoscopy approach describe in SAGES guidelines is one trocar placed periumbilically with other trocar subcostally and a last one placed xyphoid or under the left costal marging at the level of the midaxillary line and the anterior axillary line.[1]

CONTENT

The papers reviews mostly look at the feasibility of increased diagnosed by laparoscopy ultrasonography. It is well known the need of intraoperative ultrasound diagnosis in liver surgery. Then we show here the information collected.

NUMBER OF PATIENTS INVOLVED IN THE STUDIES

A total number 2580 patients are analyze in this review.[2-21] 946 out of 1290 with different types of tumors received as a complementary diagnostic ultrasound laparoscopy. And total number of 1290 patients received as a complementary diagnostic ultrasound with conventional laparotomy. All this studies were performed in patients with colorectal cancer, primary HCC and endocrine tumors.

OPERATIVE TECHNIQUE

IOU was perform in all of the cases through conventional laparotomy. LIOU approach was carried out under general anestesia CO_2 pneumoperitoneum was induced by using a standard open technique or a Veress needle. Access to the abdominal cavity was obtained by three 10 or 11 mm trocars (umbilical and left and right subcostal). Laparoscopic examination was complete if anterior and posterior surfaces of the right and left hepatic lobes, the gastrohepatic omentum, porta hepatis, pelvis, and peritoneal cavity were well-visualized. If feasible, adhesions were taken down laparoscopically.[6,7]

NUMBER OF NEW TUMORS MISSED BY IOU OR LIOU

Although IOU had the highest sensitivity for the detection of HCC lesions, it could not visualize all of the primary tumors in 14 cases (2.6%) in Dr Zhang study of 430 cases. The non-identifiable lesions were 10 at the primary hepatectomy and 4 at the second hepatectomy. The lesions missed by IOU were very small, all of them less than 10 mm. Three small lesions out of 10 were positive on lipidol CT.[4] When it compares the LIOU with CT, LIOU showed more sensitivity than CT in finding lesions between 0.3 to 2.4 cm. But we can not conclude out of these findings that LIOU is better than IOU because there is more data need. Actually, it should be more difficult accessing some liver segments due to the shape of the LIOU.[22]

IRRESECTABILITY

One of the biggest advantage of minimal access surgery in terminal patients or patients that do not meet the conditions to received the benefit of tumor resection, is the feasibility to overcome faster the surgical procedure and follow other alternative treatment, like chemotherapy, alcohol injection, chemoembolization or radiofrequency ablation.

The benefit to the patient with unresectable liver disease is clearly address in several papers, as it is the sensitivity to find small tumors, and give and early opportunity to the patient feasible to go under liver resection.

A total of 232 patients in the group of LIOU from 7 studies look to the data and refine diagnosed of irresectability. All this patients had complementary studies, CT, transabdominal ultrasound and MRI. The irresectability of the tumor or tumors was found in LIOU. Therefore, when this finding is done with IOU, means for the patient an unnecessary laparotomy with a larger probability of morbidity, larger length of hospital stay and delay in palliative treatment. 268 patients in enroll in 6 studies had tumor irresectability after IOU. Majority of the studies of IOU compares the IOU with other complementary studies, and did not take in account this important variable of irresectability.

SURGICAL PLAN CHANGED

Ninety-six patients out of 1290 that underwent LIOU, the previous surgical plan were changed to another one in term of liver resection. The fact is only 2 papers were looking to this variable out of 8 papers in the group of LIOU and 4 papers out of 8 in the IU group.[4,19-21] In the group of IOU 72 patients, the surgical decision making was changed after different tumor findings. This variable we are included the patients when this variable was included in the study by the authors. Data of irresectability is not included here, but could also be here in terms of modification in decision making and surgical plan changed. It would increase the numbers of patients and it has a clear diagnostic impact in the clinical setting.

SURGICAL TIME

This variable was address in only 2 papers, one of this compare IOU time with LIOU. In this comparison time consuming of LIOU was just 30 minutes prolonged conventional laparotomy. Other paper does not compare but give us their time in LIOU which is 58 ± 19 minutes.[6]

MORBIDITY

Three papers out of 8 analyze the morbidity of LIOU. Then numbers in each paper describe only minor complications after LIOU. MD Angelica describes in his data 27% of morbidity after IOU. The same author claim to have only 9% of morbidity in the cases performs by LIOU. There is significant difference in morbidity in MD'Angelica study that compares the advantage of LIOU *vs* IOU.[16]

HOSPITAL STAY

Hospital stay was much shorter in LIOU. Average stay was 2 days. The longest stay in patients who underwent LIOU was 5 days. The median hospital stay describe by Dr Lai in the of the laparoscopic treatment group was significantly shorter than for the open treatment group for patients with unresectable HCC (5 *vs* 7 d; P = 0.003).[3] Other authors in the LIOU report a range of 1.3-1.5 median hospital stay days. If we compare the standard stay of 8 days after IOU perform through a conventional laparotomy approach. There is a remarkable advantage when we analyze the hospital stay between these two procedures.

DISCUSSION

The liver primary and secondary tumors treatment have changed toward a more aggressive approach. Indications for metastasis resection are treated more aggressively and it surgical approach is perform by local or segmental resection for multiple lesions and bilobar disease. Definitely, a better definition of liver anatomy and the skill evolved in the use of IOUS has led to a much more safe and practical approach of these lesions.[6]

Small liver metastasis about 1 cm can be find with Intraoperative US (IOUS), for that reason is considered the gold standard, it has a sensitivity of 80% for evaluating this small liver lesions.[17]

LIOU was able to identify 55% of patients with unresectable disease, suggesting that there is much room for improvement.[4] The difficult recognize as and advantage of IOU over LIUO is the possibility to identify vascular invasion and invaded lymph nodes. Clearly, if staging laparoscopy for hepatobiliary malignancy is to be improved, efforts must be directed at better identifying vascular invasion and metastatic disease in lymph nodes. The grade of vascular invasion is difficult to establish by image studies and in particular cases only are possible to find in the pathological specimen. Because of vascular invasion is a difficult issue, most of the patients do not have encasement of vessels on imaging studies or laparoscopy, but rather have only a suggestion of vessel contact, which can often be assessed only at operation. Lymph node metastasis requires persistence at finding and requires some level of advanced laparoscopic skills and could probably require additional operative time.[4] Unresectable disease was defined as presence of histological proven extrahepatic metastases; severe cirrhosis of the proposed liver remnant, precluding resection; or extensive disease without the possibility of leaving a sufficient liver remnant, precluding radical resection.[6]

There are some issues that are very important do discuss here. First, any surgeon performing IOU has to be experience in transabdominal ultrasonography and have some basic knowledge in ultrasonography. Second, the surgeon has to be familiarized with the available probes for the ultrasound scanner, the ones use for transabdominal, intraoperative and laparoscopy. Third, the experience is very important because each different probe offers a different image and sometime area and image varies depending on how the ultrasound crystals are aligning in the probe. There are new probes coming tote market-offering improvements with working channels and biopsy needle guide. Other characteristics have to be analyze, for example echogenicity of the lever metastasis. But for sure it would take a longer time and experience to raised consistent conclusions. Many authors agreed that IOU sensitivity might be good for small lesions with different textures.[8]

Limitation of the LIUO that require converting the patient to open surgery, were cases with multiple adhesions due to previous surgeries. SMM Castro report in his study five patients (13%) from the LIOU group could not be performed because of adhesions from previous surgery.[6]

CONCLUSION

Laparoscopy ultrasound has demonstrated to be very useful in diagnostic of liver tumor lesions. Therefore, there is big room for the LIOU improved in diagnostic liver tumors. New and improved LIOU probes would very soon allow similar findings than IOU. Targeting laparoscopy to patients at high risk for unresectable disease requires consideration to avoid unnecessary laparotomy.

REFERENCES

1. Guidelines for the Use of Laparoscopic Ultrasound. Practice/ Clinical Guidelines published on: 03/2009(by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES).
2. Klaus Thaler, Shalini Kanneganti, Yashohdan Khajanchee, Charlyn Wilson RN, Lee Swanstrom, Paul D. Hansen. The Evolving Role of Staging Laparoscopy in the Treatment of Colorectal Hepatic Metastasis Arch Surg/ Vol 140, Aug 2005.
3. Lai EC, Tang CN, Ha JP, Tsui DK, Li MK. The evolving influence of laparoscopy and laparoscopic ultrasonography on patients with hepatocellular carcinoma. Am J Surg. Nov 2008;196(5):736-40.
4. Keming Zhang, Norihiro Kokudo, Kiyoshi Hasegawa, Junichi Arita, Wei Tang, Taku Aoki, Hiroshi Imamura, Keiji Sano, Yasuhiko Sugawara, Masatoshi Makuuchi, Detection of New Tumors by Intraoperative Ultrasonography During Repeated Hepatic Resections for Hepatocellular Carcinoma. Arch Surg. 2007;142(12):1170-75.
5. Casaccia M, Andorno E, Nardi I, Troilo B, Barabino G, Santori G, Valente U. Laparoscopic US-guided radiofrequency ablation of unresectable hepatocellular carcinoma in liver cirrhosis:

Feasibility and clinical outcome. J Laparoendosc Adv Surg Tech A. Dec 2008;18 (6):797-801.
6. SMM de Castro, EHBM Tilleman, ORC Busch, OM van Delden, JS Laméris, TM van Gulik, H Obertop, DJ Gouma. Diagnostic Laparoscopy for Primary and Secondary Liver Malignancies: Impact of Improved Imaging and Changed Criteria for Resection . Annals of Surgical Oncology, 11(5):522-29.
7. Gruenberger T, Jourdan J. Echogenicity of Liver Metastases is an Independent Prognostic Factor After Potentially Curative Treatment. Arch Surg 2000;135:1285-90.
8. Michael A Choti, Fanta Kaloma, Michelle L, de Oliveira, Samah Nour, et al. Patient Variability in Intraoperative Ultrasonographic Characteristics of Colorectal Liver Metastases. Arch Surg 2008;143(1):29-34.
9. MD'Angelica, W Jarnagin, R Dematteo, K Conlon, LH Blumgart, et al. Staging Laparoscopy for Potentially Resectable Noncolorectal, Nonneuroendocrine Liver Metastases. Annals of Surgical Oncology 9(2):204-09.
10. MD'Angelica, Y Fong, S Weber, M Gonen, RP DeMatteo, et al. The Role of Staging Laparoscopy in Hepatobiliary Malignancy: Prospective Analysis of 401 Cases. Annals of Surgical Oncology 10(2):183-89.
11. Klaus Thaler, Shalini Kanneganti, Yashohdan Khajanc Charlyn Wilson, RN Lee Swanstrom; Paul D. Hansen. The Evolving Role of Staging Laparoscopy in the Treatment of Colorectal Hepatic Metastasis. Arch Surg. Aug 2005;140.
12. Skrovina M, Bartos J, Cech B, Velkoborsky M, Czudek S, Kycina R, Bartos P, Adamcík L, Konvicna R, Soumarova R. Intra-operative liver ultrasound: A contribution to colorectal carcinoma staging. Acta Chir Belg. Sep-Oct 2008;108 (5):508-12.
13. Agrawal N, Fowler AL, Thomas MG. The routine use of intra-operative ultrasound in patients with colorectal cancer improves the detection of hepatic metastases. Colorectal Dis. 2006 Mar;8(3): 192-94.
14. G Li Destri, F Di Benedetto. Metachronous liver metastases and resectability: Fong's score and laparoscopic evaluation . HPB, 2008;10: 13-17.
15. Guidelines for the use of Laparoscopic Ultrasound in Liver Disease. Published on: 03/2009 by the Society of American Gastrointestinal and Endoscopic Surgeons SAGES)
16. MD'Angelica, Y Fong, S Weber, M Gonen, RP DeMatteo, K Conlon, LH Blumgart, WR Jarnagin. The Role of Staging Laparoscopy in Hepatobiliary Malignancy: Prospective Analysis of 401 Cases. Annals of Surgical Oncology 10(2):183-89.
17. RD Kim, P Nazarey, E Katz, RS Chari. Laparoscopic staging and tumor ablation for hepatocellular carcinoma in Child C cirrhotics evaluated for orthotopic liver transplantation.
18. Kuszyk BS, Bluemke DA, Urban BA, et al. Portal-phase contrast-enhanced helical CT for the detection of malignant hepatic tumors: Sensitivity based on comparison with intraoperative and pathologic findings. AJR Am J Roentgenol 1996;166:91-95.
19. Kulig J, Popiela T, Kl ek S, Milanowski W, Kol odziejczyk P, Szybiñski P, Richter P. Intraoperative ultrasonography in detecting and assessment of colorectal liver metastases. Scand J Surg 2007;96(1):51-55.
20. Zacher J, Scheuba C, Imhof M, Zacherl M, Längle F, et al. Current value of intraoperative sonography during surgery for hepatic neoplasms. World J Surg. May 2002;26(5):550-54.
21. Cervone A, Sardi A, Conaway GL. Intraoperative ultrasound (IOUS) is essential in the management of metastatic colorectal liver lesions. Am Surg. Jul 2000;66(7):611-15.
22. Arash Foroutani, Adella M, Garland; Eren Berber; Andreas String; Kristen Engle, Tamara L. Ryan; Jeffrey M. Pearl; Allan E. Siperstein. Laparoscopic Ultrasound vs Triphasic Computed Tomography for Detecting Liver Tumors. Arch Surg/ Aug 2000;135.

REVIEW ARTICLE

Transperitoneal Laparoscopic Ureterolithotomy versus Retroperitoneoscopic Ureterolithotomy

Mark C Cellona

St. Luke's Medical Center, Quezon City, Philippines

Abstract

Background and purpose: Most ureterolithiasis that require surgical management are currently managed with minimally invasive procedures like shockwave lithotripsy, ureteroscopy with lithotripsy and percutaneous nephrolithotripsy. In cases where the above procedures will most likely fail or has failed, laparoscopic ureterolithotomy in either transperitoneal laparoscopic ureterolithotomy (TPUL) or retroperitoneoscopic ureterolithotomy (RPU) is a viable option compared to open ureterolithotomy. The goal of this review is to compare the effectiveness and safety of transperitoneal laparoscopic ureterolithotomy and retroperitoneoscopic ureterolithotomy in the treatment of large, chronically impacted ureterolithiasis or as salvage treatment after failed shockwave lithotripsy, ureteroscopy and percutaneous nephrolithotomy by reviewing patient selection, operative time, blood loss, hospital stay, complications, open conversion rate and success rate.

Material and methods: A systematic literature search was performed using Highwire press, Medline, Springer link, Medscape, Google and article bibliographies to identify relevant references. Included studies must have reported outcome data for more than 20 patients with a minimum follow-up of 3 months. Stone size, operating time, blood loss, hospital stay, complications, open conversion rate and success rate were reviewed.

Aims and objectives: The aim of this study was to compare the effectiveness and safety of transperitoneal laparoscopic ureterolithotomy (TPUL) and retroperitoneoscopic ureterolithotomy (RPU) in the surgical management of ureterolithiasis. The following parameters were evaluated for both procedures.

1. Operative technique.
2. Stone size.
3. Operating time.
4. Hospital stay.
5. Intraoperative and postoperative complications.
6. Open conversion rate.
7. Success rate.

Conclusion: Transperitoneal Ureterolithotomy and retroperitoneoscopic ureterotomy were both effective procedures in the management of ureterolithiasis. Both procedures are comparable in terms of blood loss, hospital stay and success rates. RPU seemed to have a higher complication and open conversion rate compared to TPUL.

Keywords: Laparoscopy, retroperitoneoscopy, ureterolithiasis, ureterolithotomy, secondary treatment of ureteral stones.

INTRODUCTION

Currently, shockwave lithotripsy and ureteroscopy are the first line treatments for patients with ureterolithiasis requiring surgical management.[1] However, in certain difficult cases, such as with multiple, large, impacted stones and failure to the initial surgical treatment, other options may be considered.[1] In such cases, the results of these procedures are poor, and a good number of patients need multiple treatment sessions with their corresponding costs and morbidity.[2] Open ureterolithotomy is indicated in these situations,[3] but it has inherent patient morbidity, making it less acceptable to patients. Laparoscopy can reproduce the steps of open surgery in this circumstances but with far less invasive methods.[4-6] Laparoscopic approach to ureterolithiasis can transperitoneal[6-10] or retroperitoneal.[11-18] This paper will attempt to compare both procedures in terms of its efficacy, advantages and disadvantages and complications.

RESULTS

A total of 114 articles were found. Fourteen articles met the inclusion criteria. Two articles came from the same institution with a possibility of double counting so the article with the less number of patients was excluded. Five articles investigated TPUL (Table 1) while 8 articles investigated RPUL (Table 2). There was no randomized controlled trial (RCT) study comparing both procedures. One article is a RCT but it compared TPUL with percutaneous nephrolithotripsy (PCNL) and ureteroscopy (URS). Most of the articles were case series with one article comparing the operative time of TPUL and RPU only. A

total of 750 patients were enrolled with 752 procedures. 238 patients underwent TPUL while 414 patients underwent RPU.

PATIENT SELECTION

Of the 237 patients who underwent TPU, Turk and associates[7] had 21 patients, 10 of them were failures of SWL and ureteroscopy. Feyaerts[6] had 24 a total of 24 patients with 3 patients underwent RPU instead of TPUL. In 10 cases, the procedure was indicated as a salvage treatment after SWL, URS, both SWL and URS, laparoscopic ureterolithotomy, and even open ureterolithotomy failures. El-Feel[8] had 25 patients and studied the effect of BMI, location of stone (upper or lower ureter), and laterality on operative time. There was no significant difference between normal and overweight patients, upper or lower ureter as well as left or right ureter on operative time .[8] Simforoosh[9] in 2006 had the most number of patients enrolled at 123. 104 patients underwent TPUL and 19 patients underwent RPU. Basiri[10] did a RCT comparing TPUL with ureteroscopy (URS) with lithotripsy and PCNL in the management of stones in the upper and mid ureter. Results showed that TPUL had a significantly longer operative time and hospital stay compared to both URS and PCNL. On the other hand, TPUL had a significantly higher stone free rate at discharge (88%) compared to URS (54%) and PCNL (64%). Also, TPUL (10%) had a significantly lower secondary procedure rate compared to ureteroscopy (22%).

Seven articles investigated mostly on RPU and a total of 414 cases overall. Goel[11] did a study comparing RPU with open ureterolithotomy. RPU was comparable to open surgery in terms of operative time and blood loss but laparoscopic procedure was significantly better for analgesia, cosmesis, hospital stay, and convalescence. Gaur[12] in 2002 had 100 patients underwent RPU and 1 patient underwent TPUL. The procedure was done as a salvage treatment for failed URS and SWL in 37 cases and for chronically impacted stones in 36 cases. He noted that urine leakage postsurgery was longer if the ureter is left open and unstented (7.1 days) compared to when it is sutured (5 days), sutured without stenting (4.4 days) and sutured with stenting (3.2 days). Hemal[13] had 31 patients who underwent RPU with 18 of then as salvaged treatment after earlier attempts with URS and SWL failed. Demirci[14] in 2004 had 21 patients underwent RPU for failed SWL (16 cases) and impacted stones (5 cases). Soares[15] and associates had 34 patients underwent retroperitoneoscopic stone surgery to assess its effectiveness. 20 patients had proximal ureterolithiasis while 14 had renal stones. Most of the patients underwent the procedure as salvage therapy with only 8 cases as primary treatment modality. Flasko[16] had 73 patients who underwent 75 procedures, 69 cases with RPU and 6 cases with TPUL. Kivjikai[17]had 30 patients who were mostly treated with RPU as primary treatment and the rest for failed SWL or for patients who can't afford SWL. El-Moula[18] in 2008 had a total of 74 patients. 66 of them underwent RPU and 8 underwent TPUL. 38 patients underwent the procedure due to large impacted stones, 25 patients for failed SWL and 11 patients due to patient preference.

STONE SIZE

Only three articles had details on stone size in TPUL. El-Feel[8] reported stone size ranging from 1.3 to 2.9 cm with a mean size of 1.9 cm. Simforoosh[9] had patients with stone size ranging from 1 to 5.6 cm while Basiri reported patients with a mean stone size of 2.24+/– 3.2 cm. Six articles had details on stone size of patients who had RPU. Goel[11] reported stone size ranging from 0.7 to 3.3 cm with a mean size of 2.1 cm while Gaur[12] reported stone size ranging from 1-4.7 cm with a mean size of 1.6 cm. Hemal[13] reported a mean stone size of 2.2 cm in his patients. Also, Soares[15] reported stone size ranging from 0.5 to 6 cm but it included renal stones aside from ureterolithiases. Flasko[16] had patients with stone size ranging from 1.2 to 5.5 cm with a mean stone size of 2.5 cm while Kivjikai[17] reported patients with stone size ranging from 1 to 4 cm with a mean size of 1.9 cm. El-Moula[18] who had patients with middle and upper ureterolithiasis had stone size ranging from 1.5 to 2.8 cm with a mean stone size of 1.8 cm.

OPERATIVE TIME, BLOOD LOSS AND HOSPITAL STAY

Five articles reported details on the operative time in TPUL while six articles had details on operative time in patients who had RPU. Turk et al reported a mean operating time of 90 minutes.[7] Feyaerts[6] had a similar report with a mean operating time of 111 minutes (range, 45-180 minutes). El-Feel[8] had operating time ranging from 55 to 180 minutes with a mean operating time of 145 minutes. Simforoosh[9] reported a mean operating time 132+/– 52.2 minutes for TPU and 171.3+/– 91.3 minutes for RPU. This is the only study that compared operative time on both procedures with RPU taking a longer time than TPUL. Basiri[10] reported a mean operating time of 127.8+/– 41.8 minutes. In patients who underwent RPU, Goel[11] reported a mean operating time of 108.8 minutes (range, 40-275 minutes) while Gaur[12] had a mean operating time of 79 minutes. Hemal[13] reported a mean OR time of 67 minutes (range, 40-97 minutes) while Soares[15] had a variably longer mean OR time of 140 minutes (range, 60-260 minutes). Flasko[16] reported the shortest mean operating time of 45 minutes (range, 15-100 minutes) while Kivjikai[17] reported a mean operating time of 121.4 minutes (range, 75-240 minutes). El-Moula[18] had a mean OR time of 58.7 minutes, ranging from 30 to 125 minutes.

Regarding blood loss, only one article on TPUL had details. El-Feel[8] reported blood loss ranging from 50-100 ml with a mean blood loss of 62.5 ml. On patients who underwent RPU, 5 articles had details on blood loss. Goel[11] had a mean blood loss of 58.5 ml (range, 25-75 ml) while Gaur[12] had a mean blood loss of 25 ml (range, 5-100 ml). Demirci[14] reported blood loss ranging from 45-190 ml with a mean blood loss of 105 ml while Kivjikai[17] reported blood loss ranging from 20-100 ml with a mean blood loss of 39.31 ml. El-Moula[18] reported a mean blood loss of 90.6 ml (range, 30-200 ml). Blood loss was relatively insignificant on all studies with details and no blood transfusion was necessary.[8,11,12,14,17,18]

Four articles documented the length of hospital stay on patients who underwent TPUL. Turk[7] had hospital stay ranging from 1 to 4 days. Feyaerts[6] had an average hospital stay of 3.8 days (range, 2-10 days) while El-Feel[8] had an average hospital stay of 4.1 days (range, 2-21 days). Basiri[10] reported a mean hospital day of 5.8+/– 2.3 days. Eight articles provided details on hospital stay in RPU patients. Goel[11] reported hospital stay ranging from 2-14 days with an average hospital stay of 3.3 days. Gaur[12] had a mean hospital stay of 3.5 days while Hemal[13] had a mean hospital stay of 2.4 days (range, 2-3 days). Demirci[14] reported an average hospital stay of 6 days (range, 3-22 days) while Soares[15] had a mean hospital stay of 3 days (range, 1-10 days). Flasko[16] had hospital stay ranging from 2 to 5 days with an average of 3 days while Kivjikai[17] had an average hospital stay of approximately 3.86 days. He reported that he discharged patients a day after removal of the drains with averaged after 2.86 days. El-Also, Moula[18] reported an average hospital stay of 6.4 days (range, 1-12 days).

COMPLICATIONS, OPEN CONVERSIONS AND SUCCESS RATES

Feyaerts[6] reported 2 (8.3%) complications in his series. One patient had prolonged ileus and another patient had venous thrombosis. Both were managed conservatively and improved. He had 1(4%) open conversion. El-Feel[8] had only one (4%) complication. The patient had prolonged urinary leakage associated with ileus which was managed by inserting a double J Stent. He had no open conversion. Simforoosh[9] reported 14 minor complications and 1 reoperation for a total of 15 (12.2%) complications. He had 1(0.8%) open conversion due to stone migration into the peritoneum after removal from the ureter. Basiri[10] reported 9(18%) complications in his study in the form of urine leakage for more than 3 days. Two of these patients eventually needed double J stenting due to prolonged urine leak of more than 7 days. He had 2(4%) open conversions. In one patient, they could not locate the stone and in another patient, the stone dropped into the abdominal cavity. In RPUL, Goel[11] reported 10(18.2%) complications. The complications encountered were injury to the external iliac artery in one, peritoneal tear in three, fever in two and wound infection in two patients. Two patients had ureteric stricture after 3 months after surgery which was managed by balloon dilatation. He also had 10(18.2%) conversions. Two patients had stone migration into the kidney, inability to locate the stones due to periureteric fibrosis in five patients, 2 patients had peritoneal tear and one patient had vascular injury. Gaur[12] reported 30(30%) complications. Twenty patients had prolonged urine leak. One patient had bleeding, two had gross subcutaneous emphysema, two had high fever, 1 had ureteric avulsion, 1 had hypercarbia, and 3 had ureteric stricture. There were 8(8%) open conversions. In six patients, the stone could not be located laparoscopically, 1 patient had bleeding due to dense ureteric fibrosis and 1 patient had ureteric avulsion. Hemal[13] reported 2(6.45%) complications of persistent urine leakage after 48 hours which was managed with stenting. There was no open conversion. Demirci[14] reported a 100% complication rate in the form of urine leakage in all patients and 2 patients had pneumoscrotum. No open conversion was reported. Soares[15] reported 10(29.4%) complications. Two patients had bleeding intraoperatively due to injury of the gonadal vein and parietal vein respectively. One patient had retroperitoneal hematoma. These 3 cases need no blood transfusion. 2 cases had port site abscess. One patient who had a nephrostomy tube initially developed urinary sepsis after an inadvertent removal of the tube. One patient presented with pain and paresthesia on the lumbar area due to thermal injury of the intercostals nerve. One patient developed subcutaneous emphysema due to CO_2 insufflation. Two patients had prolonged urinary leakage which was managed by placement of internal stent. He reported one (2.9%) open conversion due to technical difficulty of locating the stone. Flasko[16] reported no major complications and one (2.9%) case of open conversion. Kivjikai[17] reported 3 (10%) cases of complications. One patient had prolonged urinary leakage and was managed by stent placement. 2 patients had pneumoscrotum which resolved spontaneously after a week. He reported 1 (3.3%) open conversion due to difficulty in locating the stone. El-Moula[18] reported 17 (23%) complications. Nine cases were intraoperative complications. Two patients had inadvertent peritoneal opening, 1 patient had stone migration to the kidney and 1 had severe adhesions. These 4 patients were converted to open procedures (5.4%). The five other intraoperative cases were gonadal injury in 3 patients and surgical emphysema in two patients which were managed without open conversion. There were 8 postoperative complications. Three for fever, 1 retroperitoneal hematoma which was drained on the 5th postoperative day, 1 patient with prolonged leakage which resolved spontaneously on the 11th postoperative day and 1 patient developed ureteric stricture. Two patients who underwent TPUL had mild ileus.

SUCCESS RATE

Success rates of both procedures were comparable. In TPUL success rates ranges form 86-100%[6-10] while in RPU was 80.9-100%.[11-18]

DISCUSSION

In 1979, Wickham pioneered retroperitoneoscopic ureterolithotomy[19] in the management of ureterolithiasis while Raboy in 1992 did the first transperitoneal ureterolithotomy.[20] Gaur[21] in 1993 popularized the retroperitoneal approach but due to the advent of SWL, PCNL and ureteroscopy, only a few reports were described[m]. But not all ureteral stones can be managed successfully with these three procedures and laparoscopic ureterolithotomy is a feasible alternative in the treatment of these cases.[22,23] Keeley[2] described the advantages of laparoscopic ureterolithotomy. It has a high probability of removing the entire stone in one procedure which was seen in

all of the articles included in this study. The high stone-free rate allows patients to be return to regular activities quickly.[2] Laparoscopic ureterolithotomy can be approach either transperitoneal[6-10] or retroperitoneal[11-18] Some authors advocated the transperitoneal approach for it has an advantage of providing a larger working space[2,20,24,25] while other authors preferred the retroperitoneal approach due to its direct access to the urinary tract and avoids manipulation and contact of urine with intraperitoneal organs.[15,21] In spite of the number of literatures published there had been no study comparing both procedures. In this review, we compared both in terms of stone size of patients done, operative time, intraoperative blood loss, hospital stay, as well as complications, open conversions and success rates. In all of the articles included in the study, the indications of doing both procedures were due to failure of other minimally invasive treatments like SWL, URS and PCNL as well as large impacted stones in the ureter that would most likely be unsuccessfully treated with the said minimally invasive modalities. Other indications were high cost of other procedures and patient preference.[15] There was no difference in both procedures in terms of stone size. There was a wide variability in the operative time in the studies even for the same procedure. It varies from one institution to another and it is dependent on the expertise of the surgeons doing the procedure. Blood losses were minimal in both procedures and no blood transfusion was necessary all cases. In terms of hospital stay, both procedures were similar. A nonrandomized controlled trial done by Goel and Hamel,[11] they demonstrated the superiority of laparoscopic retroperitoneal ureterolithotomy compared to open surgery in terms of shorter hospital stay, lower analgesia requirement and shorter convalescence but there was no difference in terms of operative time and blood loss. In terms of success rate, both TPUL and RPU had similar results with a success rate ranging from 80-100%. Open conversion rate were also almost similar on both groups (1-5%) except for 2 studies in the RPU group. Goel[11] had an open conversion rate of 10% while Gaur[g] had an open conversion rate of 8%. The high conversion rate in former happened in the early cases undertaken in their center. The high conversion rate reflected the need for experience and training of the surgeon and the inherent difficulty of the retroperitoneal approach.[2] In Gaur's[12] study, the main reason for failure was severe retroperitoneal fibrous reaction. The causes of open conversion noted for TPUL were stone migration into the peritoneal cavity[9,10] and the inability to locate the stone.[10] In RPU, the causes for open conversion were, inability to locate stones,[11,12,15] severe retroperitoneal fibrosis,[11,12,18] peritoneal tears,[11,18] stone migration into the kidney,[11,18] vascular injury[11] and ureteric avulsion[11] Hemal[13] suggested the following techniques to overcome these problems. Inability to locate stones can be avoided by using fluoroscopy or ultrasound while stone migration into the kidney by holding a Babcock forceps above the ureter. Peritoneal tears can be avoided by placement of secondary ports with digital guidance, using a fan retractor to retract the peritoneum, using a Veress needle to deflate the abdomen or increasing the rent to equalize the pressure. In terms of complications, RPUL seemed to have a higher complication rate compared to TPUL. Complications in TPUL included ileus,[6,8] urine leakage[8,10] and vein thrombosis.[6] In RPU, common complications include urine leakage,[12,14-18] vascular injury,[11,12,15] surgical emphysema 12,15,18 fever [11,12,15] ureteric stricture[11,12,18] peritoneal tear[11,18] and retroperitoneal hematoma.[15,18] These complications were probably inherent to the technique of the procedure. The small working space is one of the disadvantages of RPU.[12] Urine leakage which is common in both TPUL and RPU can be minimized with suturing of the ureterotomy[8,12]and insertion of a stent.[12] With regards to ureteric stricture, the etiologies are not clear. It can be due to suturing the ureterotomy too tight which can lead to wall ischemia and subsequent stenosis.[18] It can also be due to prolonged postoperative urine drainage leading to retroperitoneal fibrosis and ureteral stenosis.[26]

CONCLUSION

Transperitoneal ureterolithotomy and retroperitoneoscopic ureterotomy were both effective procedures in the management of ureterolithiasis after failed shockwave lithotripsy, ureteroscopy and percutaneous nephrolithotripsy as well as a primary treatment for large, impacted ureteral stones otherwise indicated for open ureterolithotomy. Both procedures are comparable in terms of blood loss, hospital stay and success rates. RPU seemed to have a higher complication and open conversion rate compared to TPUL.

REFERENCES

1. Preminger GM, et al. Guideline for the management of ureteral calculi. Eur Urol. Dec 2007;52(6):1610-31.
2. Keeley FX, et al. Laparoscopic ureterolithotomy: The Edinburgh experience. BJU Int 1999;84:765-69.
3. Paik ML, et al. Current indications for open surgery in the treatment of renal and ureteral calculi. J Urol 1998;159:374-78.
4. Ramakumar S, et al. Laparoscopic pyeloplasty with concomitant pyelolithotomy. J Urol 2002;167:1378-80.
5. Skrepetis K, et al. Laparoscopic versus open ureterolithotomy. A comparative study. Eur Urol 2001;40:32-36.
6. Feyaerts A, et al. Laparoscopic ureterolithotomy for ureteral calculi. Eur. Urol 2001;40:609-13.
7. Turk I, et al. Laparoscopic ureterolithotomy. Tech Urol 1998;4:29-34.
8. El-Feel A, Abouel-Fettouh H, Abdel-Hakim AM. Laparoscopic transperitoneal ureterolithotomy. J Endourol. Jan 2007;21(1):50-54.
9. Simforoosh N, et al. Laparoscopic management of ureteral calculi: A report of 123 cases. Urol J. 2007 Summer;4(3):138-41.
10. Basiri A, et al. Retrograde, antegrade, and laparoscopic approaches for the management of large, proximal ureteral stones: A randomized clinical trial. J Endourol. Dec 2008;22(12):2677-80.
11. Goel A, Hemal AK. Upper and mid-ureteric stones. A prospective unrandomized comparison of retroperitoneoscopic and open ureterolithotomy. BJU Int 2001;88:679-82.

12. Gaur DD, et al. Laparoscopic ureterolithotomy: Technical considerations and long-term follow-up. BJU Int 2002;89:339-43.
13. Hemal AK, Goel A, Goel R. Minimally invasive retroperitoneoscopic ureterolithotomy. J Urol. Feb 2003;169(2):480-82.
14. Demirci D, Gülmez I, Ekmekçioðlu O, Karacagil M. Retroperitoneoscopic ureterolithotomy for the treatment of ureteral calculi. Urol Int 2004;73(3):234-37.
15. Soares RS, Romanelli P, Sandoval MA, Salim MM, Tavora JE, et al. Retroperitoneoscopy for treatment of renal and ureteral stones. Int Braz J Urol. Mar-Apr 2005;31(2):111-16.
16. Flasko T, et al. Laparoscopic ureterolithotomy: The method of choice in selected cases. J Laparoendosc Adv Surg Tech A. Apr 2005;15(2):149-52.
17. Kijvikai K, Patcharatrakul S. Laparoscopic ureterolithotomy: Its role and some controversial technical considerations. Int J Urol. Mar 2006;13(3):206-10.
18. El-Moula MG, et al. Laparoscopic ureterolithotomy: Our experience with 74 cases. Int J Urol. Jul 2008;15(7):593-97.
19. Wickham JEA (Ed.). The surgical treatment of renal lithiasis. In:Urinary Calculus Disease. Churchill Livingstone, New York, 1979;145-98.
20. Raboy A, et al. Laparoscopic ureterolithotomy. Urol. 1992;39:223-25.
21. Gaur DD, et al. Retroperitoneal laparoscopic ureterolithotomy for multiple upper mid ureteral calculi. J Urol 1994;151:1001-02.
22. Hofbauer J, Turek C, Höbarth K, Hasun R, Marberger M. ESWL in situ or ureteroscopy for ureteric stones. World J Urol. 1993;11:54-58.
23. Koch J, Balk N. Extracorporeal shock wave lithotripsy of upper ureteral stones: In situ versus push and smash treatment. J Endolurol 1999;5:117-21.
24. Harewood LM, Webb DR, Pope AJ. Laparoscopic ureterolithotomy: The results of an initial series, and an evaluation of its role in the management of ureteric calculi. Br J Urol. 1994;74:170-76.
25. Micali S, et al. The role of laparoscopy in the treatment of renal and ureteral calculi. J Urol. 1997;157:463-66.
26. Mitchinson MJ, Bird DR. Urinary leakage and retroperitoneal fibrosis. J Urol 1971;105:56-58.

REVIEW ARTICLE

Laparoscopic versus Open Mesh (Lichtenstein) Repair of Inguinal Hernia: Current Status from Literature Review

Spencer EE Efem

Laparoscopic Hospital, New Delhi, India

Correspondence: Spencer EE Efem, FRCS, University Department of Surgery, University of Calabar, College of Medical Sciences, Calabar, Nigeria, e-mail: spencerefem@yahoo.com

Abstract

The aim of this study was to review studies conducted recently in large centers which compared the laparoscopic approach to open mesh method in the repair of inguinal hernia. Search from literature was conducted using Highwire press and Google search engine. Analyses were made using parameters like type of anesthesia, operation time, hospital stay, early and late complication, pain and narcotic usage, time of return to work, cost effectiveness and patients satisfaction. Result showed that laparoscopic group experienced less pain, returned earlier to work and had more satisfactory outcome even though paid twice as much as the open mesh group. The laparoscopic group also suffered more fatal complications such as visceral injury. Hemorrhage and bladder and intestinal injuries as well as some deaths. In conclusion opinion was divided, some favored laparoscopic while others favored open mesh repair.

Keywords: Laparoscopic versus open mesh inguinal, hernia, Lichtenstein repair.

INTRODUCTION

Laparoscopic surgery is another example of how technology invades medical practice forcing clinicians to adapt to usage of the newly introduced equipment sometimes to a great advantage albeit with its attendant high cost. Eventually the patient, the government and the insurance companies pay for the over zealousness of clinicians. Sometimes this is done at the expense of relegating tested, satisfactory and excellent orthodox practice to the background in favor of what is new. It is for this reason that the necessity for carrying out large scale multicenter randomized studies comparing laparoscopic mesh repair with open mesh repair for the repair of inguinal hernia has become paramount. Analyses of the most recent studies are the subject of this review.

MATERIAL AND METHODS

A literature search was conducted in BMJ, New England Journal of Medicine (NEJM), British Journal of Surgery and Journal of MAS using Highwire press and the search engine of Google. The following search terms were used laparoscopic versus open mesh repair of inguinal hernia. Lichtenstein mesh repair. Criteria for selection of literature for review were number of cases (excluded if less than 100) method of analysis (statitcal or nonstatitcal) operative procedure only universally accepted procedures were selected and institution where the studies were conducted (only large specialized institutions and studies conducted by MRC, NICE, and EU biomed were included which compared laparoscopic mesh repair with open mesh repair. Large studies like that of Liem et al which compared laparoscopic with Shouldice and Basini repair and the Scandinavian studies which compared laparoscopic versus shouldice repair were excluded.

CONTENT

In the MRC trial[1] of 1000 cases compared laparoscopic mesh with Lichtenstein mesh repair reported that the laparoscopic group had less pain and more rapid return to work than there counterpart who had open mesh. However there was no recurrence in the open mesh group while 1.9% of patients in the laparoscopic group had recurrence after one year follow-up. There were three major complications in the laparoscopic group including one bladder perforation and trocar injury to the left common iliac artery.

The largest randomized trial was the one conducted by Neunayer et al, 2000 patients. This trial also compared open mesh with laparoscopic mesh repair of inguinal hernia.[2] Ten percent of laparoscopic group suffered recurrence compared with 4.9% in the open group at a median follow-up period of 2 years. As with the MRC studies fatal complications were more common with the laparoscopic group. There were two deaths in the laparoscopic group one resulting from intestinal perforation and the other from pulmonary embolism on the third post-operative day. Neumayer et al concluded that open technique is superior to the laparoscopic for mesh repair of primary hernia.In their randomized control trial which compared laparoscopic *vs* open mesh repair of 403 patients with inguinal hernia,Wellwood et al[3] found that more patients in the open group (96%) than in the laparoscopic group. 89% were discharged on the same day of operation $x2 = 6.7;1$ df; $p = 0.01$. Patients in the open group also suffered less pain on the early

postoperative period as a result of persistent effect of local anesthetic. For every activity considered the median time until return to normal was significantly shorter in the laparoscopic group. The mean cost per patient was 335 pounds costlier in the laparoscopic. They concluded that laparoscopic repair has considerable short-term clinical advantage after discharge compared with open mesh hernioplasty, although it was more expensive.

In another MRC study carried out by Lawrence et al[4] data was collected on 104 patients undergoing laparoscopic and open hernia repair on a day care basis in the context of a randomized control trial. They found out that the mean total health service cost of laparoscopic repair was $1074 *vs* $489 for open repair (mean difference in total health service cost $583; 95% confidence interval C I $265-$904). They explained that the difference was largely accounted for the difference in theater cost. They concluded that laparoscopic hernia appears an expensive option in most plausible situation furthermore; many uncertainties still exist about long-term outcome after the procedure and about the condition necessary to maximize cast effectiveness.

In a long-term follow-up of laparoscopic transabdominal preperitoneal (TAPP) mesh repair under general anesthesia compared with open mesh repair under local anesthesia. Douek et al.[5] reported that long-term complication occurred less frequently in TAPP patients compared with Lichtenstein group, and 4% of TAPP group experienced groin pain and numbness compared with 33% of Lichtenstein group. The symptoms were clinically important in 12 patients in the open surgery group and not in the TAPP group. Recurrence in TAPP and open repair were 2% and 3% respectively.

Paganini et al.[6] All in their study concluded that TAPP was associated with less postoperative pain but the increase cost was uncompensated by early return to work.

DISCUSSION

In this review only studies that used mesh in the open repair were included in order to eliminate bias. All studies agreed that early postoperative pain was less in the Lichtenstein open mesh repair than with laparoscopic mesh repair but chronic pain and paraesthesia were more the Lichtenstein group. This was explained on the basis that the local anesthesia used in the open mesh group kept the patients pain free the first post-operative day but as the effect wore off pain returned.

Large single and multi-institutional studies stated that complication rate after laparoscopy hernioplasty vary from 1-13% but the complication recorded by each study differ widely and only 1-1.3% in expert specialist centers. Where as many studies reported more long-term complication in the open mesh then in laparoscopic. They also reported life-threatening complications such as bladder perforation, bowel injuries, and vascular injuries in the laparoscopic method. In a number of meta-analyses and systematic reviews on randomized comparison of laparoscopic versus open repair sponsored by EU Biomed,[7,8] program included 45 relative comparisons in 41 eligible trials involving over 700 patients. Individual patients data was available in 4165 patients. Meta analysis revealed that laparoscopic repair was associated with reduced recurrence rate when compared with open nonmesh repair but was not different to open mesh repair. This analysis also revealed six visceral injuries four bladder injuries, one bowel injury and three vascular injuries.

All studies unanimously agreed that cost of laparoscopic repair is very much higher that the cost of open mesh repair.[2-5] The MRC studies by Lawrence et al.[4] specifically stated that the cost per patient for laparoscopic repair was $1074 as against $489 for open repair. This is outrageous considering that most open repair are now carried out as day cases. The reason for this escalated cost is the cost of equipment and theater modification to accommodate the equipment and the after care of the equipment after use.

The conclusions arrived at by the various studies are as follows the MRC studies does not recommended laparoscopic approach as the method of choice for hernia repair. Neumayer et al concluded that open mesh repair is superior to laparoscopic repair for primary hernias. Wellwood and his colleague concluded in their studies that laparoscopic hernia repair has considerable advantages over open mesh repair even through more expensive. Douek et al believed that laparoscopic approach is the favored method (Table 1).

The main drawback in laparoscopic hernia are high cost and the serious complications like puncture of the bladder intestine and major blood vessels. These can be offset by thorough and intensive training of residents and the use of reusable instruments in order to bring down cost. Only then can the advantages such as short hospital stay, improved cosmesis, early return to work and patients satisfaction be meaningfully achieved.

CONCLUSION

From the review of laparoscopic versus open mesh repair of inguinal hernia there was no clear consensus on the preference of one method to the other. In advanced countries where people enjoy health insurance and are well to do and also have enough well-trained man power, laparoscopic surgery repair of inguinal hernia could be considered the favored approach. In surgically poor third would countries where people are poor and have no health insurance scheme open mesh repair will continue to be the method of choice.

ACKNOWLEDGMENT

I wish to thank Professor RK Mishra, Director of laparoscopy Hospital, New Delhi, India for his useful hints on how to conduct the literature search. I wish to thanks Mr Anil Aryan and Mr Anand Sinha for their secretarial assistance.

Table 1: Summary of results of the various studies reviewed: Laparoscopic versus open mesh hernia repair (TAPP = Total abdominal;l preperitoneal repair OM = Open mesh repair)

	MRC 1999		*NEUMAYAR et al 2004*		*WELLWOOD et al 1998*		*DOUEK et al 2003*		*PAGANINI et al 1997*	
Parameter	TAPP	OM	TAPP	OM	TAPP	OM	TAPP	OM	TAPP	OM
Duration of OPS	Longer	Shorter	Longer	Shorter	Longer	Shorter	Longer	Shorter	Longer	Shorter
Anesthesia	GA	LA	GA	LA	GA	LA	GA	LA	GA	LA
Times of discharge	Early	Same days	Early	Same days	Early	Same days	Early	Same day	Early	Same day
Intraoperative complication	Serious	Minor		Serious	Less	Present	Less			
Postoperative complication	Less	More	Less	More	Less	More	Equal	Equal	Less	More
Time of resumption of duties	Earlier	Early	Earlier	Early	Earlier	Early				
Cost effective	More expensive	Less expensive	More	Less	More	Less	More	Less		
Quality of life	Happy	Happy	Happy	Happy	Happy	Better	OK			
Recurrence rate	Recurr	No recure	More 10.10%	Less 4.9%	More	Less				
Chronic pain	Less	More	Less	More	Less	More	Less	More	Less	More

REFERENCES

1. MRC Laparoscopic Groin Hernia Trial Group. Laparoscopy versus open repair of groin hernia: A randomized comparison . Lancet 1999;345:185-90.
2. Neumayer L, Giobbie-Hurder A , Jonasson O, et al. Open mesh versus Laparoscopic mesh repair of inguinal hernia New. Engl J Med 2004;350:1819-27.
3. Wellwood J, Sculpher MJ Stoker D, et al. Randomized controlled trial of laparoscopic versus open mesh repair for inguinal hernia: Outcome and cost BMJ 1998;317:103-10.
4. Lawerence K, McWhinnie D, Godwin A, et al. An economic evaluation of Laparoscopic versus open inguinal hernia repair. J Public Health 1996;18(1):41-48.
5. Douek M, Smith G, Oshowo A, Stoker Dl, Wellwood JM. Prospective randomized controlled trial of Laparoscopic versus open inguinal hernia mesh repair: Five years follow-up. BMJ 2003;326:1012-13.
6. Paganini AM, Lezoche E, Carle F, et al. A rendomized controlled clinical study of Laparoscopic versus open tension –free ingunial hernia repair .Surg Endosc 1998;12:979-86.
7. Grant AM. Laparoscopic versus open groin repair: Meta-analysis of randomized trials based on individual patent data. the Eu Hernia colibrate. Hernia 2002;6:2-10.
8. Eu Hernia trial list collaboration. Laparoscopic compared with open methods of groin hernia: Systematic review of randomized control trials BJ Surge 2000;87:860-67.

ORIGINAL ARTICLE

Laparoscopic Instruments Marking Improve Length Measurement Precision

Isreb S, Hildreth AJ, Mahawar K, Balupuri S, Small P

Surgical Department, City Hospital Sunderland NHS Foundation Trust, UK

Correspondence: Isreb S, Surgical Department, City Hospital Sunderland NHS Foundation Trust, 26D, Bowsden Court Southgosforth, Newcastle Upon Tyne, NE3 1RR, UK, Phone: 00447973297007, e-mail: drisreb@yahoo.com

Abstract

Introduction: Bariatric surgery has increased the demand for accurate laparoscopic bowel length measurement. Measures to achieve such precision are scarce in the medical literature. Our study investigates the effect of instruments marking on measurement precision.

Methods: Eight consultants and fourteen senior trainees with laparoscopic experience were asked to estimate 150 cm on a piece of string fixed within a standard laparoscopic training stack. Each candidate carried out three pairs of measurement using standard laparoscopic instruments without marking, with 10 cm and with 5 cm mark. Each measurement was timed separately. Candidates were result blinded to prevent any self-correction. Data were analyzed using Bland-Altman plots along with ANOVA tests.

Results: Greater accuracy was achieved via marked instrumentation, the differences being statistically significant ($P < 0.01$). The improvement was significant regardless of candidates' level or initial length judgment. Time was almost doubled for the marked measurement. No statistically significance differences were found between the 5 or 10 cm instrument markings for measurement or time.

Conclusions: Marked laparoscopic instrument is a simple and effective way of enhancing length measurement precision regardless of surgeons' experience.

Keywords: Laparoscopy, instrument length measurement, bariatric surgery, laparoscopic instrument design.

INTRODUCTION

Bowel length measurement has always been a part of surgical practice, whether it is performed for Michel's diverticulum[1] or to avoid short bowel syndrome during bowel resection. The introduction and evolution of barbaric surgery has increased the demand for measurement precision. Early bariatric surgical attempts in 1950s adopted the malabsorption approach by creating short bowel syndrome.[2,3] Following the same principle, the Jejunocolic bypass was introduced followed by, the jejunoileal bypass.[4] Along with its side effects of mineral and vitamins loss, purely malabsorption procedures failed to maintain weight loss due to bowel adaptation.[5] The gastric restriction approach followed in the 1960s with gastric pouch and Billroth II gastrectomy.[6] Following the popularity of Roux-en-Y anastomosis in 1970s,[7] Mason started to perform gastric pouches with various lengths of jejunal Roux-en-Y anastomosis. Various gastroplasty and gastric banding approaches were developed under the same gastric restriction umbrella that lacked the malabsorption concept. The current approach in bariatric surgery combines the two principles of malabsorption and gastric restriction. The two dominant operations under this approach are biliopancreatic diversion[8] and the duodenal switch.[9] Both operations use the jejunal Roux-en-Y anastomosis approach.

Joining the laparoscopic era in the 1990s the first laparoscopic procedure was gastric banding.[10] Gastric bypass followed in 1994,[11] and hence the demand for accurate laparoscopic bowel length measurement started. Currently the recommendation for roux limb varies according to the body mass index, namely 75, 150, 200 and 250 cm for patients with body mass indices of less than 40, 40 to 50, greater than 60 and 70 to 80 respectively.[12] Despite the demand for length precision, there is as yet no consensus regarding a standard approach for laparoscopic measurement. The majority of laparoscopic instruments are not length marked; therefore unguided estimation of length is common practice. One study suggested that a 5 cm groove mark be introduced to the Babcock shaft to help standardize bowel length measurements.[12] Two text books hinted at the possibility of using a special bowel grasper with 10 cm marking, premeasured umbilical tap or a ruler for length measurement without ruling out the established length estimation practice.[13,14]

Multiple factors affect the laparoscopic vision including lens magnification, distance from the object, resolution, depth of the field and optical light transmission.[15] Magnification is well known to change length perception as there is an inverse association between magnification and length perception. This effect is well-established even when background landmarks are given.[16] All these effects will impair length estimation under laparoscopic vision.

This study was designed to investigate the difference between estimation and length measurement using marked and

unmarked instruments, and to look at other factors that might influence precision.

METHODS

Twenty-two surgeons with previous laparoscopic surgery exposure were recruited to the study, eight consultants and eleven senior surgical trainees at Sunderland city hospital general surgical department. Three visiting senior trainees from Gateshead Health NHS Foundation Trust were also included. Candidates were asked to estimate 150 cm on a piece of string fixed within a standard laparoscopic training stack. The string length was four meters and was fixed at both ends. The laparoscopic camera was held on a metal fixed holder to eliminate human movement and any depth of field effects on the magnification. The experiment consisted of three phases. During the first phase each candidate carried out the estimation twice, one from each fixed string end, using standard laparoscopic instruments without marking. Candidates judged length via a range of values from 2 to 20 cm incrementally in order to estimate the target length of 150 cm. These increments were classified into three groups as 5 cm or less, 10 cm and 15 cm or more. The estimated 150 cm length on the string was marked with the laparoscopic autoclip applicator. Each measurement was timed independently. The estimated lengths were measured and the clips were removed before the next phase. Candidates were oblivious of their results and string length to prevent any self-correction. The experiment was repeated twice after marking the same instrument at 10 cm and at 5 cm level respectively.

STATISTICAL ANALYSIS

Data were analyzed using Bland-Altman plots along with ANOVA tests.

RESULTS

Using an unmarked instrument, half the candidates initially attempted to estimate length in 10 cm increments in order to achieve the 150 cm target. Seven candidates initially opted for 5 cm increments and two chose 15 cm increments. Only one candidate judged 2 cm and 20 cm respectively (Fig. 1).

Bland-Altman plots were used to analyze and visualize the results by comparing the average of the two attempts for each of the three scenarios against the differences (Figs 2 to 4). By comparing the plots one can see the magnitude of errors obtained via each of the three methods. The distributions are clustered tighter around the target value of 150 cm when using the 5 and 10 cm guide marks. The error between measurements was also considerably reduced when using the 5 cm guide (Figs 2 to 4).

Therefore candidates might have gained a practicing advantage while conducting the other two. In order to investigate this further, ANOVA tests were performed on the measurement and the time data.

The mean of the measurements estimated using the unmarked instrument was 115.4 cm compared to 139.0 cm and

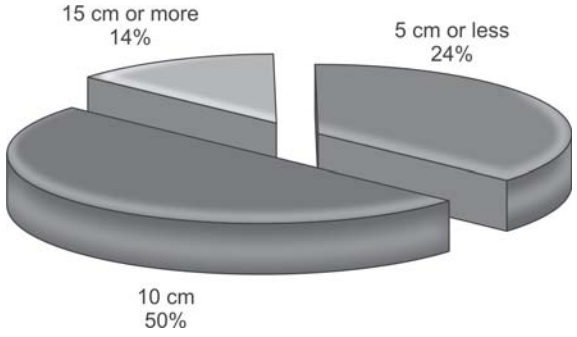


Fig. 1: The percentage of candidates who chose 5 cm or less, 10 cm or 15 cm or more as their repeated measuring unit

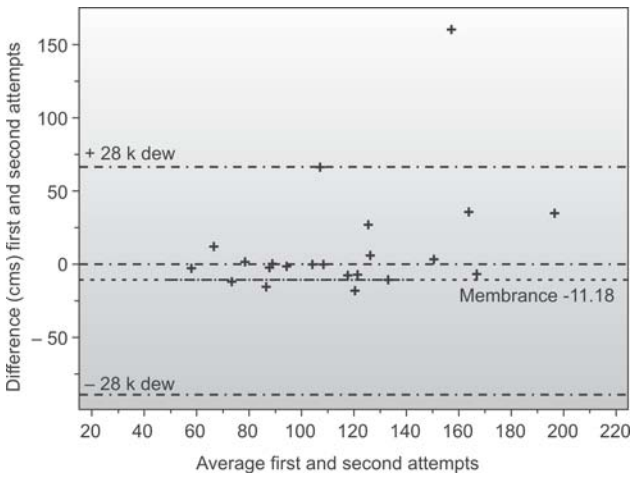


Fig. 2: Bland-Altman plot for attempts without guide marks. The graph represents the mean of the two attempts as the (X-axis) value, and the difference between the two attempts as the (Y-axis) value. Ideally the points should be on 150 cm at the X-axis and on zero on the Y-axis

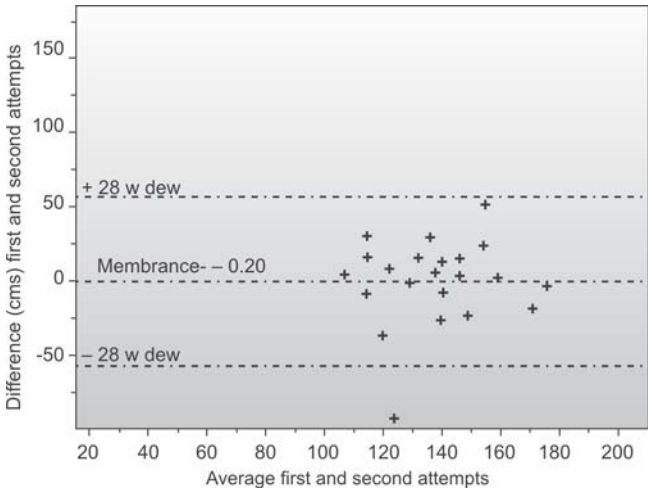


Fig. 3: Bland-Altman plot for attempts using 10 cm guide mark. The graph represents the mean of the two attempts as the (X-axis) value, and the difference between the two attempts as the (Y-axis) value. The distributions are clustered tighter around the target value of 150 cm than the nonguide mark attempts

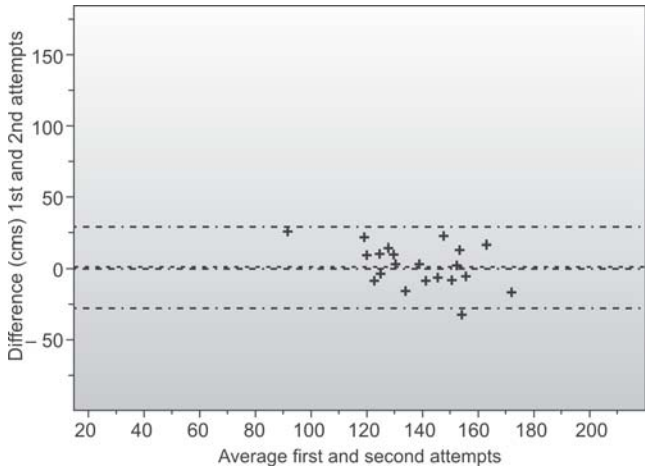


Fig. 4: Bland-Altman plot for attempts using 5 cm guide mark. The graph represents the mean of the two attempts as the (X-axis) value, and the difference between the two attempts as the (Y-axis) value. The distributions are clustered tighter around the target value of 150 cm than the nonguide mark attempts. The error between measurements was also considerably reduced when using the 5 cm guide

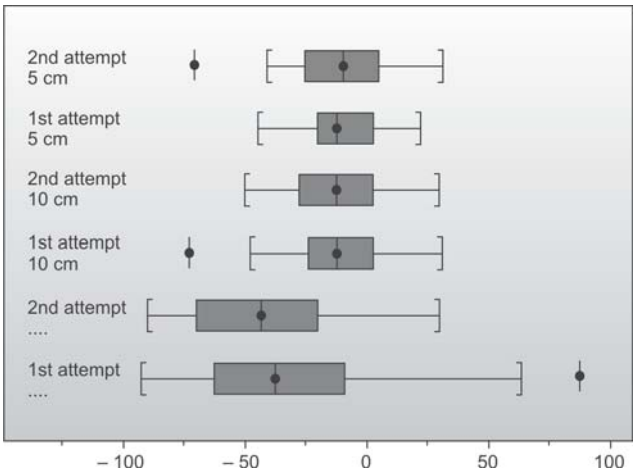


Fig. 5: Boxplots showing distributions of distance from target by guide mark. The mean distance from target was reduced between unmarked and marked measurements

137.5 cm when 5 cm and 10 cm marked instruments were used respectively. The improvement was statistically significant between the unmarked and marked measurements, with P values of 0.001 and 0.002 for the 5 cm and 10 cm marking respectively (Table 1 and Fig. 5). The mean distance from target was reduced from 34.6 cm for the unmarked to 12.5 cm and 11.0 cm for the 10 cm and 5 cm marked measurements respectively. Although candidates found the 10 cm marking harder to use due to field vision limitation, no statistical significant difference was found between the two markings. Even when we included the candidates' initial judgment, the difference between 5 cm and 10 cm remained statistically insignificant. Although senior trainees did slightly better than consultants, the experience level of the candidate was not a significant factor.

Interestingly, time was almost doubled from 2.5 minutes for the unmarked instrument to 4.1 and 3.9 minutes for the 5 cm and 10 cm marked measurement respectively (Fig. 6). Although 5 cm marking requires 30 repeated measurements to achieve the 150 cm as opposed to 15 ones in the case of 10 cm marking, the difference in timing between the two markings was not statistically significant.

Table 1: Using ANOVA tests the improvement was statistically significant between the unmarked and marked measurements, with P values of 0.001 and 0.002 for the 5 cm and 10 cm marking respectively

				95% confidence interval	
Guide line comparisons	*Mean difference*	*Std. error*	*P value*	*Lower bound*	*Upper bound*
None *vs* 5 cm	–23.6	6.2	0.001	–38.7	–8.5
None *vs* 10 cm	–22.1	6.2	0.002	–37.5	–7.0
5 cm *vs* 10 cm	1.43	6.2	1.00	–13.7	16.6

CONCLUSION

Multiple factors affect laparoscopic length estimation. Amongst them, magnification plays a major impact on surgeon's length judgment. Such estimation cannot be trusted to give accurate measurements. Marking the laparoscopic instruments on 5 cm and/or 10 cm levels improved length measurement

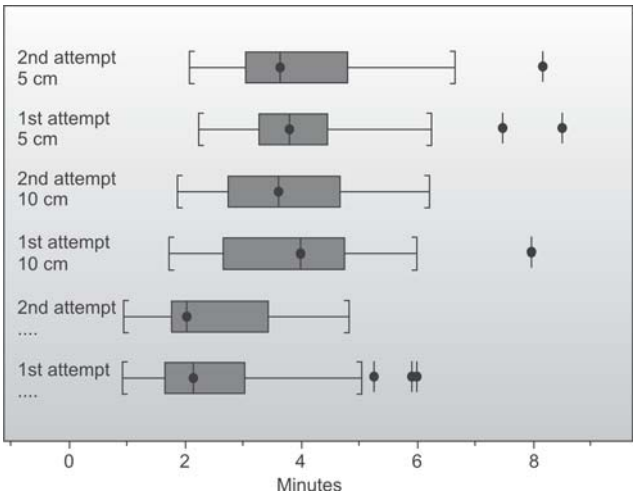


Fig. 6: Boxplots showing distributions of 'time to complete' by guide mark. Time was almost doubled between the unmarked instruments and the marked measurements

accuracy considerably. This improvement is not related to surgeon's initial experience or length judgment. Although measurement time was almost doubled, there was a considerable increase in the measurement accuracy. This extra time is well justified under these circumstances. Bowel stretch was not counted for in our experiment since it was carried out on a piece of string. Despite this difference between live bowel measurements and our experience, our results are still valid since bowel stretch will have a minute impact on length precision.

However gauging the impact of this requires a standardized method of measurement to be in place before such an effect could be investigated. As a result, we suspect that bowel grasper marking will provide the ideal standard measurement method as it will eliminate the bias in the current estimation practice.

REFERENCES

1. Dowse JLA. Meckel's diverticulum. Br J Surg 1961;48:392-99.
2. Rucker RD Jr, Chan EK, Horstmann J, Chute EP, Varco RL, Buchwald H. Searching for the best weight reduction operation. Surgery 1984;96:624-31.
3. Kremen AJ, Linner JH, Nelson CH. An experimental evaluation of the nutritional importance of proximal and distal small intestine. Ann Surg 1954;140:439-48.
4. Deitel M. Overview of operations for morbid obesity. World J Surg 1998;22:913-18.
5. Mason EE. Surgical Treatment of Obesity. Philadelphia, London, Toronto: WB Saunders 1981.
6. Mason EE, Ito C. Gastric bypass in obesity. Surg Clin North Am 1967;47(6):1345-51.
7. Deitel M. Surgery for the Morbidly Obese Patient. Philadelphia: Lea and Febiger 1989.
8. Marceau P, Hould FS, Potvin M, Lebel S, Biron S, Biliopancreatic diversion (duodenal switch procedure). Eur J Gastroenterol Hepatol 1999;11(2):99-103.
9. Hess DS, Hess DW. Biliopancreatic diversion with a duodenal switch. Obes Surg 1998;8:267-82.
10. Catona A, Gossenberg M, La Manna A, Mussini G. Laparoscopicm gastric banding: Preliminary series. Obes Surg 1993;3(2):207-09.
11. Wittgrove AC, Clark GW, Tremblay LJ. Laparoscopic gastric bypass, Roux-en-Y: Preliminary report of five cases. Obes Surg 1994;4(4):353-57.
12. Scott D, Provost D, Tesfay S, Jones D. Laparoscopic Roux-en-Y Gastric Bypass Using the Porcine Model. New York Springer; 2001;11(1):46-53.
13. Schauer p, Schirmer B, Brethauer S. Minimally Invasive Bariatric Surgery. New York; Springer; 2007.
14. Soper N, Swanström L, Eubanks W. Mastery of Endoscopic and Laparoscopic Surgery (3rd ed). Lippincott Williams and Wilkins 2008.
15. Armenta J, Iqbal A, Di Martino A. Resolution and magnification of the laparoscope: An observational analysis. Revista Mexicana de Cirugía Endoscópica 2004.
16. Kraft R, Green J. Distance perception as a function of photographic area of view. Percepnon and Psychophysics 1989.