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Editorial

The World Journal of Laparoscopic Surgery is widely recognized as an inclusive surgical journal of minimal access surgery. The impetus of this scientific journal remains research-based academic surgery, and its main aim is to promote the shared vision of research and academic pursuits through the exchange of ideas between senior surgical residents, junior faculties, and established academic surgical professors.

The journal regularly publishes quality original articles concerned with clinical and laboratory investigations relevant to minimal access surgical practice and teachings. The journal functions as an outstanding forum for continuing education in surgery and diseases which can be treated by minimally invasive techniques. The journal emphasizes reports of clinical investigations or fundamental research bearing directly on surgical management which will be of general interest to a broad range of laparoscopic surgeons and gynecologist.

In this issue many interesting article are there like "various tissue retrieval techniques and post positioning" that will definitely increase the fundamental knowledge of resident surgeons. When I was discussing few weeks ago about the achievements and progress of this journal with my Professor and Editor-in-Chief of surgical endoscopy, Sir Alfred Cuschieri, showed his interest in publishing new research article to WJOLS.

The members of WJOLS are committed to helping others. Service of WJOLS is well-known among laparoscopic surgery readers and we are continuously looking toward their contribution.

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ORIGINAL ARTICLE

Laparoscopic Sleeve Gastrectomy—A Novel Surgical Tool for Weight Loss in morbidly Obese Patients: A Prospective Cohort Study

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ABSTRACT

Introduction: Obesity has reached epidemic proportions worldwide. India ranks 3rd after the United States and China. The health consequences range from increased risk of premature death due to serious chronic illness like hypertension and diabetes mellitus (DM) which reduces the overall quality of life. Laparoscopic sleeve gastrectomy (LSG) produces long-lasting control of obesity as well as associated comorbidities.

Materials and methods: A prospective cohort study was conducted between the period of January 2015 and March 2016. The criteria for selection were Body mass index (BMI) ≥ 40 kg/m^2 or BMI ≥ 35 kg/m^2 with comorbidities. All the patients were screened by a multidisciplinary team. All the patients were operated by the same surgeon to avoid any procedural biasness. Follow-up visit as per our study protocol were evaluated.

Results: Out of 60 patients operated for morbid obesity, the weight loss is substantial and statistically significant. Excess weight loss (EWL) (in %) were 4.31, 8.14, 16.28, and 30.61% at subsequent visits at 1st, 2nd, 4th, and 12th week respectively. Except for a few minor complications which were managed conservatively, the procedure was uneventful.

Conclusion: Laparoscopic sleeve gastrectomy is simple, effective, and reproducible surgical method to treat morbid obesity.

Keywords: Excess weight loss, Laparoscopic sleeve gastrectomy, Morbid obesity.

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INTRODUCTION

World Health Organization (WHO) defines obesity as a chronic multisystem disease resulting from complex interaction between the human genotype and the environment.[1] It has reached epidemic proportion worldwide. The worldwide prevalence of obesity more than doubled between 1980 and 2014. There are over 600 million adults are obese globally. According to WHO Report 2014, about 13% of the world's adult population were obese of which 11% are men and 15% are women. There is dramatic increases in the prevalence of both overweight and obesity in Canada over the last 15 years, and the problem is particularly pronounced among children.[1] The obesity rate has increased dramatically in the last 15 years from 2 to 10% among boys and from 2 to 9% among girls.[2,3] Interestingly, there has been a 14 times increase of the number of bariatric surgeries in Canada in the last 2 years.[3,4] According to the WHO's World Health Statistics Report 2012, globally one in six adults is obese and nearly 2.8 million individuals die each year due to overweight or obesity.

Obesity involves a complex interaction of metabolic, genetic, psychological, and social issues and has become the second leading cause of preventable death in developed countries after smoking. Body mass index (BMI) is a simple index that is used to classify obesity in adult population. Body mass index is calculated by the following method: BMI = kg/m^2. Obesity is defined as BMI > 25 kg/m^2. Morbid obesity is defined as BMI > 40 kg/m^2 or > 35 kg/m^2 with associated comorbidities like diabetes mellitus (DM) and hypertension.

Obesity has reached an epidemic proportion in India. India is currently facing double burden of disease as malnutrition due to poverty now being rapidly replaced by obesity associated with affluence.[5] Industrialization and urbanization are playing a big role in increased prevalence of obesity. The changing lifestyle of the rural dwellers is an upcoming contributory factor for the rising rates of obesity and associated metabolic diseases, such as diabetes.[6] Studies from different parts of India have provided evidence of the rising prevalence of obesity.[5,7-9]

Mechanization of rural and urban areas is an important cause of the increasing prevalence of obesity. For example, two-wheeler sales have increased from 5,076,551 in 2002 to 8,418,626 in 2009.[10] The figures state that there is an increasing use of automobiles to commute, with

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obviously negative implications on exercise and energy expenditure at the biological level. Apart from that medical care, food habits, educational status, and family income have dramatically improved, which, along with easy access to city and television watching, result in unwanted changes in lifestyle. These have eventually led to significant increase in BMI.

Obesity is one of the major risk factors for diabetes, yet there has been little research focusing on this risk factor across India.[11] Therapeutic interventions for the treatment of obesity range from lifestyle and diet modifications to pharmacologic and surgical therapy.[12] Studies showed that the nonoperative interventions for sustained weight loss usually fail to provide real benefits and are usually insufficient and not sustainable.[13,14] Bariatric surgery is an evidence-based treatment of morbid obesity with proven, sustained weight loss and improvement in comorbidities.[15-17]

The limited and nonsustainable success of behavioral, lifestyle modification and drug therapies in morbidly obese patients has led to a increase interest in bariatric surgery in Canada.[6] A variety of surgical procedures are available, and currently it is difficult to identify the most effective option based on patient characteristics and comorbidities. Furthermore, little is known regarding the effect of the various surgical procedures on glycemic control and on Type 2 diabetes mellitus (T2DM) remission.[18-21]

Laparoscopic sleeve gastrectomy (LSG), a single-stage procedure, is a relatively new and effective surgical option for morbid obesity.[22] Although LSG functions as a restrictive procedure, it may also cause early satiety by removing the ghrelin-producing portion of the stomach.[23]

MATERIALS AND METHODS

The prospective cohort study was conducted at the Dr. Ram Manohar Lohia Hospital and Post Graduate Institute of Medical Education and Research, New Delhi, India, between January 2015 and March 2016. Patients included were of either sex of age 18 to 60 years who had tried for weight loss for at least 6 months by dietary restriction and lifestyle modification, but failed to maintain sustained weight loss. The criteria for selection were BMI ≥ 40 kg/m^2 or BMI ≥ 35 kg/m^2 with comorbidity. All the patients were screened by a multidisciplinary team consisted of a surgeon, a nutritionist, a cardiologist, an endocrinologist, a chest physician, and a psychologist. All the patients were thoroughly evaluated and an informed consent in detail was taken.

The percentage of excess weight loss (EWL) was measured on each follow-up visit. The BMI up to 25 was taken as the normal, and weight beyond that were taken as the excess weight.

Preoperative Preparation

All routine investigations including upper gastrointestinal endoscopy, echocardiography, and psychological assessment for conducting LSG were done on every patient. All patients were instructed to start chest physiotherapy using incentive spirometry and liver shrinkage diet 1 week prior to surgery. Deep venous thrombosis (DVT) prophylaxis with DVT pump during surgery and subcutaneous low-molecular-weight heparin were given to all patients 12 hours before and continued for 7 to 10 days after the surgery.

SURGICAL METHOD

A procedure of LSG was performed using classical five ports under general anesthesia. The patients were in antitrendelenburg position with legs apart to facilitate the small intestine to remain out of field of surgery. The surgeon stood between the legs. Pneumoperitoneum was achieved using a closed technique with a Veress needle, placed in supraumbilical area just left to the midline. The xiphisternum was taken as the reference point. Three ports of size 12 mm were placed from the reference point at 15 to 18 cm at right mid-clavicular line (left working port), 2 to 3 left to mid-line (optical port), and left mid-clavicular line (right working port) respectively. The 4th port of 5 mm (assistant port) were inserted at left anterior axillary line below the costal margin. The epigastric port of 5 mm was inserted to retract the left lobe of liver. All surgeries were done by the same surgeon to minimize the biasness (Figs 1 to 3).

The stomach was decompressed by placing an orogastric tube. The operating surgeon stood in between the legs of the patient with the first and second assistant standing to the patient's right and left side respectively. Omentolysis was started about 3 to 5 cm proximal to the

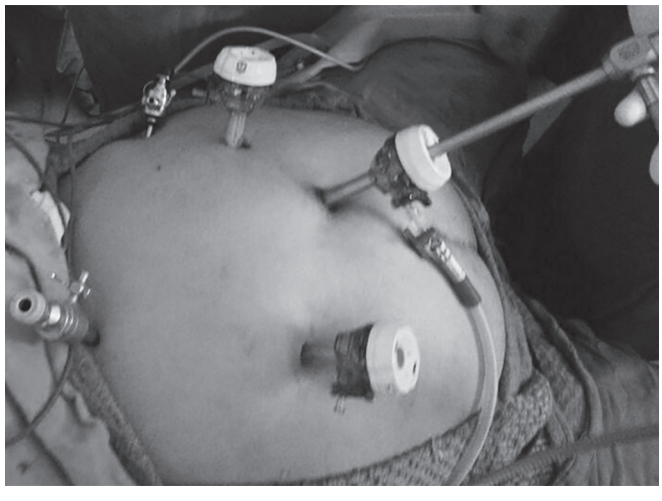


Fig. 1: Port placement

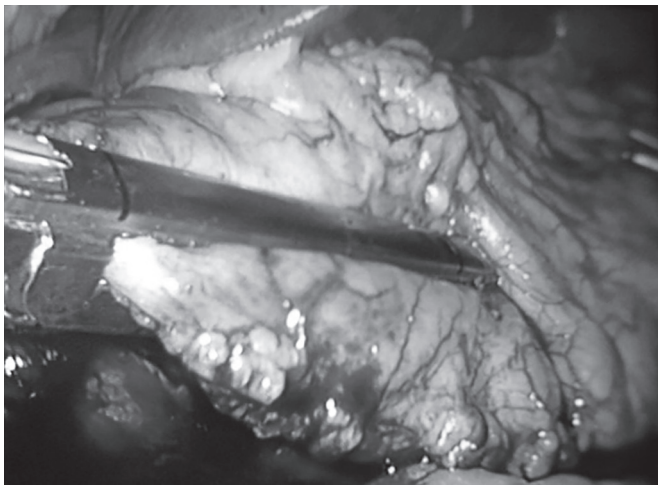


Fig. 2: Starting point of sleeve gastrectomy after omentolysis using 1st green fire (Endo GIA)

Fig. 3: Resected specimen

pylorus up to the gastroesophageal junction using the harmonic scalpel. The orogastric tube was then removed and replaced by a 38-French (Fr) gastric calibration tube placed in the stomach by the anesthesiologist and guided laparoscopically to sit on the lesser curvature of the stomach up to the pylorus. The first two 60 mm green cartridge (Endo GIA Stappler) was used to divide the stomach starting 3 to 5 cm proximal to the pylorus. Next 60 mm blue cartridges were used to complete the division of the remainder of the stomach. The specimen was then taken out of the abdominal cavity through the 12 mm port. The bougie was then removed, and leak test was performed with by air insufflations test. We routinely performed transfascial closure our all 12 mm ports. We routinely put 24 Fr abdominal drain along the sleeve.

Postoperative Period

Patients were observed in the high-dependency unit for the first night after the procedure. Patients were encouraged to sit out of bed and chest physiotherapy using incentive spirometry on the evening after surgery in order to minimize postoperative atelectasis. No leak test was done postoperatively. Patients were allowed clear liquid on postoperative day 1 along with maintenance intravenous fluid. Antibiotic and prokinetics/antiemetic were continued for a period of 5 days and 14 days respectively. Patients were discharged and followed up at 1st, 2nd, 4th, and 12th weeks. At each follow-up visit, weight loss was evaluated.

STATISTICAL ANALYSIS

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Statistical tests were applied as follows:

- Quantitative variables were compared using unpaired t test/Mann–Whitney test (when the datasets were not normally distributed) between the two groups.
- Qualitative variables were correlated using chi-square test/Fisher's exact test. The p-value of <0.05 was considered statistically significant.

The data was entered in MS EXCEL spreadsheet, and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0. All of the results are presented as two-tailed values with statistical significance defined as $p<0.05$.

RESULTS AND OBSERVATIONS

A total of 60 patients were operated for morbid obesity of the age from 27 to 55 years with a mean of 41.53 ± 8.89 years, and the male-to-female ratio is 3:7. The patients were selected randomly who came to our OutPatient Department (OPD). All patients were thoroughly investigated for any reversible causes of obesity as well as any psychiatric, cardiac, and respiratory problems including obstructive sleep apnea syndrome.

Postoperatively all patients were strictly followed up as per the research protocol, that is, at 1st, 2nd, 4th, and 12th weeks and were given same diet plan for the first three months of the follow-up.

The mean weight of the all morbidly obese patients preoperatively was 111.03 ± 8.78 kg (100–130) and the mean height was 1.6 gm (1.5–1.73). On follow-up, the mean weight at 1st, 2nd, 4th, and 12th weeks reduced to 109 ± 8.23, 107.2 ± 7.88, 103.37 ± 7.81, and 96.63 ± 7.06 kg respectively. On statistical analysis it was found to be significant (p-value <0.05).

Similarly, the mean BMI of all the patients was 43.68 ± 3.75 kg/m^2 (37.63–56.44). Preoperatively and on follow-up the mean BMI reduced to 42.9 ± 3.52, 42.09 ± 3.26, 40.55 ± 3.14, and 38.01 ± 2.31 kg/m^2 at 1st, 2nd, 4th, and

12th weeks respectively. All these observations were analyzed and found statistically significant ($p < 0.05$) (Table 1 and Graph 1).

DISCUSSION

World Health Organization reveals in its report that obesity is one of the most common, yet among the most neglected public health problems in both developed and developing countries.[17] Obesity is strongly associated with other comorbidity including diabetes, hypertension, dyslipidemia, cardiovascular disease, and some cancers.[24]

There is a growing consensus that bariatric surgery is the predominant treatment option available for the management of morbid obesity and its associated comorbidities. Diet therapy, medical treatment, exercise, and yogas are relatively ineffective in treating morbid obesity in the long term.[25] Recently, the LSG has emerged as a standalone procedure for the treatment of morbid obesity, and unlike the Roux-en-Y gastric bypass (RYGB), the LSG does not bypass the foregut.[26,27]

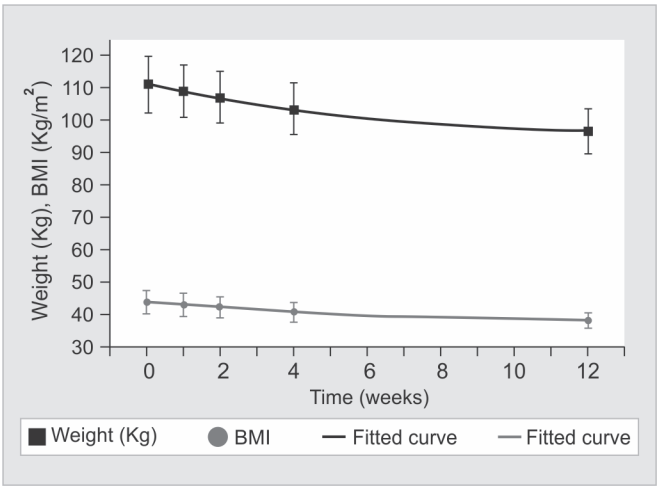
The mechanisms of action of LSG are probably mechanical restriction and hormonal modulation. It reduces the size of the gastric reservoir to 60 to 100 mL, permitting the intake of only small amounts of food and imparting a feeling of satiety earlier. Ghrelin, a hunger-regulating peptide hormone, produced by P/D1 cells that are found mainly in the fundus of the stomach are removed, thus reducing plasma ghrelin levels and, subsequently, the feeling of hunger. Ghrelin regulation is also disturbed following the sleeve gastrectomy. In a prospective study of 20 patients, the effects of LSG on immediate and 6-month postoperative ghrelin levels were compared with those of laparoscopic adjustable gastric banding.[28] The LSG patients showed a significant decrease in plasma ghrelin levels on day 1, which remained low throughout 6 months. In a prospective double-blind study of 32 patients, LSG resulted in a marked reduction in fasting ghrelin levels and significant suppression after a meal, which was not seen after RYGB.[29] Furthermore, appetite was also reduced to a greater extent after LSG.[29] Laparoscopic sleeve gastrectomy was also reported to have a hindgut effect with increasing levels of glucagon-like peptide-1 and peptide YY due to the increased transit time after LSG.[30]

Laparoscopic Sleeve Gastrectomy Efficacy Profile

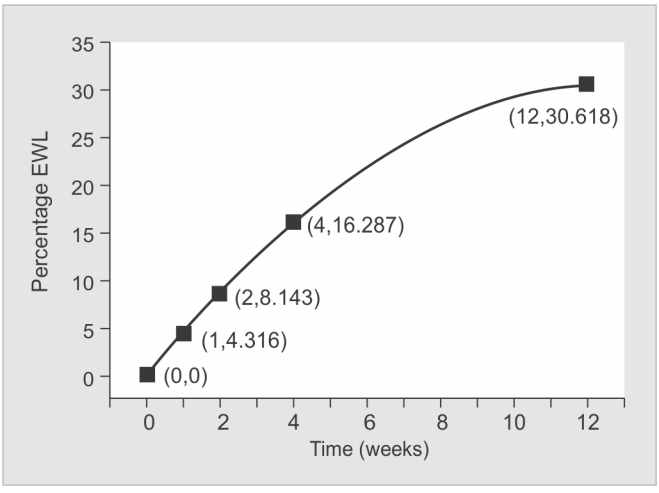
Early safety and efficacy of LSG was examined prospectively by Mognol and colleagues.[31] Mean operative time was 120 (90–150) minutes and the average length of stay

Table 1: Correlation of weight and BMI with postoperative period after LSG

Duration	*Sample size*	*Parameter*	*Mean ± SD*	*Min–Max*	*p-value*
0 Week	60	Weight (kg)	111.03 ± 8.78	100–130	
		BMI	43.68 ± 3.75	37.63–56.44	
1st Week	60	Weight (kg)	109 ± 8.23	98–126	<0.0005
		BMI	42.9 ± 3.52	37.63–55.55	<0.0005
2nd Week	60	Weight (kg)	107.2 ± 7.88	97–124	<0.0005
		BMI	42.09 ± 3.26	37.26–53.33	<0.0005
4th Week	60	Weight (kg)	103.37 ± 7.81	94–120	<0.0005
		BMI	40.55 ± 3.14	36.13–51.11	<0.0005
12th Week	60	Weight (kg)	96.63 ± 7.06	84–112	<0.0005
		BMI	38.01 ± 2.31	34.62–44.44	<0.0005



Graph 1: Weight and BMI trends following LSG



Graph 2: Percentage of EWL trend with postoperative period

in hospital was 7.2 days. No early mortalities or complications were reported. At 1 year after LSG, an EWL of 51% and a BMI decrease to 41 was reported in the 30% of patients who completed follow-up.

Similar results were demonstrated in a retrospective study by Baltasar et al,[32] involving 31 patients who had undergone LSG for various reason. There were no instances of deep vein thrombosis or pulmonary embolism, leak or pneumonia. However, there were two instances of trocar-related intraabdominal bleeding, with one leading to death. Mean EWL ranged from 56.1% (at 4–27 months) in the super-obese patients to 62.3% (3–27 months follow-up) in the lower BMI patients with significant comorbidities. Himpens et al[33] published a prospective randomized study involving 40 patients undergoing LSG. With a median initial BMI of 39 (30–53), their 3-year follow-up data found a median weight loss of 29.5 kg (1–48), median BMI decrease of 27.5 kg/m^2 (0–48), and a median percent of EWL of 66% (–3.1 to 152.4) after LSG.

Milone et al[34] retrospectively compared their experience with 20 LSG patients (BMI > 50) to that of 57 Bio-Enterics Intragastric Ballons. In LSG patients, the only complication was a trocar site infection. Laparoscopic sleeve gastrectomy not only produced significantly more weight loss but also had fewer complications in this limited study.

Laparoscopic sleeve gastrectomy as a sole weight loss procedure was also examined by Langer et al.[35] At 6 months, mean EWL among all 23 patients was 46%, and it was 56% at 1 year. Two patients required conversion to RYGB.

In our study the percentage of EWL was 4.31, 8.14, 16.28, and 30.61% at 1st, 2nd, 4th, and 12th weeks respectively, which is significant and in consistent with other studies. Similarly, the mean BMI also reduced substantially in accordance with the earlier studies. It is expected that the loss of excess weight may be even more if patients follow the nutritional guidelines strictly, which is high-protein low-calorie diet and regular exercise (Graph 2).

A recent survey conducted at the First International Consensus Summit for Sleeve Gastrectomy asked "Is LSG indicated as a primary procedure in patients with a BMI > 40 or BMI > 35 with comorbidities?" Of the respondents, 58% completely agreed, 19% somewhat agreed, 8% had no opinion, 14% somewhat disagreed, and 0% completely disagreed.[36]

COMPLICATIONS

The risk of postoperative bleeding has been reported to be between 1 and 6% after LSG.[37,38] The bleeding may be intraluminal or extraluminal and are managed conservatively. The extraluminal bleeding may be from gastric staple line, spleen, liver, or abdominal wall at the sites of trocar entry. A number of buttressing materials are commercially available to attempt to reduce the rate of bleeding from the staple line. Several authors have described oversewing the long staple line, whereas others have used buttressed staples (i.e., Gore Seamguard Bioabsorbable Staple Line Reinforcement) or fibrin glue as a sealant[39] and were able to demonstrate significantly less intraoperative blood loss in the buttressed staple line group (120 *vs* 210 mL, $p < 0.05$). Albanopoulos and colleagues,[29] however, did not observe a significant difference in their rate of postoperative bleeding between patients with staple line suturing or buttressing with Gore Seamgard after LSG.

In our series, there were three cases of bleeding from the staple line of which two were managed with the titanium clips and one required staple line suturing. We routinely did not reinforce the suture line. The other minor bleeding from short gastric vessels (one case) and one from liver during retraction were managed conservatively. We did not encounter any case of intraluminal bleeding and any case of bleeding in the postoperative period.

Gastric leak is the most serious and dreaded complications of LSG. It occurs in up to 5% of patients following LSG.[22,38] An early leak is generally diagnosed within the first 3 days after surgery, whereas a delayed leak is usually diagnosed more than 8 days after surgery.[40]

In a study by Kolakowski et al,[41] a combination of clinical signs of fever, tachycardia, and tachypnea was found to be 58.33% sensitive and 99.75% specific for detection of anastomotic leaks clinically. In the presence of a leak, an abdominal washout laparoscopically with surgical repair of the leak (if technically feasible) and feeding jejunostomy should be performed.

Treatment of delayed gastric leak is more challenging and includes conservative or surgical management. This depends on the patient's hemodynamic condition and on physical and radiological findings. In the absence of hemodynamic instability and physical findings suggestive of peritonitis, conservative management, including intraluminal stenting,[42] should be initiated. Himpens et al[43] reported their experience in the management of 29 patients with gastric leak after sleeve gastrectomy with stenting in which the stents were left *in situ* on average for 7 weeks. Immediate success was observed in 19 patients after placement of the first stent, whereas five patients required placement of a second stent. In a septic patient with radiological evidence of a leak with diffuse intraabdominal fluid collections, surgical drainage of the fluid collection is warranted.

Abscess

Intraabdominal abscess is another known complication after LSG. In a series of 164 patients undergoing

LSG, Lalor et al[44] reported one patient with an abscess (0.7%). Treatment includes percutaneous drainage and antibiotics.

We did not encounter any staple line leak and intraabdominal abscess during the study.

Other chronic complications like stricture formation, kinking of the stomach, nutritional deficiencies, and gastroesophageal reflux disease (GERD) has been reported in different studies. The kinking of the stomach following LSG has been reported,[45] and the most common site of stenosis is at the incisura angularis[46] and is diagnosed by endoscopy. The treatment options include endoscopic dilations/seromyotomy/convertion to RYGB.

Nutritional deficiencies have been reported after LSG probably owing to impaired absorption and decreased oral intake. In a study by Gagner et al,[26] the prevalence of vitamin B12, vitamin D, folate, iron, and zinc deficiency was reported to be 3, 23, 3, 3, and 14% respectively after LSG. These deficiencies are less prevalent after LSG than RYGB. Folic acid deficiency was slightly more common after LSG than RYGB (22 *vs* 12%).[48]

Gastroesophageal reflux disease is also seen in the bariatric surgery population. Chiu et al,[47] found the data to be inconclusive with respect to the effect of LSG on GERD. Carter et al[49] performed a retrospective study on patients who underwent LSG and found 47% of their patients to have persistent (> 30 days) GERD symptoms and were treated with proton pump inhibitor.

CONCLUSION

Laparoscopic sleeve gastrectomy is a simple and effective surgical treatment option for weight loss and should be considered as a definitive bariatric surgical management option. Long-term data for weight loss and other chronic complications of sleeve gastrectomy need to be studied further.

REFERENCES

1. Tremblay MS, Katzmarzyk P, Wilms J. Temporal trends in overweight and obesity in Canada, 1981–1996. Int J Obes Relat Metab Disord 2002 Apr;26(4):538-543.
2. Canning PM, Courage ML, Frizzell LM. Prevalence of overweight and obesity in a provincial population of Canadian preschool children. CMAJ 2004 Aug;171(3):240-242.
3. Steinbrook R. Surgery for severe obesity. N Engl J Med 2004 Mar;350(11):1075-1079.
4. Padwal RS, Lewanczuk RZ. Trends in bariatric surgery in Canada, 1993–2003. CMAJ 2005 Mar;172(6):735.
5. Mohan V, Deepa R. Obesity and abdominal obesity in Asian Indians. Indian J Med Res 2006 May;123(5):593-596.
6. Ramachandran A, Snehalatha C. Rising burden of obesity in Asia. J Obes 2010;2010:pii. 868573.
7. Bhardwaj S, Misra A, Misra R, Goel K, Bhatt SP, Rastogi KV, Vikram NK, Gulati S. High prevalence of abdominal, intraabdominal and subcutaneous adiposity and clustering of risk factors among urban Asian Indians in North India. PLoS One 2011;6(9):e24362.
8. Deepa M, Farooq S, Deepa R, Manjula D, Mohan V. Prevalence and significance of generalized and central body obesity in an urban Asian Indian population in Chennai, India (CURES: 47). Eur J Clin Nutr 2009 Feb;63(2):259-267.
9. Misra A, Khurana L. Obesity and the metabolic syndrome in developing countries. J Clin Endocrinol Metab 2008 Nov;93 (11 Suppl 1):S9-30.
10. Available from: http://www.business-standard.com/india/news/auto-sales-grow-highest-indecade/394471/
11. Rao CR, Kamath VG, Shetty A, Kamath A. A cross-sectional analysis of obesity among a rural population in coastal southern Karnataka, India. Australas Med J 2011;4(1):53-57.
12. Low A, Bouldin M, Sumrall C, Loustalot F, Land A. A clinician's approach to medical management of obesity. Am J Med Sci 2006 Apr;331(4):175-182.
13. Weintraub M. Long-term weight control study: Conclusions. Clin Pharmacol Ther 1992 May;51(5):642-646.
14. Zhang F, Strain G, Lei W, Danger M, Pomp A. Changes in lipid profile in morbidly obese patient after laparoscopic sleeve gastrectomy (LSG). Obes Surg 2011 Mar;21(3):305-309.
15. Pories WJ, Swanson MS, MacDonald KG, Long SB, Morris PG, Brown BM, Barakat HA, de Ramon RA, Israel G, Dolezal JM, et al. Who would have thought it? An operation proves to be the most effective therapy foradult-onset diabetes mellitus. Ann Surg 1995 Sep;222(3):339-350. Discussion 350-332.
16. Sjostrom L, Narbro K, Sjostrom CD, Karason K, Larsson B, Wedel H, Lystig T, Sullivan M, Bouchard C, Carlsson B, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. N Engl J Med 2007 Aug;357(8):741-752.
17. World Health Organization. WHO fact sheets (Fact sheet No. 311). [online]. Available from: www.who.int/mediacentre/factsheets/fs311/en/. Accessed January 5, 2011.
18. Lee WJ, Chong K, Ser KH, Lee YC, Chen SC, Chen JC, Tsai MH, Chuang LM. Gastric bypass *vs* sleeve gastrectomy for type 2 diabetes mellitus: A randomized controlled trial. Arch Surg 2011 Feb;146(2):143-148.
19. Lee WJ, Wang W, Lee YC, Huang MT, Ser KH, Chen JC. Effect of laparoscopic mini-gastric bypass for type 2 diabetes mellitus: Comparison of BMI > 35 and < 35 kg/m^2. J Gastrointest Surg 2008 May;12(5):945-952.
20. Kim Z, Hur KY. Laparoscopic mini-gastric bypass for type 2 diabetes: The preliminary report. World J Surg 2011 Mar;35(3):631-636.
21. Cutolo PP, Nosso G, Vitolo G, Brancato V, Capaldo B, Angrisani L. Clinical efficacy of laparoscopic sleeve gastrectomy *vs* laparoscopic gastric bypass in obese type 2 diabetic patients: A retrospective comparison. Obes Surg 2012 Oct;22(10): 1535-1539.
22. Moon Han S, Kim WW, Oh JH. Results of laparoscopic sleeve gastrectomy (LSG) at 1 year in morbidly obese Korean patients. Obes Surg 2005 Nov-Dec;15(10):1469-1475.
23. Gumbs AA, Gagner M, Dakin G, Pomp A. Sleeve gastrectomy for morbid obesity. Obes Surg 2007 Jul;17(7):962-969.
24. Lorein SD, George AK. Dialysis: Obesity and mortality on dialysis-does age matter? Nat Rev Nephrol 2012;8:258-260.
25. Klein S, Sheard NF, Pi-Sunyer X, Daly A, Wylie-Rosett J, Kulkarni K, Clark NG; American Diabetes Association; North American Association for the Study of Obesity; American Society for Clinical Nutrition. Weight management through

lifestyle modification for the prevention and management of type 2 diabetes: Rationale and strategies. A statement of the American Diabetes Association, the North American Association for the Study of Obesity, and the American Society for Clinical Nutrition. Am J Clin Nutr 2004 Aug;80(2): 257-263.

26. Gagner M, Deitel M, Kalberer TL, Erickson AL, Crosby RD. The second international consensus summit for sleeve gastrectomy, March 19–21, 2009. Surg Obes Relat Dis 2009 Jul-Aug;5(4):476-485.
27. Fuks D, Verhaeghe P, Brehant O, Sabbagh C, Dumont F, Riboulot M, Delcenserie R, Regimbeau JM. Results of laparoscopic sleeve gastrectomy: A prospective study in 135 patients with morbid obesity. Surgery 2009 Jan;145(1):106-113.
28. Langer FB, Reza Hoda MA, Bohdjalian A, Felberbauer FX, Zacherl J, Wenzl E, Schindler K, Luger A, Ludvik B, Prager G. Sleeve gastrectomy and gastric banding: Effects on plasma ghrelin levels. Obes Surg 2005 Aug;15(7):1024-1029.
29. Karamanakos SN, Vagenas K, Kalfarentzos F, Alexandrides TK. Weight loss, appetite suppression, and changes in fasting and postprandial ghrelin and peptide-YY levels after Roux-en-Y gastric bypass and sleeve gastrectomy: A prospective, double blind study. Ann Surg 2008 Mar;247(3):401-407.
30. Ramachandran A, Ma RC, Snehalatha C. Diabetes in Asia. Lancet 2010 Jan;375(9712):408-418.
31. Mognol P, Chosidow D, Marmuse JP. Laparoscopic sleeve gastrectomy as an initial bariatric operation for high-risk patients: Initial results in 10 patients. Obes Surg 2005 Aug;15(7): 1030-1033.
32. Baltasar A, Serra C, Perez N, Bou R, Bengochea M, Ferri L. Laparoscopic sleeve gastrectomy: A multi-purpose bariatric operation. Obes Surg 2005 Sep;15(8):1124-1128.
33. Himpens J, Dapri G, Cadière GB. A prospective randomized study between laparoscopic gastric banding and laparoscopic isolated sleeve gastrectomy: Results after 1 and 3 years. Obes Surg 2006 Nov;16(11):1450-1456.
34. Milone L, Strong V, Gagner M. Laparoscopic sleeve gastrectomy is superior to endoscopic intragastric balloon as a first stage procedure for super-obese patients (BMI > or = 50). Obes Surg 2005 May;15(5):612-617.
35. Langer FB, Bohdjalian A, Felberbauer FX, Fleischmann E, Reza Hoda MA, Ludvik B, Zacherl J, Jakesz R, Prager G. Does gastric dilatation limit the success of sleeve gastrectomy as a sole operation for morbid obesity. Obes Surg 2006 Feb;16(2):166-171.
36. Deitel M, Crosby RD, Gagner M. The First International Consensus Summit for Sleeve Gastrectomy (SG), New York City, October 25–27, 2007. Obes Surg 2008 May;18(5): 487-496.
37. Frezza EE. Laparoscopic vertical sleeve gastrectomy for morbid obesity. The future procedure of choice? Surg Today 2007;37(4):275-281.
38. Melissas J, Koukouraki S, Askoxylakis J, Stathaki M, Daskalakis M, Perisinakis K, Karkavitsas N. Sleeve gastrectomy: A restrictive procedure? Obes Surg 2007 Jan;17(1):57-62.
39. Dapri G, Cadiere GB, Himpens J. Reinforcing the staple line during laparoscopic sleeve gastrectomy: Prospective randomized clinical study comparing three different techniques. Obes Surg 2010 Apr;20(4):462-467.
40. Csendes A, Burdiles P, Burgos AM, Maluenda F, Diaz JC. Conservative management of anastomotic leaks after 557 open gastric. Obes Surg Bypasses 2005 Oct;15(9):1252-1256.
41. Kolakowski S, Kirkland ML, Scuricht AL. Routine postoperative upper gastrointestinal series after Roux-en-Y gastric bypass. Arch Surg 2007 Oct;142(10):930-934.
42. Márquez MF, Ayza MF, Lozano RB, Morales Mdel M, Diez JM, Poujoulet RB. Gastric leak after laparoscopic sleeve gastrectomy. Obes Surg 2010 Sep;20(9):1306-1311.
43. Himpens J, Dapri G, Cadiere GB. Treatment of leaks after sleeve gastrectomy. *Bariatric Times*. Sep, 2009. [Accessed 2012 Oct 29]. Available from: http://bariatrictimes.com/treatment-of-leaks-after-sleeve-gastrectomy/
44. Lalor PF, Tucker ON, Szomstein S, Rosenthal RJ. Complications after laparoscopic sleeve gastrectomy. Surg Obes Relat Dis 2008 Jan-Feb;4(1):33-38.
45. Uglioni B, Wolnerhanssen B, Peters T, Christoffel-Courtin C, Kern B, Peterli R. Midterm results of primary versus secondary laparoscopic sleeve gastrectomy (LSG) as an isolated operation. Obes Surg 2009 Apr;19(4):401-406.
46. Cottam D, Qureshi F, Mattar S, Sharma S, Holover S, Bonanomi G, Ramanathan R, Schauer P. Laparoscopic sleeve gastrectomy as an initial weight-loss procedure for high-risk patients with morbid obesity. Surg Endosc 2006 Jun;20(6):859-863.
47. Chiu S, Birch DW, Shi X, Sharma AM, Karmali S. Effect of sleeve gastrectomy on gastro-esophageal reflux disease: A systematic review. Surg Obes Relat Dis 2011 Jul-Aug;7(4):510-515.
48. Gehrer S, Kern B, Peters T, Christoffel-Courtin C, Peterli R. Fewer nutrient deficiencies after laparoscopic sleeve gastrectomy (LSG) than after laparoscopic Roux-en-Y-gastric bypass (LRYGB) – A prospective study. Obes Surg 2010 Apr;20(4): 447-453.
49. Carter PR, LeBlanc KA, Hausmann MG, Kleinpeter KP, de Barros SN, Jones SM. Association between gastroesophageal reflux disease and laparoscopic sleeve gastrectomy. Surg Obes Relat Dis 2011 Sep-Oct;7(5):569-572.

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ORIGINAL ARTICLE

Role of Mishra's Knots in Various Surgeries in Laparoscopy

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ABSTRACT

Introduction: In the present era of laparoscopy and its ever-expanding application to various different types of surgeries, the art of suturing and knotting still plays a pivotal role in determining the success of any surgery as in case of open surgeries. Despite the introduction of various energy sources as an alternative to suturing and knotting, the various complications associated with them and the cost limitations have to be considered.

Extracorporeal and intracorporeal knotting in laparoscopic surgery can be used in various situations and though it can be technically demanding, it can be overcome with repeated practice. Here we describe a new technique of knot which is simple, easy, and a safe extracorporeal knotting technique which can be used for any continuous tubular structure up to a maximum diameter of 22 mm. This technique was introduced by Professor and Doctor Mishra who has himself worked upon it in the last 2 years after trying various other knots and modifying them to achieve better security.

Technique description: Mishra's knot is a modification of the Roeder's knot or the Meltzer's knot. It's a relative simple technique where we use 3 hitches and 3 loops alternating each other. The modification aims to achieve better knot security by application of a lock after every wind.

Materials and methods: A literature review was performed using PubMed, SpringerLink, HighWire Press and search engines like Google and Yahoo. The following search terms were used: Extracorporeal knot, Roeder's knot, Meltzer's knot, Mishra's knot. A total of more than 300 citations were found. Selected papers were screened for further references according to our requirements.

A list of 280 surgeries where Mishra's knot was successfully used was given to us for study purpose by Professor Dr RK Mishra.

Conclusion: "This is a very simple and safe technique and has been successfully followed in more than 300 cases for tying an extracorporeal knot. It's a very safe and reliable knot even for the critical structures like cystic duct, uterine artery, and various arteries and we observed it to be very secure."

Keywords: Extracorporeal sutures, Mishras Knot, Sliding knot.

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INTRODUCTION

"Minimal access surgery" (MAS) or the more Layman's term keyhole surgeries has revolutionized the current trends in all fields of surgery varying from single laparoscopic surgery to robotic surgery. The advantages of laparoscopy are that it is less painful, permits earlier return to work, provides better cosmesis, and is more acceptable to the patient than traditional surgeries. Advanced MAS requires that the surgeon should be well versed at intracorporeal suturing and knotting. However, mastering this skill is a very difficult process with a long and steep learning curve. Extracorporeal knots permit the knot to be tied outside and then by using a knot pusher, it is applied snugly inside the body.[1]

Some of the extracorporeal slip knots are: Roeder knot, Duncan loop, Nicky's knot, Tennessee slider, SMC knot, Weston knot, Meltzer, Tayside knot, and others. The above-mentioned knotting techniques are variations around the axis or the number of reversed half hitches on alternating post. Each technique has its proponents and some have been modified for improvement, but some of the disadvantages with these techniques are in terms of size of suture material, the numbers of knots that can be applied at once, and the ease of sliding in the extracorporeal knot.

A good knot must fulfill the two basic qualities:

1. The knot must be properly formed, so the suture does not slip or cut into itself.
2. It must be easily tightened to ensure maximum strength.

For a knot to be effective and strong without slippage, it must possess the attributes of both knot security and loop security.[2,3]

Knot security is defined as the effectiveness of the knot at resisting slippage when load is applied and depends on three factors: Friction, internal interference, and slack between throws. Loop security is defined as the ability to maintain a tight suture loop as a knot is made.[4-7] Thus, any tied knot can have good knot security but poor loop security (a loose suture loop), and therefore it will be ineffective in approximating the tissue edges to be repaired.

DEFINITIONS

Postlimb: The straight portion of the suture limb purely defined as the suture limb under the most tension.

Wrapping limb: The free portion of the suture limb that wraps around the postlimb.
Effective knot: Possesses the attributes of both knot security and loop security.
Knot security: The effectiveness of a knot to resist slippage when load is applied.
Loop security: The ability of a knot to maintain a tight suture loop as a knot is tied.[3,7,8]

TECHNIQUE

More than one turn of the wrapping limb around the post (i.e., any sliding knot other than a half hitch) is there for compound sliding knots. They can be used in situations where the suture slides smoothly and freely through the tissue and anchoring device. They are advantageous since compound sliding knots can be made to slide down the postlimb without unraveling or jamming prematurely. Theoretical disadvantages include abrasion of suture against the anchor eyelet, and suture cutting through tissue as it slides.[4,9,10]

Mishra's knot is one important extracorporeal knot that combines the loop and knot securities of many other extracorporeal knot that is fast gaining wide acceptance by many laparoscopic surgeons. The steps in tying Mishra's knot is highlighted in Figures 1 to 10.

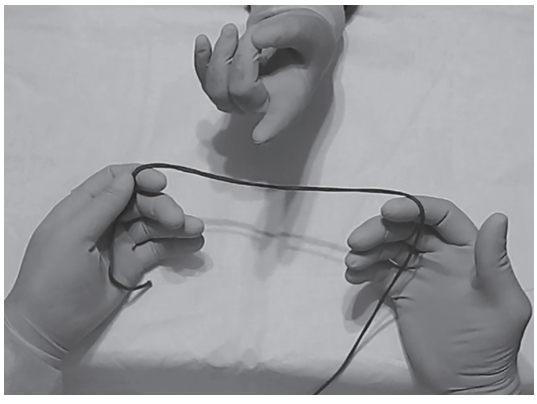

Fig. 1: Use assistants finger to form a knot

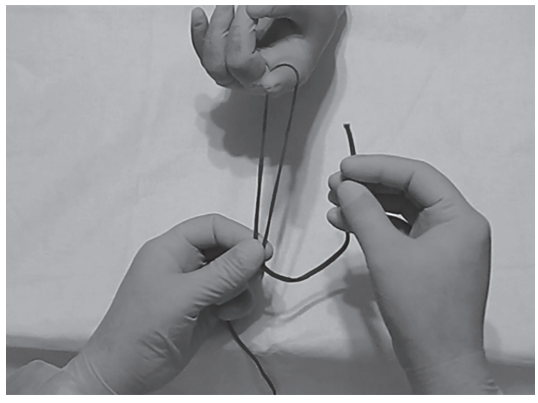

Fig. 2: Shorter hand to be placed over longer hand

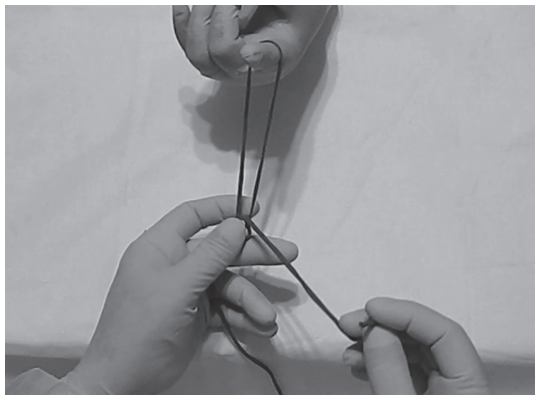

Fig. 3: Take half hitch on the right side

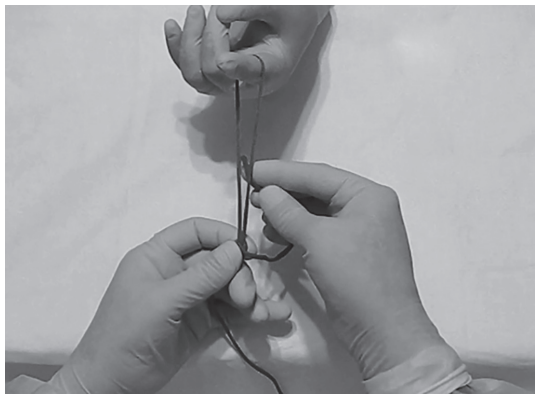

Fig. 4: Take one wind

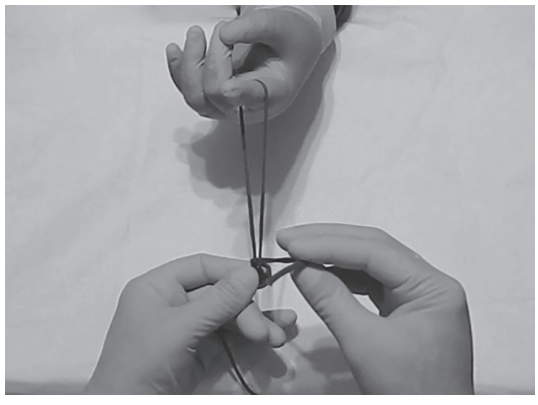

Fig. 5: Complete the wind

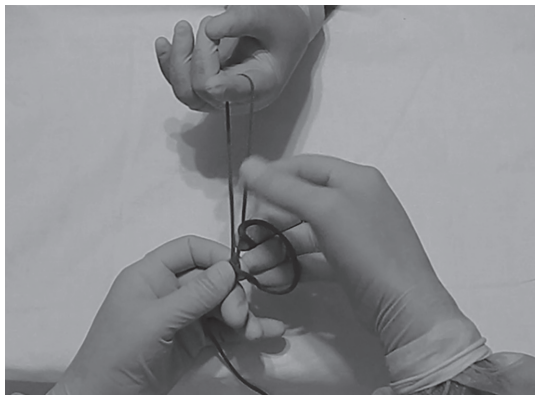

Fig. 6: Take second half lock

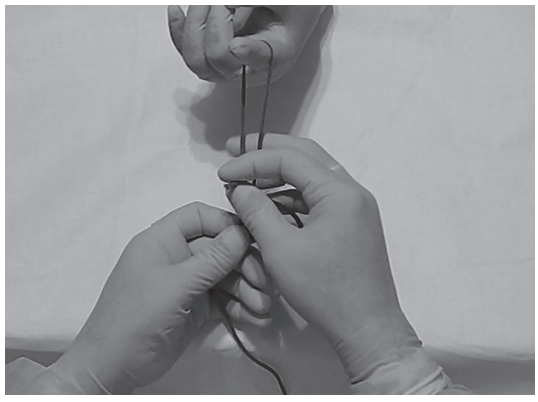

Fig. 7: Complete the second wind

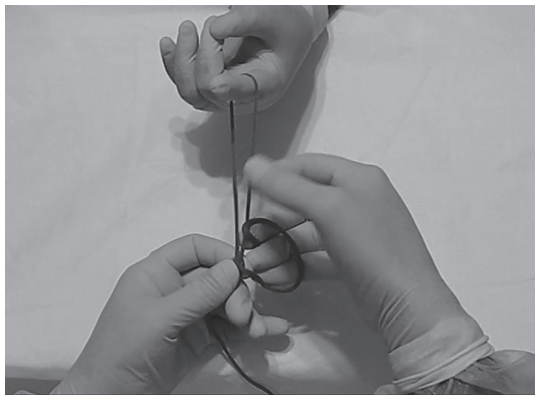

Fig. 8: Complete the third lock

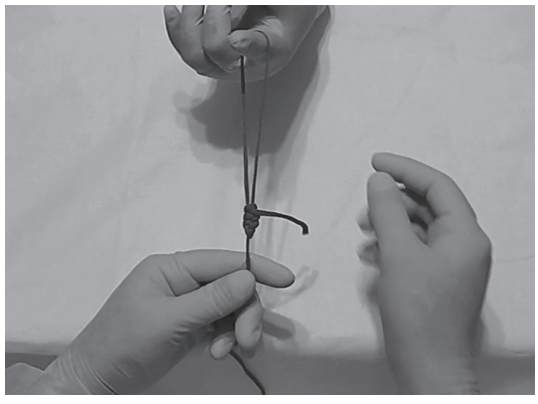

Fig. 9: Make the knot and slide it up

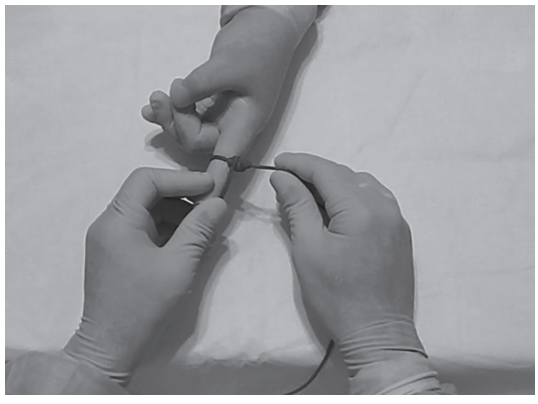

Fig. 10: Knot complete

DISCUSSION

Despite the great usefulness of laparoscopy for the treatment of surgical and gynecological diseases, suture tying in the cavity remains a great challenge. Optimization of both knot security and loop security[1,10,11] for any given knot is critical, and recommendations regarding a specific knot should not be made without taking both characteristics under consideration.

Most of the studies showed that the loop security of almost all sliding knots tied without reversing half hitches on alternating posts (RHAPs) was poor; hence RHAPs improve both the knot and loop securities. Although this locking mechanism is particularly useful in preventing the knot from sliding back, locking the knot also causes expansion of the suture loop.[4] This effect was seen in almost every knot that required a flipping maneuver to be locked. There has been previous classification of sliding knots as either lockable or nonlockable, with lockable knots further divided into proximal-locking and distal-locking knot.[8] In lockable sliding knots, tensioning the wrapping limb distorts the postlimb, resulting in a kink in the post, thereby increasing the internal interference that increases the resistance of the knot from backing off. This locking effect is also known as the "one-way ratchet effect" or the "self-locking effect."[12]

Locking knots have previously been divided into proximal-locking and distal-locking knots (as referenced relative to the surgeon) according to where the wrapping limb deforms the postlimb when it is tensioned.[6] That is, a proximal-locking knot deforms in that portion of the knot which is closest to the surgeon, whereas a distal-locking knot deforms in the part of the knot that is furthest away from the surgeon. Mishra's knot appears to combine the characteristics of the three categories.[12]

Here, we have been using Mishra's knot for various procedures like appendicectomies, cholecystectomies, total laparoscopic hysterectomy, splenectomy, nephrectomy, and pedunculated subserous myoma. We have found that even in acute cases of appendicitis and even cholecystitis *en masse* ligation of the cystic artery and cystic duct have been very promising, easy to apply, and very secure when compared to other knots.

List of cases in which we have successfully tried Mishra's knot are as follows:

Sl. no.	*Surgeries*	*No.*
1	Appendicectomy	129
2	Cholecystectomy	84
3	Total laparoscopic hysterectomy	51
4	Splenectomy	7
5	Nephrectomy	3
6	Pedunculated subserous myoma	6

RESULTS

Using a servohydraulic materials testing system (MTS model 858, Bionix, Eden Prairie, MN) to test the knot and loop security of each combination of the knots and suture types (Ethibond and FiberWire) and using 5N preload and critical loop circumference of 30 mm, it was found that in all cases, no knots failed by suture breakage, suggesting that all knots failed by a combination of knot slippage and suture elongation. When tied with no. 2 Ethibond suture or no. 2 FiberWire suture, the Weston knot provided the highest load to failure when compared with the other sliding knots. However, the maximum force of the surgeon's knot was significantly higher than the Weston knot when tied with either Ethibond or FiberWire suture.

When the sliding knots were tied with three RHAPs using no. 2 Ethibond suture, the Weston RHAP, Roeder RHAP, Mishra RHAP, and SMC RHAP provided the highest force to failure. These forces were not significantly different from the force to failure of the surgeon's knot tied with no. 2 Ethibond suture.

When the sliding knots were tied with three RHAPs using no. 2 FiberWire suture, the Weston RHAP provided the highest force to failure. This force was not significantly different from the force to failure of the surgeon's knot. In all cases, tying with either no. 2 Ethibond or no. 2 FiberWire suture, the addition of three RHAPs after a base sliding knot significantly improved the force to failure. Of the sliding knots tied with no. 2 Ethibond suture, the Duncan loop, Roeder knot, Weston knot, Mishra knot, and Tennessee slider, all provided similar loop circumferences at 5N of preload, although the loop circumferences associated with these knots were significantly larger than the loop circumference of the surgeon's knot. When tied with no. 2 Ethibond suture, the Roeder RHAP, Mishra RHAP, Duncan RHAP, and Nicky's RHAP provided the smallest loop circumferences and were not significantly different from the surgeon's knot. Similarly, when tied with no. 2 FiberWire, the Roeder RHAP, Mishra RHAP, Duncan RHAP, and Nicky's RHAP provided the smallest loop circumferences and were not significantly different from the surgeon's knot.

Does securing a sliding knot with three RHAPs decrease the loop circumference (improve loop security)? With knots tied with no. 2 Ethibond suture, the addition of three RHAPs decreased the loop circumference of the Nicky's knot, Mishra knot, Roeder knot, the SMC knot, and the Tennessee slider. No significant difference was found in the Duncan loop or the Weston knot when tied with or without three RHAPs. When tying knots with no. 2 FiberWire, the addition of three RHAPs decreased the loop circumference of the Nicky's knot, the Mishra knot, and the Roeder knot.

CONCLUSION

A surgeon's knot provides the best balance of loop security and knot security within the knot configurations tested. A sliding knot without RHAPs has both poor loop security and knot security and should not be tied. The addition of three RHAPs improves knot security of all sliding knots tested and improves loop security of most of the sliding knots tested. The addition of three RHAPs improved the knot security of all sliding knots to adequately resist predicted *in vivo* loads, and Mishra's knot has been proved to be one of the most secure, safe extracorporeal knot in laparoscopy. It can be used for all continuous tubular structures of up to 22 mm diameter. The technique is easy to perform and can be done in minimal possible time. "This technique of the extracorporeal knotting is simple, easy, and reproducible with good knot and loop security and can be used with any suture material of any size."

REFERENCES

1. Akindele RA, Fasanu AO, Mondal SC, Komolafe JO, Mishra RK. Comparing extracorporeal knots in laparoscopy using knot and loop securities. World J Laparos Sur April 2014;7(1):28-32.
2. Stephen W, Eubanks ES, Lee L, Swanstrom MD, Soper NJ. Mastery of endoscopic and laparoscopic surgery. 2nd ed. Lippincott Williams, Wilkins. 2004.
3. J Indian Assoc Paediatric Surg 2010 Oct-Dec:122-126. Available at: http://www.jiaps.com
4. Nottage WM, Lieurance RK. Current concepts: arthroscopic knot tying. Arthroscopy 1999;15:515-521.
5. Weston PV. A new clinch knot. Obstet Gynaecol 1991 Jul;78(1):144-147.
6. Kim SH, Ha KI. The SMC knot: a new slip knot with locking mechanism. Arthroscopy 2000 Jul-Aug;16(5):563-565.
7. Chan KC, Burkhart SS. Arthroscopic knot tying. In: McGinty J, Burkhat S, Jackson R, et al., editors. Operative arthroscopy. Philadelphia, PA: Lippincott, Williams and Wilkins, 2004.
8. Sami Walid M, Heaton RL. Laparoscopy-to-laparotomy quotient in obstetrics and gynaecology residency programs. Arch Gynecol Obstet 2011 May;283(5):1027-1031.
9. Westerbring–van der Putten EP, Goossens RHM, Jakimowicz JJ, Dankelman J. Haptics in minimally invasive surgery: a review. Minim Invasive Ther 2008;17(1):3-16.
10. Croce E, Olmi S. Intracorporeal knot-tying and suturing techniques in laparoscopic surgery: technical details. JSLS 2000 Jan-Mar;4(1):17-22.
11. Lieurance RK, Pflaster DS, Abbott D, Nottage WM. Failure characteristics of various arthroscopically tied knots. Clin Orthop Relat Res 2003 Mar;408:311-318.
12. Hage JJ. How capsizing, flipping and flyping of traditional knots can result in new endoscopic knots: a geometric review. J Am Coll Surg 2007 Nov;205(5):717-723.
13. Burkhat SS, Wirth MA, Simonich M, Salem D, Lanctot D, Athanasiou K. Knot security in simple sliding knots and its relationship to rotator cuff repair: how secure must the knot be? Arthroscopy 2000 Mar;16(2):202-207.

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REVIEW ARTICLE

Should Laparoscopy be the Gold Standard for Isthmocele?

Roshan Zeirideen Zaid

ABSTRACT

Isthmocele is born due to the overwhelmingly increasing cesarean section (CS) rates all over the world. It was an unknown entity in the last century. Cesarean sections are and can be responsible for short- and long-term maternal and fetal morbidity, mortality, and financial issues, directly and indirectly associated to the former. Out of the many problems that are caused by CS, isthmocele is a growing surgical concern that needs attention in identifying, diagnosing, managing, and treating this problem. Currently, treatments include medical and surgical approaches. Hysteroscopy as well as laparoscopy are used in the treatment. This review was carried out to show that laparoscopy is superior in treating an isthmocele than all other treatment modalities.

Materials and methods: An electronic search was done and various articles and studies were reviewed to support the hypothesis.

Keywords: Cesarean section, Hysteroscopy, Isthmocele, Niche, Postmenstrual bleeding, Scar defect.

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INTRODUCTION

Cesarean section (CS) was always believed to be a lifesaving operation for the mother and the unborn. But ironically, its rates are rising in the midst of highly improving medical advances in maternal and newborn care. Forbes magazine[1] has recently published that in the Organisation for Economic Co-operation and Development (OECD) countries, the CS rate approximately stands at 28%. This includes 34 countries around the world. Further, the World health organization (WHO) Global Survey indicates that overall CS rates have increased over time in all countries except Japan from 26.4 to 31.2% in a multicountry survey ($p = 0.003$).[2]

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The ripple effect of the rising CS rates are being seen in many ways. Apart from the well-known placental complications and others following CS, the rising concerns have turned toward the potential long-term morbidity of the scar. Isthmocele is an iatrogenic entity created in the last few decades due to the worldwide increase in CS rates. Isthmocele aka CS scar defect (CSD), CS scar abnormality, pouch, niche, atypical cesarean scar syndrome or cesarean scar syndrome, uterine diverticulum, uteroperitoneal fistula is a result of weak or incompletely healed scar.[3-7]

Isthmocele is believed to cause symptoms like postmenstrual spotting, discharge, smelly postmenstrual bleeding, chronic pelvic pain, and dyspareunia,[8] and lately, there has been evidence that this could be related to secondary subfertility.[9] Apart from the above, other problems associated with scar defect are high-risk complications with subsequent pregnancies,[10] such as dehiscence, placenta previa or accrete,[11] and cesarean scar ectopic pregnancy,[12] and difficulty with gynecological procedures like uterine evacuation, hysteroscopy, and intrauterine-device insertion.[13]

Thurmond postulated in 1999 that a niche in the cesarean scar could be the cause of abnormal bleeding due to the collection of menstrual blood in the pouch.[14]. In 1961 it was first described as a wedge in HSG (hysterosalpigogram) by Poidevin.[15] Also Morris[16] had similar findings while analyzing uterine specimens of women who underwent hysterectomies. U- or V-shaped hypoechoic or anechoic fluid accumulation in the region of former uterotomy was considered as diagnostic[17] with the above-described symptoms.

The incidence of ismocele varies so much from as low as 24% to as high as 84%. Prospective cohort studies done by Florio state the prevalence as 30 to 52%.[9,18,19] Van der voet et al.[20] found the prevalence to be 64.5% 6 to 12 weeks after CS in women using transvaginal ultrasound and sonohysterography. All studies agree that all women who have the scar defect are not symptomatic. Tower and Frishman[21] found the prevalence of symptomatic CSD could be as low as 19.4% to as high as 88%.

Theories/Risk Factors Contributing to the Formation of the Defect

The exact reason is unknown, but there are many hypotheses regarding the contributing factors. The niche is typi-

Fig. 1: Cesarean scar defect

cally found on the anterior surface of the uterus on the hysterotomy scar. Thinning of the myometrium creates a pouch (Fig. 1).[7]

Patient Related Factors

- Multiple Cesarean deliveries
- Factors impacting wound healing
- Factors that possibly hamper normal wound healing and related angiogenesis,[8] retroflexed uterus,[18]
- Labour before CS.[21,22]

Surgery Related

- Single-layer uterine wall closure (incomplete/disrupted closure of myometrium),
- Use of locking sutures, closure of hysterotomy with endometrial-sparing technique.[7]
- Low location (cervix) of uterine scar at the time of CS,
- Surgical activities that may induce adhesion formation (i.e., non closure of peritoneum, inadequate hemostasis, applied sutures, use of adhesion barriers).[8]

This abnormality can be visualized on transvaginal ultrasound, saline-infused sonohysterography (SIS), and hysterosalpingography (HSG).[9] It is seen as a hypoechoic area as a discontinuation of the myometrium. An magnetic resonance imaging (MRI) should be used to confirm the position and defect size prior to attempting to repair the defect.[23] Hysteroscopy is also a useful modality to assess the defect.[24]

Treatment Options

All theories point to a thin disrupted layer of myometrium surrounding the niche. Possibilities of the niche been covered by polypoidal endometrium, congested endometrium/new blood vessels,[8,16] and hyalinized myometrium[6] are being described in histological specimens.

On this basis, treatment should be aimed to relieve the symptoms and strengthen the wall of the myometrium again to prevent potential complications, that is, surgical reconstruction of the uterotomy scar.[17]

Medical and hormonal (combined contraceptive pills and intra uterine device (IUD)) have not shown any improvement in quality of life. Hysteroscopy and treatment appear to remove the symptoms. Also some studies have suggested hysterectomies for postmenstrual bleeding. Laparoscopy has been used on its own or in conjunction with hysteroscopy in surgically correcting this defect. Very few cases of vaginal revision and endometrial ablations have also been mentioned.

Saline infusion sonohysterosonography (SIS lavage) was described by Ida et al[25] in successfully healing the defect spontaneously in a single case report.

DISCUSSION

The niche is still an unknown or a new entity for many. There is no clear definition for a CSD; neither is it a common terminology. Hence, the prevalence of the condition has huge variations. Some have a vague definition ie a U-, V-, or triangular-shaped anechoic or hypoechoic fluid collection[17] seen on scan or SIS[21] is simply considered as a niche. No standardized definition is found in the literature. Hence, comparing studies is challenging.

Possible Mechanism

The collected blood from the niche present as postmenstrual bleeding problems. The flow of menstrual blood through the cervix may be slowed by the presence of isthmocele, as the blood may accumulate in the niche because of the presence of fibrotic tissue, causing pelvic pain in the suprapubic area. Moreover, persistence of the menstrual blood after menstruation in the cervix may negatively influence the mucus quality and sperm quality, obstruct sperm transport through the cervical canal, and interfere with embryo implantation, leading to secondary infertility.[9]

Hysteroscopy is the most commonly reported approach in the literature. Other methods include mostly laparoscopy in combination with hysteroscopy or on its own. Few suggest vaginal, medical (hormonal, IUD),[26,27] and SIS lavage). In spite of hysteroscopy being the famous method, it has its own pitfalls. Resectoscope is less invasive and can be used to correct the defect,[9] but the hysteroscopic approach is not possible in all cases, and also it is good only in correcting the defect, not strengthening the myometrium or correcting the disruption and reinforcing the endurance. Potential scar rupture or dehiscence is not corrected in hysteroscopic approach.[28,29]

In the hysteroscopy procedure, the surface is coagulated, distal rim resected,[24,30,31] or polyps removed.[8] The randomized controlled trial (RCT) by Vevroot compared hysteroscopy with other methods in the control group (Combined oral contraceptive pills (COC), Intrauterine device (IUD), and hysterectomy). They concluded that this is not good for defects that are too thin (less than 3 mm) since the bladder injury/perforation is too high; also this cannot be used for niches more than 5 mm. They found that quality of life and sex life improved following the procedure; they have not looked into the fertility outcome. Also hysteroscope has the capacity to only coagulate the superficial vessels, not the deep ones, so possibility of recurrence or converting to open or laparoscopy surgery is always there if the bleeding becomes heavy. Prospective and retrospective studies done by Gubbins et al[32], Fabres et al[24,33] and many others state possible improvement of fertility. All studies that show improvement in fertility following hysteroscopic treatment have a very small sample size.

CONCLUSION

A common terminology and definition is needed for this defect in the myometrium following hysterotomy. We need more RCT in order to assess the best treatment options. As opposed to hysteroscopy, in laparoscopy the defect explored, fibrous tissue excised, and the defect in the myometrium is closed, hence functional and anatomical aspects of the niche are restored.[23] Symptoms vanish, fertility restored, and the potential future problems negated. Hence, with the available current evidence, laparoscopy is the way forward to correct the niche.

REFERENCES

1. The Forbes. Which countries have the highest caesarean section rates? 2016 Jan.
2. Roberts CL, Nippita TA. International caesarean section rates: The rising tide. Lancet 2015 May;3(5):241-242.
3. Clark EA, Silver RM. Long-term maternal morbidity associated with repeat cesarean delivery. Am J Obstet Gynecol 2011 Dec;205(6 Suppl):S2-S10.
4. Silver RM. Delivery after previous cesarean: Long-term maternal outcomes. Semin Perinatol 2010 Aug;34(4):258-266.
5. Monteagudo A, Carreno C, Timor-Tritsch IE. Saline infusion sonohysterography in nonpregnant women with previous cesarean delivery: The "niche" in the scar. J Ultrasound Med 2001 Oct;20(10):1105-1115.
6. Masuda H, Uchida H, Maruyama T, Sato K, Sato S, Tanaka M. Successful treatment of atypical cesarean scar defect using endoscopic surgery. BMC Pregnancy Childbirth 2015;15:342.
7. Nezhat C, Grace L, Soliemannjad R, Razavi GM, Nezhat A. Cesarean scar defect: What is it and how should it be treated? OBG Manage 2016 April;28(4):32.
8. Vervoort AJ, Uittenbogaard LB, Hehenkamp WJK, Brölmann HAM, Mol BWJ, Huirne JAF. Why do niches develop in Caesarean uterine scars? Hypotheses on the aetiology of niche development. Hum Reprod 2015 Dec;30(12):2695-2702.
9. Florioa P, Filippeschi M, Moncinia I, Marrac E, Franchinid M, Gubbini G. Hysteroscopic treatment of the cesarean-induced isthmocele in restoring infertility. Curr Opin Obstet Gynecol 2012 Mar;24(3):180-186.
10. Chazotte C, Cohen WR. Catastrophic complications of previous cesarean section. Am J Obstet Gynecol 1990 Sep;163(3): 738-742.
11. Clark SL, Koonings PP, Phelan JP. Placenta previa/accreta and prior cesarean section. Obstet Gynecol 1985 Jul;66(1):89-92.
12. OuYang Z, Yin Q, Xu Y, Ma Y, Zhang Q, Yu Y. Heterotopic cesarean scar pregnancy: Diagnosis, treatment, and prognosis. J Ultrasound Med 2014 Sep;33(9):1533-1537.
13. Perez-Medina T, Sancho-Sauco J, Rios M, Pereira A, Argila N, Cabezas E, Cayuela E. Hysteroscopy in pregnancy-related conditions: Descriptive analysis in 273 patients. J Minim Invasive Gynecol 2014 May-Jun;21(3):417-425.
14. Thurmond AS, Harvey WJ, Smith SA. Cesarean section scar as a cause of abnormal vaginal bleeding: Diagnosis by sonohysterography. J Ultrasound Med 1999 Jan;18(1):13-16.
15. Poidevin LO. The value of hysterography in the prediction of cesarean section wound defects. Am J Obstet Gynecol 1961 Jan;81:67-71.
16. Morris H. Surgical pathology of the lower uterine segment caesarean section scar: Is the scar a source of clinical symptoms? Int J Gynecol Pathol 1995 Jan;14(1):16-20.
17. Schepker N, Garcia-Rocha GJ, von Versen-Höynck F, Hillemanns P, Schippert C. Clinical diagnosis and therapy of uterine scar defects after caesarean section in non-pregnant women. Arch Gynecol Obstet 2015 Jun;291(6):1417-1423.
18. Wang CB, Chiu WW, Lee CY, Sun YL, Lin YH, Tseng CJ. Cesarean scar defect: Correlation between cesarean section number, defect size, clinical symptoms and uterine position. Ultrasound Obstet Gynecol 2009 Jul;34(1):85-89.
19. Regnard C, Nosbusch M, Fellemans C, Benali N, van Rysselberghe M, Barlow P, Rozenberg S. Cesarean section scare valuation by saline contrast sonohysterography. Ultrasound Obstet Gynecol 2004 Mar;23(3):289-292.
20. van der Voet LF, Bij de Vaate AM, Veersema S, Brölmann HA, Huirne JA. Long-term complications of caesarean section. The niche in the scar: A prospective cohort study on niche prevalence and its relation to abnormal uterine bleeding. BJOG 2014 Jan;121(2):236-244.
21. Tower AM, Frishman GN. Cesarean scar defects: An underrecognized cause of abnormal uterine bleeding and other gynecologic complications. JMIG 2013 Sep-Oct;20(5):562-572.
22. Osser Vikhareva O, Valentin L. Risk factors for incomplete healing of the uterine incision after caesarean section. BJOG 2010 Aug;117(9):1119-1126.
23. Marotta M-L, Donnez J, Squifflet J, Jadoul P, Darii N, Donnez O. Laparoscopic repair of post-cesarean section uterine scar defects diagnosed in nonpregnant women. J Minim Invasive Gynecol 2013 Jan;20(3):386-391.
24. Fabres C, Aviles G, De La Jara C, Escalona J, Muñoz JF, Mackenna A, Fernández C, Zegers-Hochschild F, Fernández E. The cesarean delivery scar pouch: Clinical implications and diagnostic correlation between transvaginal sonography and hysteroscopy. J Ultrasound Med 2003 Jul;22(7): 695-700.
25. Ida A, Kubota Y, Nosaka M, Ito K, Kato H, Tsuji Y. Successful management of a cesarean scar defect with dehiscence of the

uterine incision by using wound lavage. Case Rep Obstet Gynecol 2014;2014:Article ID 421014. 4 pages.

26. Florio P, Gubbini G, Marra E, Dores D, Nascetti D, Bruni L, Battista R, Moncini I, Filippeschi M, Petraglia F. A retrospective case – Control study comparing hysteroscopic resection versus hormonal modulation in treating menstrual disorders due to isthmocele. Gynecol Endocrinol 2011 Jun; 27(6):434-438.
27. Tahara M, Shimizu T, Shimoura H. Preliminary report of treatment with oral contraceptive pills for intermenstrual vaginal bleeding secondary to a cesarean section scar. Fertil Steril 2006 Aug;86(2):477-479.
28. Api M, Boza A, Gorgen H, Api O. Should cesarean scar defect be treated laparoscopically? A case report and review of the literature. J Minim Invasive Gynecol 2015 Nov-Dec;22(7): 1145-1152.
29. Shao MJ, Hu M. A growing concern: Cesarean scar defect and massive uterine bleeding. J Clin Case Rep 2015;5:599.
30. Gubbini G, Casadio P, Marra E. Resectoscopic correction of the "isthmocele" in women with postmenstrual abnormal uterine bleeding and secondary infertility. J Minim Invasive Gynecol 2008 Mar-Apr;15(2):172-175.
31. Chang Y, Tsai EM, Long CY, Lee CL, Kay N. Resectoscopic treatment combined with sonohysterographic evaluation of women with postmenstrual bleeding as a result of previous cesarean delivery scar defects. Am J Obstet Gynecol 2009 Apr;200(4):370-374.
32. Gubbini G, Centini G, Nascetti D, Marra E, Moncini I, Bruni L, Petraglia F, Florio P. Surgical hysteroscopic treatment of cesarean-induced isthmocele in restoring fertility: Prospective study. J Minim Invasive Gynecol 2011 Mar-Apr;18(2): 234-237.
33. Fabres C, Arriagada P, Fernández C, Mackenna A, Zegers F, Fernandez E. Surgical treatment and follow-up of women with intermenstrual bleeding due to cesarean section scar defect. J Minim Invasive Gynecol 2005 Jan-Feb;12(1):25-28.

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REVIEW ARTICLE

Challenges in the Widespread use of Minimal Access Surgery for the Management of Abdominal Trauma: A Primer

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ABSTRACT

Minimal access surgery (MAS) has made great strides in the evaluation and treatment of elective surgical pathology. The use of MAS for intervention in the patient with abdominal trauma has cautiously lagged behind. We undertook an in-depth analysis of published surgical literature in this regard. The aim was essentially to succinctly summarize current evidence and identify obstacles to its more widespread use. Lack of skill and experience has been identified as the main factor. Addressing this issue with further training and education will be the panacea for the success of MAS for abdominal trauma henceforth. Nevertheless, laparoscopy remains an integral component of the surgical armamentarium in dealing with abdominal trauma.

Keywords: Blunt, Laparoscopy, Minimal access, Penetrating, Trauma.

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INTRODUCTION

Since the advent of minimal access surgery (MAS), patients have benefitted from all its purported advantages. Less pain, earlier mobilization, reduced wound sepsis, and limited hospital stay are just some of the features of MAS that has sparked interest for its use in the trauma patient. The reduced financial implication was of further relevance to developing countries plagued by a high trauma rate. After the initial enthusiasm for MAS in the elective setting, it began to be utilized for the trauma patient. Several studies have since attested to the applicability of MAS for trauma, mainly for diagnosis. However, the therapeutic benefit appears illegitimately more controversial and general skepticism still prevails.

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AIMS

- Review the surgical literature to assess the current global stance for the use of MAS in the trauma setting.
- Identify challenges and obstacles to more widespread use of MAS for abdominal trauma.
- Suggest possible solutions to the challenges and obstacles with a view to maximizing the benefits of MAS for the trauma patients.

MATERIALS AND METHODS

- A thorough online search of the surgical literature regarding the relationship of MAS and abdominal trauma was conducted.
- Google Scholar, HighWire Press, and PubMed databases were used for the purpose of literature review.
- Main keywords used in the search were "laparoscopy," "minimal access," and "abdominal trauma."
- Emphasis was placed on literature published in the last decade, that is, from 2005 onward.

RESULTS

The results of 11 randomly selected papers are shown on the next page.

Studies evaluating the relationship of MAS and abdominal trauma are marred by heterogeneity. In addition, the majority of these studies are retrospective and have small population sizes. Conversion rates are heavily influenced by surgeon preference, institutional protocol and algorithms, surgeon skill and experience, and the availability of suitable equipment and adjuncts, such as energy devices and surgical staplers. As such, the results are entrenched in selection bias. While the mean success rate for MAS in abdominal trauma is approximately 80%, there is definitely room for improvement. Authors are unanimous in identifying lack of skill and experience as the Achilles heel to the more widespread use of laparoscopy in abdominal trauma.

There is a general consensus that MAS is safe and cost-effective in the management of blunt and penetrating abdominal trauma. Furthermore, it has been shown to markedly limit the number of unnecessary laparotomies.

Table 1: Management of blunt and penetrating abdominal trauma

Study	*Total number*	*Blunt trauma*	*Blunt trauma converted*	*Penetrating trauma*	*Penetrating trauma converted*	*Overall conversion rate (%)*	*Overall success rate (%)*
Kaban et al[1]	43	18	9	25	9	42	58
Bombil et al[2]	40	6	1	34	7	20	80
Matsevych et al[3]	189	–	–	189	0	0	100
Zafar et al[4]	4,755	1,579		3,176		20	80
Memon et al[5]	32	32	2	–	–	6	94
Yehia et al[6]	40	40	13	–	–	33	67
Kawahara et al[7]	75	–	–	75	20	27	73
Lim et al[8]	41	30		11		18	82
Morsi et al[9]	65	21	5	44	7	18	82
Gohil et al[10]	25	25	1	–	–	4	96
O'Malley et al[11]	2,563	–	–	2,563		34	66

Missed injury rates in open and laparoscopic surgery appear similar. Missed small bowel trauma can be prevented by a hand-over-hand evaluation at 10 cm intervals from the ligament of Treitz to the ileocaecal valve (Table 1).[1-11]

DISCUSSION

There is unquestionable hesitation in embarking on MAS where intervention is anticipated. Furthermore, there is unnecessary trepidation in utilizing minimal access techniques for penetrating abdominal trauma. In order to promote the more widespread use of MAS, the treating surgeon has to select the case appropriately. On that score, the indications and contraindications for MAS use in the patient with abdominal trauma are enlisted below:

Indications[12-14]

- Blunt abdominal trauma with equivocal computed tomography (CT) scan in the setting of ongoing abdominal pain
- Penetrating injury
- Blunt trauma with CT scan suggesting intra-abdominal injury not amenable to conservative management, or presence of free intraperitoneal fluid
- Hemodynamic instability that improves with resuscitation.

Contraindications[13,14]

- Established peritonitis/sepsis
- Polytrauma (relative)
- Major vessel injury
- Inexperience and poor skill
- Previous abdominal surgery (relative)
- Distended abdomen (relative) or abdominal compartment syndrome
- Ruptured abdomen
- Several/large penetrating wounds to abdominal wall precluding establishment of pneumoperitoneum
- Ongoing hemodynamic instability, that is, despite best resuscitation attempts
- Concomitant head injury with increased intracranial pressure
- Explosive or blast injuries.

GENERAL PRINCIPLES, ACCESS, AND PORT POSITION

General anesthesia is recommended. However, diagnostic laparoscopy can be accomplished with local anesthesia. Patients with a concomitant pneumothorax must have an intercostal drain placed prior to induction of anesthesia. In patients with mild head trauma, it is best to avoid Trendelenburg position. Attempts must be made to maintain normothermia during the procedure. Prophylactic antibiotic is administered.

Access method and establishment of pneumoperitoneum is at the discretion of the treating surgeon. Where a patient has a small puncture wound to the abdominal wall, this could be used as the site for the first port placement. Alternatively, the infraumbilical crease may be the default primary port position. Most studies, however, anecdotally prefer the Hasson technique. Should a CT scan detect specific organ injury or there is clinical suspicion of specific organ trauma prior to embarking on surgery, it is best to stay away from the area of concern for the primary port. The preset abdominal pressure should be 8 mm Hg initially and increased, as tolerated, to 12 to 15 mm Hg. Further port positions follow the baseball diamond concept as popularized by Dr RK Mishra subsequent to the detection of trauma. At the expense of ergonomics, longer instruments may be used to obviate the insertion of additional ports merely for diagnostic purpose. The priority when first examining the peritoneal contents is to suction all blood and free fluid, arrest hemorrhage, control ongoing sepsis, and then, finally, to undertake a thorough examination of the abdomen in systematic and controlled fashion. The importance of meticulously evaluating the gastrointestinal tract from stomach to rectum cannot be overemphasized.

SPECIFIC-ORGAN TRAUMA[4,14]

The advancements in stapler technology and energy devices, (as well as the enhanced knowledge of suturing and knotting techniques), have enabled the minimal access surgeon to intervene efficiently and safely for specific-organ trauma. There is little minimal access techniques cannot accomplish equivocally or better than open surgery. Some examples are shown below (Table 2).

Table 2: Suturing and knotting techniques

Injured organ	*Possible intervention*
Diaphragm	Suture repair ± mesh application
Liver	Suture; application of hemostatic agent
Gallbladder	Cholecystectomy
Stomach	Repair or resection and anastomosis
Pancreas	Drain placement; distal pancreatectomy
Spleen	Splenectomy
Small bowel/ colon/rectum	Repair/resect and anastomosis/stoma
Ureter	Anastomosis over stent
Mesenteric bleed	Suture, clip, or hemostasis with energy device
Bladder	Repair
Abdominal wall defect	Repair

Copious peritoneal lavage with warmed saline and intraperitoneal drain placement is indicated for peritoneal soiling. At the conclusion of the operation, all 10 mm port sites must be repaired.

CONTROVERSIES AND SPECIAL CIRCUMSTANCES

Laparotomy versus Laparoscopy[4,8,12,13,15]

Laparoscopy has been shown to be equally efficacious as laparotomy in selected circumstances as indicated above. The missed injury rate is negligible with good technique. Conversion to open surgery must not be deemed to be a failure of the laparoscopic modality. However, the conversion rate is minimized in experienced hands. Length of stay and costs are comparatively reduced with laparoscopy. The concern that carbon dioxide pneumoperitoneum promotes septicemia in the setting of bowel content spillage or peritonitis appears to be unwarranted.

Second-Look Laparoscopy

This has not been clearly validated in the trauma literature. Technically, it is viable and must be done on demand. Previous port sites or the drain site can be used for a "second-look."

Damage Control Laparoscopy

Damage control laparoscopy has not been adequately described in the trauma literature. Patients in extremis are often only candidates for open surgery. In very experienced hands and in a highly controlled environment, it appears intuitively possible to conduct damage control laparoscopy especially when surgical staplers and a wide array of energy devices are at the disposal of the surgeon.

Pediatric Considerations[16]

There is a relative paucity of literature for the use of MAS in the pediatric trauma patient. Diagnostic laparoscopy has been shown to be feasible and safe. Interventional work is possible in the hands of a surgeon *au fait* with pediatric minimal access surgical techniques and with the availability of appropriately sized instruments.

Pregnancy[14]

Surgery in the gravid patient is hazardous in emergent open surgery and often results in maternal and child morbidity or mortality. This is especially more pronounced with MAS especially in light of trocar injuries and the effects of pneumoperitoneum. Extrapolating from the nontrauma setting, MAS may be possible in the first and second trimester. Intense maternal counseling is advocated. More studies are recommended prior to firm recommendations on MAS for the pregnant patient with abdominal trauma.

CONCLUSION[4,8,12-15]

Minimal access surgery represents a viable, safe, and cost-effective alternative in the adult and pediatric trauma patient for selected injuries. Lack of training and experience in minimal access techniques is the main impediment to widespread use. Trauma centers and other surgical facilities dealing with trauma patients are encouraged to incorporate minimal access techniques in their training programs. Results obtained with laparoscopic examination and therapy utilizing MAS techniques are commensurate with the skill and experience of the operator. Preliminary data suggest that laparoscopy should be further popularized for abdominal trauma; however, randomized controlled studies are required to truly validate the role of MAS for the trauma setting.

REFERENCES

1. Kaban GK, Novitsky YW, Perugini RA, Haveran L, Czerniach D, Kelly JJ, Litwin DE. Use of laparoscopy in evaluation and treatment of penetrating and blunt abdominal injuries. Surg Innov 2008 Mar;15(1):26-31.
2. Bombil I, Maraj A, Lunda WS. Laparoscopy at Sebokeng Hospital with emphasis on trauma. Global J Med Res 2014; 14(4).

3. Matsevych OY, Koto MZ, Motilall SR. The role of laparoscopy in management of stable patients with penetrating abdominal trauma and organ evisceration. J Trauma Acute Care Surg 2016 Aug;81(2):307-311.
4. Zafar SN, Onwugbufor MT, Hughes K, Greene WR, Cornwell EE, 3rd, FullumTM, Tran DD. Laparoscopic surgery for trauma: The realm of therapeutic management. Am J Surg 2015 Apr;209(4):627-632.
5. Memon MR, Sanghi AG, Abassi SA. Role of laparoscopy in blunt abdominal trauma. Rawal Med J 2013;38(1):40-43.
6. Yehia MA, Khalifa SA, Atia ME. Role of laparoscopy in blunt abdominal trauma. ZUMJ 2013 Sep;19(5):374-380.
7. Kawahara NT, Alster C, Fujimura I, Poggetti RS, Birolini D. Standard examination system for laparoscopy in penetrating abdominal trauma. J Trauma 2009 Sep;67(3):589-595.
8. Lim KH, Chung BS, Kim JY, Kim SS. Laparoscopic surgery in abdominal trauma: A single center review of a 7-year experience. World J Emerg Surg 2015 Mar;10:16.
9. Morsi M, Mansy W, Zakaria Y. Use of laparoscopy in the management of abdominal trauma: A center experience. Egypt J Surg 2015;34(1):11-16.
10. Gohil VD, Palekar HD, Ghoghari M. Diagnostic and therapeutic laparoscopy in various blunt abdomen trauma. World J Laparosc Surg 2009 May-Aug;2(2):42-47.
11. O'Malley E, Boyle E, O'Callaghan A, Coffey JC, Walsh SR. Role of laparoscopy in penetrating abdominal trauma: A systematic review. World J Surg 2013 Jan;37(1):113-122.
12. Uranues S, Popa DE, Diaconescu B, Schrittwieser R. Laparoscopy in penetrating abdominal trauma. World J Surg 2015 Jun;39(6):1381-1388.
13. El-Bendary YB, Al-Adawi J, Al-Qadhi H. The use of laparoscopy in the management of trauma patients (brief review). Sultan Qaboos Univ Med J 2016 Feb;16(1):e9e14.
14. Grushka J, Ginzburg E. Through the 10-mm looking glass: Advances in minimally invasive surgery in trauma. Scand J Surg 2014 Apr;103(2):143-148.
15. Li Y, Xiang Y, Wu N, Wu L, Yu Z, Zhang M, Wang M, Jiang J, Li Y. A comparison of laparoscopy and laparotomy for the management of abdominal trauma: A systematic review and meta-analysis. World J Surg 2015 Dec;39(12):2862-2871.
16. Numanoglu A. Laparoscopy in abdominal trauma. CME 2010 Mar;28(3):119-121.

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REVIEW ARTICLE

Minimally Invasive Surgical Techniques *vs* Open Myomectomy for Treatment of Uterine Fibroids

Bhawna Bansal

ABSTRACT

Introduction: Myomectomy is the surgical remedy of preference for women with symptomatic fibroids, who prefer or want uterine conservation. Myomectomy can be finished by using conventional laparotomy, by means of minilaparotomy, or by means of minimal access techniques, such as hysteroscopy and laparoscopy. Since the advent of minimal access surgery, there has been interest in the relative advantages and disadvantages of both surgical modalities.

Objectives: To determine the benefits and harms of laparoscopic myomectomy compared with open myomectomy.

Materials and methods: We used various search engines – PubMed, HighWire Press, Google, and Yahoo – to search for all trials and articles comparing myomectomy via laparotomy, minilaparotomy, or laparoscopically assisted minilaparotomy *vs* laparoscopy. We found several articles of which 10 were used in this review article based on the outcomes studied, date of publication (after 2005), methodology of study, level of evidence, and the journal in which they were published. The results of these trials were then compared.

Conclusion: Laparoscopic myomectomy is a process associated with less subjectively reported postoperative pain, lower postoperative fever, and shorter hospital stay as opposed to all kinds of open myomectomy. No data suggested a difference in recurrence risk between laparoscopic and open myomectomy. Even more studies are needed to determine fertility outcomes, rates of uterine rupture, occurrence of thromboembolism, and need for repeat myomectomy and hysterectomy at a later stage.

Keywords: Blood loss, Laparoscopic, Laparotomy, Myomectomy, Pain, Postoperative.

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INTRODUCTION

Fibroids are common benign tumors of the uterus. They are asymptomatic in most women and warrant treatment only when symptomatic. Symptoms associated with fibroids include abnormal uterine bleeding, infertility, severe pain, and complications in pregnancy.

Traditionally, the treatment of fibroids is surgical, but various medical treatments including progesterones and gonadotropin-releasing hormone (GnRH) analogues have been tried. The surgical treatment of choice in women who prefer to conserve their uterus is myomectomy. The routes to perform myomectomy are conventional laparotomy, minilaparotomy, and minimal access techniques, such as laparoscopy and hysteroscopy.

Laparoscopic myomectomy is suggested to be associated with reduced morbidity compared with open myomectomy. Evidence suggests that laparoscopic myomectomy is associated with reduced morbidity compared with open myomectomy, including reduced blood loss, postoperative pain, and shorter hospital stay. Comparable rates of pregnancy, fibroid recurrence, and operative complications have also been reported. However, due to small sample size in most clinical trials conclusive evidence regarding the preferred surgical approach is still not available.

It is important to know the best surgical approach so as to help surgeons and patients make an informed choice.

OBJECTIVES

The objective behind undertaking this review is to analyze the different studies available and the quality of evidence and study the advantages and disadvantages of different surgical approaches.

MATERIALS AND METHODS

We used various search engines, such as PubMed, HighWire Press, Google, and Yahoo to search for all trials and articles comparing myomectomy via laparotomy, minilaparotomy, or laparoscopically assisted minilaparotomy *vs* laparoscopy. Among the trials found, we chose 10 that had studied similar outcomes. Date of publication, methodology of trial, level of evidence, and the journal in which they were published. The results of these trials were then compared and tried to reach a definitive conclusion regarding the best surgical approach.

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RESULTS

Ten articles were selected for this review. Among these six were randomized control trials, and one of the six was double-blind. One was a retrospective matched control analysis, one was a systematic review, and two articles were prospective nonrandomized trials.

- 4 out of 10 studies reported postoperative pain (within the first 7 days) (Table 1).[1,2,6-10]
- 6 out of 10 studies reported in-hospital adverse events.[1,5,6,7,9,10]

Table 1: Summary of outcomes of various studies comparing laparoscopic vs open myomectomy

Author and year of publication	*Type of study; sample size*	*Outcomes studied*	*Laparoscopy*	*Laparotomy*	*p-value*
Chittawar et al (2014)[1]	Systematic review; 808	• Postoperative pain			MD –2.40
		• In-hospital adverse events			OR 0.44
		• Hospital stay			
Tinelli et al (2014)[2]	Prospective study; 124	• Operating time	95±7.2 min	63±5.6	<0.0001
		• Intraoperative blood loss	65 mL	105±5 mL	<0.0001
		• Postsurgical blood loss	30±5 mL	60±5 mL	<0.0001
		• Postsurgical pain relief requirement	8 patients	17 patents	<0.05
Malzoni et al (2010)[3]	Retrospective, nonrandomized study; 680	• Operative time	63±21 min	57±23 min	95% CI
		• Hospital stay	2.1±0.8	3.1±0.5	95% CI
		• Pregnancy rate	56%	50%	NS
Kalogiannidis et al (2010)[4]	Nonrandomized prospective study; 75	• Blood loss	246±161 mL	351±219 mL	=0.03
		• Operative time	68±21 min	83±24 min	=0.01
		• Days of bowel reactivity	1.04±0.2	1.8±0.5	<0.0001
		• Duration of hospitalization	1.2±0.6	4.2±0.8	<0.0001
Cicinelli et al (2009)[5]	Prospective randomized study; 80	• Mean blood loss	Conversion to laparotomy in one patient		<0.001
		• Mean duration of postoperative ileus			<0.001
		• Mean decrease in hemoglobin			<0.001
		• Mean operative time			NS
		• Duration of hospitalization			<0.001
		• Intraoperative complications			
Tan et al (2008)[6]	Randomized trial; 52	• Mean operating time	96±26.20 min	75.50±25.70	=0.006
		• Intraoperative blood loss	96.34±32.42 mL	71.92±18.98 mL	=0.002
		• Hemoglobin level decrease	1.65±0.61	1.22±0.61	=0.014
		• Hospitalization days	1.81±0.57 days	2.04±0.66 days	=0.183
		• Postoperative ileus	23.20±4.37	22.80±3.94	=0.738
Sesti et al (2008)[7]	Randomized trial; 100	• Mean discharge time	98.4±1.4 hr	52.8±1.6 hr	<0.001
		• Operation time	79.5±25.1 min	103.5±24.9 min	<0.001
		• Intraoperative blood loss	154.2±1.2 mL	188.6±1.3 mL	<0.001
Palomba et al (2007)[8]	Randomized controlled trial; 136	• Pregnancy rate per cycle	36/556 (6.5)	26/669 (3.9)	0.040
		• Cumulative pregnancy rate	36/68 (52.9)	26/68 (38.2)	0.090
		• Live-birth rate per cycle	32/556 (5.8)	22/669 (3.1)	0.036
		• Cumulative live-birth rate	32/36 (88.9)	22/26 (84.6)	0.620
		• Time to first pregnancy (month)	5 (3), 1–9	6 (2.5), 4–11	0.008
		• Time to first live-birth (month)	14 (3), 10–18	15 (3), 13–20	0.003
		• Abortion rate	4/32 (12.5)	4/26 (15.4)	0.751
		• Preterm delivery	1/32 (3.1)	1/22 (4.5)	0.786
		• Vaginal delivery	9/32 (28.1)	8/22 (36.4)	0.522
		• Cesarean delivery	23/32 (71.9)	14/22 (63.6)	0.522
Holzer et al (2006)[9]	Prospective, double-blind; 40	• VAS pain	2.28±1.38	4.03±1.63	<0.01
Alessandri et al (2006)[10]	Randomized study; 148	• Operation time (min)	98±13	85±14	0.001
		• Decline of hemoglobin concentration	1.1±0.5	2.2±0.5	0.001
		• Pain intensity 6 hr	4.1±1.5	6.5±1.5	0.001
		• Pain intensity 24 hr	3.1±1.5	2.8±1.8	0.519
		• Request of analgesic	25 (34.7%)	54 (73.0%)	0.001
		• Time of postoperative ileus (hr)	28±6	45±6	0.001
		• Time to discharge	38±12	48±12	0.001
		• Patient recuperated on day 15	65 (90.3%)	55 (74.3%)	0.012

NS: Non significant

- 7 out of 10 studies reported length of hospital stay.[1,2-6,10]
- 8 out of 10 studies reported operating time.[1-8,10]
- 2 out of 10 studies studied the fertility outcomes.[3,8]

There have been two types of trials to compare laparoscopy and laparotomy. The first type compares the short- and long-term intra- and postoperative parameters. The second type compares the fertility outcomes of both the surgical approaches.

Operating time has been one parameter considered. There has been a consistent finding of decreased operating time in minimal access approach except one study.[10] This study had compared laparoscopy-assisted myomectomy with minilaparotomy.

Intraoperative blood loss has been analyzed by 5 of the 10 studies. There has been found to be a significant difference between the two surgical approaches as far as blood loss is concerned with the minimal access approach resulting in significantly less blood loss. Decrease in hemoglobin concentration is another way of measuring blood loss and has been used by three studies. All three studies found a significant difference.

Postsurgery pain perception and pain relief requirement have also been measured by 4 out of 10 studies, and here also the laparoscopic approach was found to be significantly better, as the patients perceived less pain and required less amount of analgesia.

Days of bowel reactivity/postoperative paralytic ileus was measured by 3 of the 10 studies considered in this review. While two of these found a significant difference with the laparoscopic approach, Tan et al failed to find a significant difference.[6]

Duration of hospitalization is another important aspect which is different for both surgical approaches. The time to discharge was found to be significantly less by all studies which analyzes this parameter, except by Tan et al.[6]

Two of the 10 studies considered in this review have reported about fertility outcomes post myomectomy and whether the surgical approach makes a difference to the same. Palomba et al[8] did not find any significant difference in any of the outcomes except the time to first pregnancy, while Malzoni et al[3] did not find any difference in the pregnancy rate.

DISCUSSION

Operating time has been found to be consistently less with laparoscopic approach, except in an earlier study.[10] This could also be due to the learning curve of minimal access surgery. The availability of better instruments and energy sources may also have contributed to decrease in operative time over the course of last 10 years.

Articles in this review have been consistent in the finding of less intraoperative blood loss in the laparoscopic approach. This is undoubtedly due to the energy sources available which reduce blood loss in the same.

Laparoscopic myomectomy is a less painful procedure compared to open myomectomy, as indicated by lower visual analog scale (VAS) pain scores at 6 and at 48 hours. However, no proof of a big difference in pain scores was noted at 24 hours by VAS after surgery between laparoscopic myomectomy and all types of open myomectomy. Moderate heterogeneity (43%) for this assessment could be explained by Tan et al in 2008, which included laparoscopically assisted minilaparotomy myomectomy in which laparoscopy is employed for fibroid enucleation and rapport, and specimen removal and suturing are carried out through small abdominal incision. This might reduce tissue damage and operating time compared with open myomectomy and may skew the results of pain scores. The overall level of evidence for postoperative pain is modest, which means that further research is more likely to have an important impact on our confidence in the estimate of effect of minimal access surgery.

The minimal access approach also involves less bowel handling, which invariably results in less postoperative paralytic ileus and a shorter time of return to normal bowel reactivity. This finding, however, has been refuted by Tan et al.

All the above factors also are contributory toward early discharge of the patient from the health care facility and better patient acceptance of the procedure.

Myomas have been considered a contributory factor for infertility, and a lot of patients undergo myomectomy in order to conceive. Not many studies have compared the fertility outcomes of myomectomy surgery vis-à-vis the surgical approach. However, the limited data available does not indicate any significant difference in the results in patients of infertility problem.

Laparoscopy is a technically challenging procedure that requires both specialized instruments and advanced intracorporeal suturing capability of the surgeon. Clearly, laparoscopic myomectomy is not feasible to all patients, and even skilled operative laparoscopists choose laparotomy in patients with large multiple myomas.

Many women choose minimally invasive surgery because of obvious advantages, such as shorter postoperative recovery time and a reduced risk of infection for laparoscopic hysterectomy or myomectomy compared with abdominal hysterectomy or myomectomy.[11] Nevertheless an important aspect of safety associated with laparoscopic hysterectomy or myomectomy is discussed in the recently published US Food and Drug Administration (FDA) safety communication about

laparoscopic uterine power morcellation in hysterectomy and myomectomy. Authors of this report suggest that occurrence of unsuspected uterine sarcoma among patients undergoing hysterectomy or myomectomy for assumed benign leiomyoma is 1 in 352, and the prevalence of unsuspected uterine leiomyosarcoma is 1 in 498. Therefore, FDA concludes that when "using power morcellation in women with unsuspected uterine sarcoma, there would be a risk of spread of the cancerous tissue within the abdomen and pelvis, significantly worsening the patient's likelihood of survival. For this reason, and because there is absolutely no reliable method for predicting if the woman with fibroids may have an uterine sarcoma, the FDA attempts the use of laparoscopic power morcellation during hysterectomy or myomectomy for uterine fibroids."[12-15]

CONCLUSION

The popularity of minimal access surgery has been rising over the past two decades. Some of it may be contributed to its increased accessibility to patients. Though there do not appear to be considerable long-term benefits of the laparoscopic approach, there seem to be little doubt regarding immediate intra- and postoperative benefits of the same.

More studies are needed to evaluate laparoscopically assisted minilaparotomy myomectomy compared with open and laparoscopic myomectomy. This procedure is less challenging technically, and it avoids endosuturing and morcellation. Also more studies are needed to evaluate whether surgical approach affects future fertility outcomes.

In conclusion, data suggests that when compared with minilaparotomic myomectomy, laparoscopic myomectomy may offer several benefits and faster postoperative recovery. Minimal access surgery is the way of future and, though more research is needed, it definitely scores a point over open approach in several important aspects.

REFERENCES

1. Bhave Chittawar P, Frankin S, Pouwar AW, Farquhar C. Cochane library. [Online]. 2014. Available from: http://onlinelibrary.wiley.com.
2. Tinelli A, Mettler L, Malvasi A, Hurst B, Catherino W, Mynbaev O, Guido M, Alkaout I, Schollmeyer T. Impact of surgical approach on blood loss during intracapsular myomectomy. Minim Invasive Ther Allied Technol 2014 Mar;23(2):87-95.
3. Malzoni M, Tinelli R, Consentino F, Iuzzlino D, Surico D, Reich H. Laparoscopy versus minilaparotomy in women with symptomatic uterine myomas: short-term and fertility results. Fertil Steril 2010 May;93(7):2368-2373.
4. Kalogiannidis I, Prapas N, Xiromeritis P, Prapas Y. Laparoscopically assisted myomectomy versus abdominal myomectomy in short-term outcomes: A prospective study. Arch Gynecol Obstet 2010 May;281(5):865-870.
5. Cicinelli E,Tinelli R, Colaligilio G, Saliani N. Laparoscopy *vs* minilaparotomy in women with symptomatic uterine myomas: A prospective randomized study. J Minim Invasive Gynecol 2009 Jul-Aug;16(4):422-426.
6. Tan J, Sun Y, Dai H, Zhong B, Wang D. A randomized trial of laparoscopic versus laparoscopic-assisted minilaparotomy myomectomy for removal of large uterine myoma: Short-term outcomes. J Minim Invasive Gynaecol 2008 Jul-Aug;15(4):402-409.
7. Sesti F, Copobiano F, Copozzolo T, Pielropolli A, Piccone E. Isobaric gasless laparoscopy versus minilaparotomy in uterine myomectomy: A randomized trial. Surg Endosc 2008 Apr;22(4):917-923.
8. Palomba S, Zupi E, Falbo A, Russo T, Marconi D, Tolino A, Manguso F, Matte A, Zulio F. A multicenter randomized, controlled study comparing laparoscopic versus minilaparotomic myomectomy: Reproductive outcomes. Fertil Steril 2007 Oct;88(4):933-941.
9. Holzer A, Jirececl S, Illievich UM, Huber J, Wenzl. Laparoscopic versus open myomectomy: A double blind to evaluate postoperative pain. Anesth Analg 2006 May;102(5):1480-1484.
10. Alessandri F, Davide L, Emanuela M, Simone F, Nicole R. Randomized study of laparoscopic versus minilaparotomic myomectomy for uterine myomas. J Minim Invasive Gynecol 2006 Mar-Apr;13(2):92-97.
11. Nieboer TE, Johnson N, Lethaby A, Tavendar E, Curr E, Gary R et al. Cochrane Database of systemic reviews. [Online]; 2009. Available from http://www.ncbi.nlm.nih.gov.
12. Food, Drug Administration. Quantitative assessment of the prevalence of unsuspected uterine sarcoma in women undergoing treatment of uterine fibroids. Summary and key findings. FDA Safety Communications; 2014.
13. Jin C, Hu Y,Chen X, Zheng F, Lin F, Zhou K, Chen FD, Gu HZ. Laparoscopic versus open myomectomy-a meta-analysis of randomized controlled trials. Eur J Obstet Gynecol Reprod Biol 2009;145(1):14-21.
14. Aziken ME. Laparoscopy hospital.com. [Online]. 2008. Available from: https://www.laparoscopyhospital.com/laparoscopic_myomectomy_versus_open_myomectomy.html
15. Iavazzo C, Mamais I, Gkeqkes I. Robotic assisted *vs* laparoscopic and/or open myomectomy: Systematic review and meta-analysis of the clinical evidence. Arch Gynecol Obstet 2016 Jul;294(1):5-17.

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REVIEW ARTICLE

Perspective of Electrosurgical Sources in Minimal Access Surgery

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ABSTRACT

Introduction: There are devices that apply energy to cut, coagulate, and desiccate the tissue with minimal bleeding and by overcoming the hindrance of laparoscopy facilitate minimal access surgery. The inappropriate utilization of electrosurgical devices may expand horrible morbidity and mortality. The present article surveys different electrosurgical sources as far as their basic uses and safe practices.

Objectives: The aim of this review is to discuss about various types of available energy sources, their biophysics, their tissue effects, and complications. It also emphasizes the advantages and disadvantages of these electrosurgical devices and the need for learning required with them.

Materials and methods: With the end goal of this review, a general pursuit was led through NCBI, SpringerLink, and Google. Articles depicting laparoscopic or minimally access surgeries utilizing single or different energy sources were considered, in addition to articles contrasting different marketed energy devices in lab settings. Keywords, such as laparoscopy, vitality, laser, electrosurgery, monopolar, bipolar, harmonic, ultrasonic, and difficulties were utilized as a part of the search.

Results: The authors in this review of the literature likewise accentuate on the unprejudiced learning of all the energy devices before using them. It also shows that the performance of the energy devices depends upon the type of effect needed. There is no accord as to which device is ideal for a given purpose. The specialized expertise level of the specialist and the learning about the device are both critical variables in choosing safe results.

Conclusion: To defeat the deceptions of laparoscopic hemostasis and cutting, electrosurgery has turned out as an imaginative innovation. It has made the life of an expert simple. Be that as it may, everything accompanies its own burdens. Electrosurgery also has its own disadvantages and complexities. The utilization of electrosurgery ought to be constrained just for spots where essential. An expert ought to try to know totally about the device he/she is utilizing and ought not to be driven by marketing companies.

Keywords: Electrosurgery, Energy sources in surgery, Minimally access surgery.

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INTRODUCTION

Minimal access surgery has posed unique challenges with regard to cutting and hemostasis due to visual, tactile, and mechanical limitations. But this has resulted in a variety of creative solutions with their own advantages and disadvantages, electrosurgery being one of them.

The terms "electrocautery" and "electrosurgery" are frequently used interchangeably; however, these terms define two distinctly different modalities. Electrocautery is the use of electricity to heat an object that is then used to burn a specific site – for example, a hot wire – whereas in electrosurgery, the electrical current heats the tissue. The current must pass through the tissue to produce the desired effect.

Today's specialists are spoilt for decision when it comes to minimal access electrosurgery sources, due to a business sector where there has been noteworthy change in the course of the most recent decade. Moreover, new instruments frequently arrive joined by much ballyhoo and buildup. Shockingly, many of the research facilities and clinical information on new electrosurgery sources are from studies attempted, and also supported, by the producer, and information from randomized trials is unavailable. Regardless, it remains the obligation of the specialist to procure information on the scope of tissue impacts accessible with different laparoscopic electrosurgery sources, how these gadgets give their tissue impacts, and the related advantages and dangers for every gadget. Thus, it is not a simple assignment for specialists to settle on choices about the sources they use for operative laparoscopy.

PRINCIPLES OF ELECTRICITY

Electricity always follows some universal rules. These are that electricity always seeks the ground and invariably seeks the path of least resistance.

There are three variables involved in any electrical circuit. These are voltage (v), impedance or resistance (R), and current (I). The relationship between them is established by the Ohm's law.

$$I = \frac{V}{R}$$

But the electrosurgical device does not give us the privilege to set the current on our own. They allow us to set the power (W) for application. The relationship of power to above variables is product of voltage and current.

$$W = V \times I$$

For example, as the current flows through the target tissue and coagulates it, the tissue becomes nonconductive and current takes the path of least resistance. Hence, the path of current in living tissue is erratic.

Broadly, there are two types of electrosurgery resources available: Monopolar and bipolar energy sources.

MONOPOLAR ENERGY

All electrosurgery is "bipolar" in light of the fact that the electrical current streams from one electrode on to the other. In monopolar electrosurgery, the active terminal is one electrode in surgeon's hand and the patient return cathode is the other. The primary contrast between monopolar electrosurgery and the other electrosurgery modalities is that electrical current courses through the patient. This distinction benefits the best scope of tissue impacts to monopolar electrosurgery.[1,2]

The tissue impacts produced with monopolar electrosurgery incorporate vaporization (tissue destruction and cutting), fulguration (tissue destruction and little vessel hemostasis), desiccation (cell wall break and cytoplasm boiling), and coaptation (vessel sealing inferable from denaturation and renaturation of proteins) (Table 1).[2] These tissue impacts are fundamentally accomplished by using the "cut" or "coag" mode of electrosurgical unit (ESU) while contacting or non contacting the objective tissue (Table 2).[3] Varying other parameters are under the specialist's control, such as power setting, length of enactment, and terminal arrangement, can facilitate adjusting the wanted tissue effect.[1-3]

All energy sources generate tissue temperatures above 45°C, the temperature at which irreversible cell damage occurs. Monopolar electrosurgery generates tissue temperatures of ~100°C, 100–200°C, and >200°C for desiccation, vaporization, and fulguration respectively. Other laparoscopic energy sources have limited tissue effects of desiccation and coaptation, and they also generate tissue temperatures of ~100°C.[1,4]

Table 1: The main classes of laparoscopic energy sources and their tissue effects[2]

Energy source	*Tissue effects*
Monopolar electrosurgery	Vaporization, fulguration, desiccation, coaptation*
Conventional bipolar electrosurgery	Desiccation, coaptation
Advanced bipolar electrosurgery**	Desiccation, coaptation, blade tissue transection
Ultrasonic technology	Desiccation, coaptation, mechanical tissue transection

*Vessel sealing achieved with coagulation and compression.
**Tissue impedance monitoring optimizes activation time.

The major disadvantage of monopolar electrosurgery is the unavoidable risk of stray current injury (SCI). These injuries are regularly not seen amid of surgery as they ordinarily happen outside of the specialist's field of vision. They are not attributable to specialist mistake or absence of ability. Rather, it is the physics at fault. When used in contact mode, there is the risk of lateral thermal spread injury to adjacent structures with monopolar electrosurgery, just as for all energy sources that yield tissue effects of desiccation and coaptation. Smoke production during monopolar electrosurgery may be problematic, especially during fulguration.[3]

There is a risk of capacitative coupling if by mistake the wire gets wrapped around other instrument. So, monopolar electrosurgery is a relatively inexpensive, readily available, and versatile energy source that yields the best range of tissue effects, but despite all this it has a large risk of complications leading to smaller safety margin.

PRINCIPLES OF MONOPOLAR ELECTROSURGERY

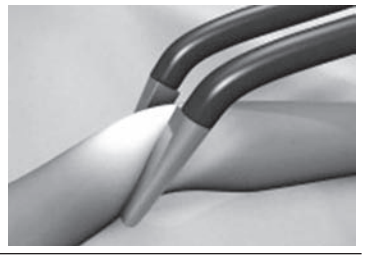
Current Pathway

In monopolar electrosurgery, electrical current goes from the ESU to the active electrode, then via the patient to exit by means of a dispersive electrode, at last coming to "electrical ground" (Fig. 1). The potential for SCI emerges in light of the fact that power inside the patient will take whatever pathway it can to come back to ground, including by means of unintended tissue targets.[1-7]

Current Density

The tissue impacts of monopolar current are identified with the current density in the tissue. Consequently, engaged current from the active electrode enters the patient at the site of surgery to yield a tissue impact though current, leaving the patient by means of a dispersive return electrode just results in a clinically inconsequential ascent in tissue temperature due to low current density. Any damage can happen at any part of the circuit in the event where the current density is sufficiently high. For case, blazes have beforehand happened at the patient return electrode inferable from poor contact with the patient's skin, leading to high current density at the current way out point.

Table 2: Monopolar electrosurgery tissue effects[3]

Tissue effect	*Surgical effect*	*Current waveform*	*Contact with tissue*	*Characteristics*	
Vaporization	Cutting	Continuous (cut)	No contact	Low-voltage sparks, moderate smoke	
Fulguration	Hemostasis of small vessels (<1 mm)	Interrupted (coag)	No contact	High-voltage sparks, significant smoke and charring	
Desiccation	Hemostasis of small vessels (<1 mm)	Continuous (cut) or interrupted (coag)	Contact	Similar action to bipolar electrosurgery, pronounced lateral thermal spread	
Coaptation	Sealing of small-to-medium vessels (<2 mm)	Continuous (cut) or interrupted (coag)	Contact and compression of vessel wall	Similar action to bipolar electrosurgery, pronounced lateral thermal spread	

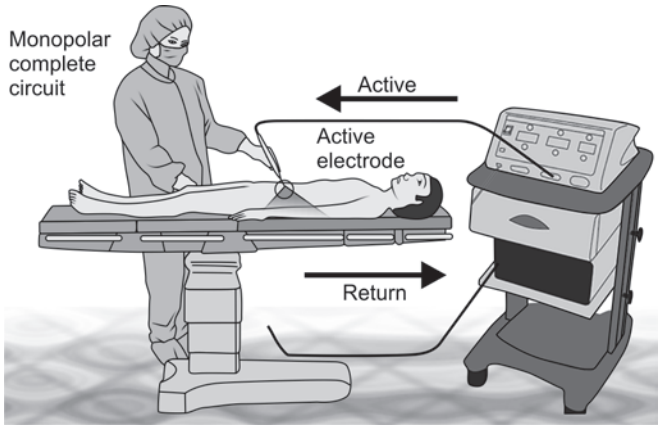


Fig. 1: Pathway of monopolar current

Waveforms

The waveforms in monopolar electrosurgery are "cut," "coagulation," and "blend" (Fig. 2). It is important to realize that these waveforms do not imply a particular tissue effect – e.g., the tissue effect is different when cut

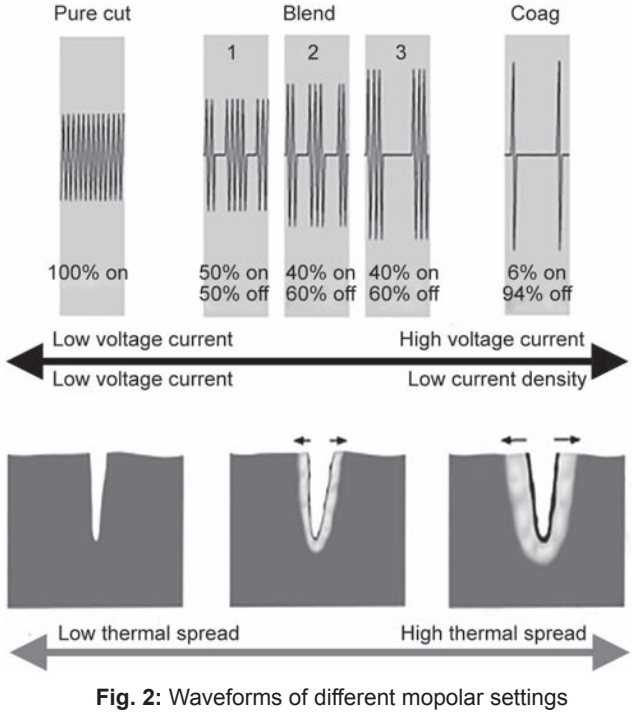


Fig. 2: Waveforms of different mopolar settings

waveform is used in either contact or noncontact mode, yielding desiccation or vaporization respectively. Cut waveform is a continuous sinusoidal waveform with current flowing 100% of the time (duty cycle), coagulation waveform is an intermittent or "damped" waveform where the duty cycle is reduced, and blend waveforms are also intermittent waveforms, but with interrupted duty cycle.

Conventional Bipolar Electrosurgery

In bipolar electrosurgery (including advanced bipolar modalities), the active and return electrodes are the two jaws of the energy source placed at the target tissue. In 1974, scientist introduced bipolar electrosurgery as a means of eliminating the risk of complications that had been observed with monopolar electrosurgery, while at the same time a means of sealing larger vessels.[5]

In bipolar electrosurgery, electrical current passes through the tissue held between the jaws of the instrument, not through the patient, and results in tissue desiccation and vessel coaptation. Alternating current is standard output for ESUs, and it is this physical property that results in efficient sealing of vessels with bipolar electrosurgery, via change of direction of current flow through the tissue compressed between the instrument jaws, as orientation of the active and return electrodes rapidly alternates.[6] A major advantage of conventional bipolar over monopolar electrosurgery is the ability to seal vessels up to ~5 mm in diameter. The dissection capability of the bipolar forceps is good, especially in the grasping configuration. Bipolar electrosurgery is generally available and relatively inexpensive. Disadvantages of bipolar electrosurgery include lateral thermal spread that will continue until device activation is ceased; no audio signal from the ESU to inform the surgeon when desiccation or coaptation is complete, which increases the risk of injury from lateral thermal spread as well as tissue charring and tissue adherence to the instrument jaws; and the need for another instrument, such as a laparoscopic scissor, for tissue cutting.[6]

PRINCIPLES OF BIPOLAR ENERGY

Current Pathway

A high frequency electrical current flows from one tong to the other tong of the surgical pencil, through the intervening tissue (Fig. 3). The tissue within the forceps completes the circuit. An indifferent electrode is not required as the patient is not part of the circuit. So, no risk of SCI is seen.

Current Density

The tissue effects of bipolar energy are identified as desiccation and coaptation depending upon the current density and pressure applied. As the current density cannot be concentrated at a single focal point in bipolar electrode, it is unable to produce cutting effect. To battle this hindrance, the progressive bipolar devices have a mechanical cut mechanism along in form of blade.

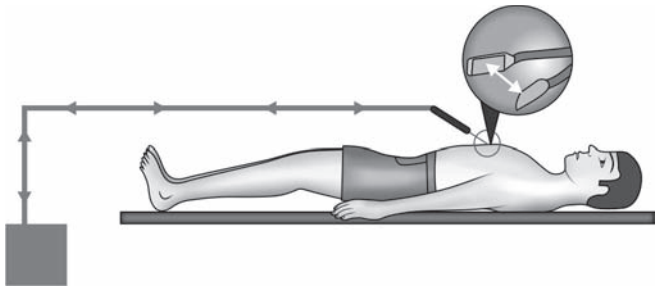


Fig. 3: Pathway of current in bipolar energy

Waveform

The waveform applied is similar to that applied during monopolar "coag" mode. It is a high-voltage interrupted duty cycle current. Best permutation and combinations are incorporated in the device to achieve a high vessel-sealing capacity.

Advanced Bipolar Electrosurgery

In addition to the features of conventional bipolar electrosurgery, advanced bipolar energy sources are progressive in many ways. Main advance is computer-controlled tissue feedback system. Newer products floating in the market are LigaSure (Fig. 4; Covidien), EnSeal (Fig. 5; Ethicon), and Lyons Dissecting Forceps (Fig. 6; Gyrus ACMI). The tissue impedance is monitored with continuous adjustment of the generated voltage and current to maintain the lowest possible power setting to achieve the desired tissue effect, at which time an audio signal alerts the specialist that the terminal point has been achieved. In this way, the risk of lateral thermal spread as well

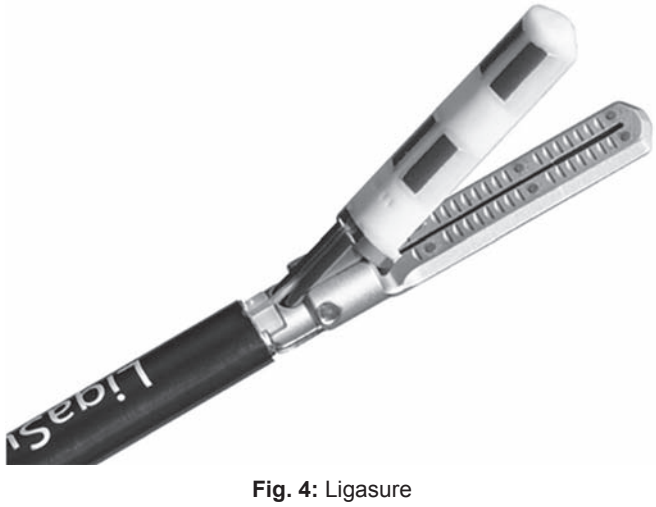


Fig. 4: Ligasure

Fig. 5: Enseal articulating forceps

Fig. 6: Gyrus plasmakinetic probe

as charring of the tissue and adherence of tissue to the device jaws is reduced.[3]

These energy sources were the first to be endorsed by the US Food and Drug Administration (FDA) to seal vessels up to 7 mm in width inferable from innovative advances, e.g., tissue impedance observing up to 4000 times each second (LigaSure); temperature-delicate material in the gadget jaws that optimizes tissue temperatures at ~100°C (EnSeal); delivery of pulsed energy with nonstop input control to counteract tissue overheating (PK Framework); and jaw outline that advances mechanical pressure to the vascular pedicle (LigaSure, EnSeal).[2,6] Although the capacity of these more up-to-date devices to seal vessels up to 7 mm in width is unchallenged, the normal minimization of thermal spread attributable to these advancements has yet to be demonstrated in clinical trials. Some devices incorporate a cutting blade into the device jaws (LigaSure, EnSeal) that decreases the need for a laparoscopic scissor.

Hence, the decision to use a particular bipolar device will depend on the specialist need and choice. Albeit progressive bipolar energy sources are costly, they are by far available in all the hospitals.[3]

Ultrasonic Devices

Previously called the "laparoscopic scalpel"; it has the double usefulness of tissue cutting and vessel sealing.[6] Ultrasonic energy sources convert electrical energy into ultrasonic energy (vibrations) in the handpiece of the device which then gets converted to the thermal energy at frequencies more than 10000 cycles per second. These vibrations are produced by piezoelectric crystals present in the handpiece that oscillate the nonarticulating jaw of the instrument. Tissue is compressed between the two jaws to achieve the desired tissue effects from combination of thermal and mechanical energy. Desiccation and vessel sealing (coagulation) is achieved at lower setting, and tissue cutting occurs at higher setting. The tissue effects are accomplished at temperature of 50 to 60°C due to mechanical effect of vibrations. These are FDA affirmed to seal vessels 5 mm in diameter. The device available is the Harmonic ACE+ (Fig. 7, ethicon), and it has "Adaptive Tissue Technology" that gives a sound sign to the specialist when changes in the objective tissue are sensed – this is an aberrant evaluation and less dependable than the tissue capacitance monitoring utilized by cutting-edge bipolar devices to demonstrate endpoint. More as of late the new up-to-date model have been specifically produced for larger vessel fixing and cutting, this gadget has been evaluated by the FDA to seal vessels up to 7 mm in diameter.[3]

These tissue impacts are accomplished without the passage of electric current through the patient or the tissue held by the device. Points of interest of ultrasonic devices incorporate less instrument movement, inferable from the blend of vessel-fixing and tissue cutting, and less smoke. The dissection capacity is great, yet not as much as that of monopolar scissors or Maryland bipolar forceps. The detriment is that the obscure harmful tissue gets vaporized in the smoke and can get scattered.

Fig. 7: Harmonic scalpel

Fig. 8: Thunderbeat tip

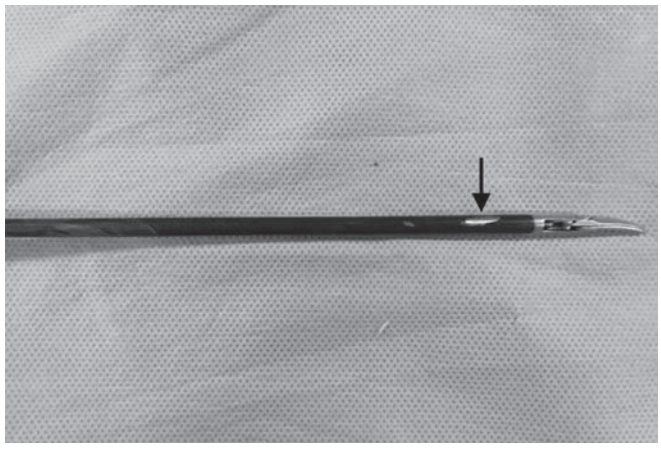


Fig. 9: Break in the insulation of monopolar scissor

Hybrid Devices

Laparoscopic gadgets have as of late been built up that join a few energy source advancements together. These are LigaSure Advance (monopolar and bipolar electrosurgery; Covidien) and Thunderbeat (Fig. 8; ultrasonic and bipolar advancements; Olympus). Joining of different advancements into a solitary device may lessen instrument movement and, furthermore, reduce the general expense, albeit such advantages should be an auxiliary thought if the singular functionalities are bargained in the cross breed setup. Great-quality trials on the adequacy and well-being of the cross-breed devices are lacking.[6]

Complications of Electrosurgery

The rate of electrosurgical complications during delivery of energy to the surgical site is estimated to be 25.6% (70/273) and is the second most common laparoscopic complication after a misplacement of trocar or Veress needle, which is 41.8% (114/273).[8]

According to a review by Van der Voort et al,[8] 61.6% (154/250) of bowel injuries were recognized intraoperatively, and 5.2% (13/250) and 10.4% (26/250) were recognized during early (within the next 48 hours) and late (at least on the 3rd postoperative day or later) postoperative phases respectively. Laparotomy was the most frequently performed procedure to manage laparoscopy induced bowel injury (78.6%). Conservative and laparoscopic treatment were used considerably less often (7.0 and 7.5% respectively).[8,9]

In a review, conducted by Huang et al[10] they concluded that alertness to postoperative warning signs, patient education prior to discharge, and the detection of delayed manifestations with salvage maneuvers may minimize catastrophic complications.

Vancaillie et al[11], in her review of monopolar energy, has stressed upon the use active electrode monitoring system for detecting insulation failures.

Direct Application

Damage by direct utilization of the electrosurgical probe can emerge either from mixed up focusing on or unintended initiation. The pace of the system will bring about either less or more coagulation and thermal spread. The stay time decides the measure of tissue impact. Drawn out enactment will deliver more extensive and more profound tissue harm more than the expected sought tissue effect.[12]

Stray Current

A stray current emerging from blemished insulation can harm the neighboring structure (Figs 9 and 10). A cautious preoperative and after use assessment of gear is the best method for distinguishing imperfect insulation.[13] The two noteworthy reasons for insulation failure incorporate the utilization of high voltage streams and the regular resterilization of instruments, which can debilitate and break the insulation.[14]

Fig. 10: Current getting dispersed from the insulation failure site and causing burning of tissue

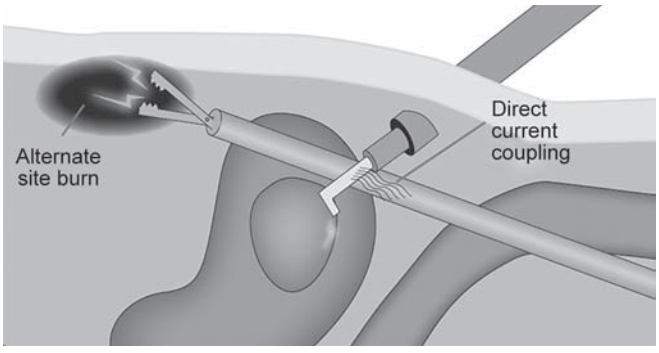


Fig. 11: Direct coupling

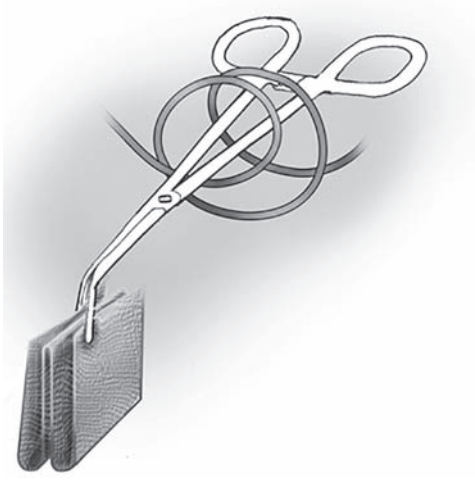


Fig. 13: Capacitance due to wrapping of monopolar code around artery forceps

Direct Coupling

Direct coupling happens when the active terminal is unintentionally enacted or is in close nearness to another metal instrument inside the pelvis, e.g., laparoscope or metal grasper forceps[14] (Fig. 11). Direct coupling can be prevented by keeping the electrode in vision and keeping away from whatever other conductive instruments before enacting the electrode.[13,15]

Capacitive Coupling

Capacitive coupling happens when the electric current is exchanged from one conductor (the dynamic terminal), through in-place insulation, into nearby conductive materials (e.g., bowel) without direct contact (Fig. 12). Longer length of instruments, thinner protection, higher voltages, and different conductivity instruments, such as unknown wrapping of electrosurgical codes (Fig. 13) and thin trocars build the danger of this kind of injury.[16] Capacitor coupling can be minimized by enacting the active electrode just when it is in contact with target tissues and restricting the time length of high-voltage peaks.[12,17]

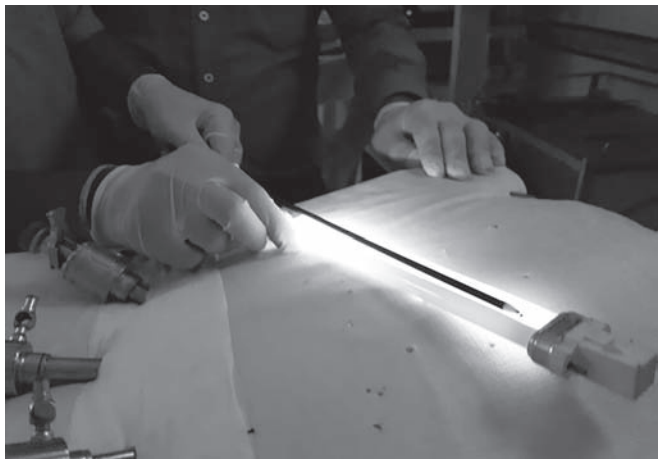


Fig. 12: Glowing of bulb due to capacitative coupling from monopolar hook

Return Electrode or Alternative Site Burns

If the return electrode is not completely in contact with the patient's skin, or is not able to disperse the current safely, then the exiting current can have a high enough density to produce an unintended burn.[14] It is important to have good contact between the patient and a dispersive pad.[13] The minimum size of return electrode should be 100 cm^2.

RESULTS

The author in this review of the literature likewise accentuates on the unprejudiced learning of all the energy devices before using them. It also shows that the performance of the energy devices depends upon the type of effect needed. There is no accord as to which device is ideal for a given purpose (Table 3). Wang and Advincula[14] have stressed on a careful comprehension of the upsides and downsides of the innovative technical advances can enhance the operative experience for both specialist and patient. The specialized expertise level of the specialist and the learning about the device are both critical variables in choosing safe results.

Holloran-Schwartz et al,[18] in a randomized control trial of 46 laparoscopic hysterectomy patients, compared

Table 3: Comparison of various energy sources

Device	*Skill*	*Risk of stray current*	*Cutting*	*Coagulation*	*Reusable*
Monopolar hook	✓	✓	✓	✓	✓
Bipolar dissector	✓	×	×	✓	✓
Ligasure	✓	×	✓	✓	×
Enseal	✓	×	✓	✓	×
Gyrus	✓	×	✓	✓	×
Harmonic	✓	×	✓	✓	×
Thunderbeat	✓	×	✓	✓	×

the efficacy of single use energy devices with standard methods and found them to be significantly beneficial.

Aytan et al,[19] in their randomized trial of 45 laparoscopic hysterectomy patients, compared the adequacy of advanced bipolar devices. But none of the three devices was found to be superior to other.

CONCLUSION

To defeat the deceptions of laparoscopic hemostasis and cutting, electrosurgery has turned out as an imaginative innovation. It has made the life of an expert simple. Be that as it may, everything accompanies its own burdens. Electrosurgery also has its own danger and complexities. The utilization of electrosurgery ought to be constrained just for spots where essential. The expert ought to try to know totally about the device he is utilizing and ought not to be driven by marketing companies.

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REFERENCES

1. Kingston AJ, Lyons SD, Abbott JA, Vancaillie TG. Principles and practical applications of electrosurgery in laparoscopy. J Minim Invasive Gynecol 2008 Nov;15(6):6S.
2. Law KS, Lyons SD. Comparative studies of energy sources in gynecological laparoscopy. J Minim Invasive Gynecol 2013 May-Jun;20(3):308-318.
3. Law KS, Abbott JA, Lyons SD. Energy sources for gynecological laparoscopic surgery: A review of the literature. Obstet Gynecol Surv 2014 Dec;69(12):763-776.
4. "Principles of Electrosurgery" Covidien Energy-based Professional Education [Internet] www.valleylabeleducation.org. [cited 24 July 2016]. Available from: http://www.asit.org/assets/documents/Principles_in_electrosurgery.pdf
5. Sutton C, Abbott J. History of power sources in endoscopic surgery. J Minim Invasive Gynecol 2013 May-Jun;20(3): 271-278.
6. Lyons SD, Law KS. Laparoscopic vessel sealing technologies. J Minim Invasive Gynecol 2013 May-Jun;20(3):301-307.
7. Odell RC. Surgical complications specific to monopolar electrosurgical energy: Engineering changes that have made electrosurgery safer. J Minim Invasive Gynecol 2013 May-Jun;20(3):288-298.
8. Van der Voort M, Heijnsdijk EA, Gouma DJ. Bowel injury as a complication of laparoscopy. Br J Surg 2004 Oct;91(10): 1253-1258.
9. Deziel DJ, Millikan KW, Economou SG, Doolas A, Ko ST, Airan MC. Complications of laparoscopic cholecystectomy: A national survey of 4,292 hospitals and an analysis of 77,604 cases. Am J Surg 1993 Jan;165(1):9-14.
10. Huang H, Yen C, Wu M. Complications of electrosurgery in laparoscopy. Gynecol Minim Invasive Ther 2014;3(2):39-42.
11. Vancaillie TG. Active electrode monitoring. How to prevent unintentional thermal injury associated with monopolar electrosurgery at laparoscopy. Surg Endosc 1998 Aug;12(8): 1009-1012.
12. Advincula AP, Wang K. The evolutionary state of electrosurgery: Where are we now? Curr Opin Obstet Gynecol 2008 Aug;20(4):353-358.
13. Jones CM, Pierre KB, Nicoud IB, Stain SC, Melvin WV, 3rd. Electrosurgery. Curr Surg 2006 Nov-Dec;63(6):458-463.
14. Wang K, Advincula AP. "Current thoughts" in electrosurgery. Int J Gynaecol Obstet 2007 Jun;97(3):245-450.
15. Ito M, Harada T, Yamauchi N, Tsudo T, Mizuta M, Terakawa N. Small bowel perforation from a thermal burn caused by contact with the end of a laparoscope during ovarian cystectomy. J Obstet Gynaecol Res 2006 Aug;32(4):434-436.
16. Harrell AG, Kercher KW, Heniford BT. Energy sources in laparoscopy. Semin Laparosc Surg 2004 Sep;11(3):201-209.
17. Lipscomb GH, Givens VM. Preventing electrosurgical energy-related injuries. Obstet Gynecol Clin North Am 2010 Sep;37(3):369-377.
18. Holloran-Schwartz MB, Gavard JA, Martin JC, Blaskiewicz RJ, Yeung PP Jr. Single-use energy sources and operating room time for laparoscopic hysterectomy: A randomized controlled trial. J Minim Invasive Gynecol 2016 Jan;23(1):72-77.
19. Aytan H, Nazik H, Narin R, Api M, Tok EC. Comparison of the use of LigaSure, HALO PKS cutting forceps, and ENSEAL tissue sealer in total laparoscopic hysterectomy: A randomized trial. J Minim Invasive Gynecol 2014 Jul-Aug;21(4):650-655.

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REVIEW ARTICLE

Various Port-site Closure Techniques in Laparoscopic Surgeries

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ABSTRACT

Introduction: Minimally invasive surgeries are the advantageous and cosmetically better surgical procedures nowadays. But laparoscopic trocars do create wounds. It is necessary to close these wounds with a good technique in order to decrease the complications related to port-site complications, especially hernia.

Aim: This study is to review and list different techniques used for closure of port-site wounds.

Materials and methods: A literature search was performed for the articles related with techniques of closure of trocar sites. For this purpose, the search engines used were Google, HighWire Press, and SpringerLink. Only those techniques that include the usage of suture materials, suture carriers, and various needles were reviewed in this study. Special devices made for port-closure are not reviewed here.

Results: The study describes many techniques, including classical closure using curved needles, such as the Grice needle, Maciol needles, spinal needles, dual hemostat, suture carrier, modified Veress needle with a slit made in retractable brunt tip, dental awl with an eye, prolene 2/0 on straight needle aided by Veress needle, straight needle armed with suture, modified Veress needle bearing a crochet hook at tip; Foley catheter threaded through port-hole for elevation of fascial edge upon traction; fish-hook needle improvised out of a hypodermic needle by bending it to 180°; U-shaped purse-string suture placed in the fascia around port-hole.

Conclusion: There are plenty of techniques for closure of trocar-site wounds, all of them are effective in closing the fascial defect of abdominal wall.

Keywords: Laparoscopic surgeries, Port-site closure techniques, Trocar-site hernia.

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INTRODUCTION

In 1996, the modern era of laparoscopy started with the invention of Hopkin-Rod system by Professor Hopkins.[1]

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Minimally invasive surgeries are the advantageous and cosmetically better surgical procedures nowadays. But laparoscopic trocars do create wounds. So any surgeon, whether a neophyte or an expert, needs a systematic approach to exit the abdomen after any laparoscopic procedure. It is necessary to close these wounds with a good technique in order to decrease the complications related to port-site complications, especially hernia. Precise anatomical closure of abdominal wall fascia of port sites 10 mm or larger is mandatory. Because larger ports can cause increase in possibility of complication following surgery.[2] These complications include incisional bowel herniation as well as bowel obstruction.[3,4] Many techniques and devices have been introduced into practice to minimize risk of port-site complications which occur in 1 to 6% of cases.[5,6] It is recommended that all 10 and 12 mm trocar sites in adults and all 5 mm port sites in children be closed, incorporating peritoneum into fascial closure.[7-10] A number of techniques have been developed in an attempt to prevent trocar-site hernia, but there is still no gold standard. Traditional suturing techniques have been used, but proven to be blind closure of fascial defect.[11] Therefore, many modified techniques using various devices and needles have been developed to facilitate the aim of prevention of trocar-site hernia.

MATERIALS AND METHODS

A literature search was performed for the articles related with techniques of closure of trocar sites. For this purpose, the search engines used were Google, HighWire Press, and SpringerLink. The term used for search was port-site closure techniques. All the articles dealing with port-site closure methods were reviewed along with their references.

RESULTS

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

First group: Needle must be seen through telescope (laparoscopic visualization).

Second group: Needle must be seen by surgeon and no telescope required for it (no laparoscopic visualization).

First Group

In this group, port closure is performed from inside the abdomen under direct abdomen under direct visualization of telescope, so as to avoid visceral injuries. They include maciol needles, grice needle, catheter or spinal needles, modified veress needle with a slit made in retractable brunt tip, prolene 2/0 on straight needle aided by a veress needle, straight needle armed with suture, modified veress needle bearing a crochet hook at tip, and Veress needle loop technique.[12]

Grice Needle

It was used by Stringer et al[13] It was inserted into the abdomen at an angle by the side of trocar site to close. Then under direct telescopic vision the needle was placed through both peritoneum and fascia. Within abdomen, the suture was grasped and removed from Grice needle with a grasper inserted from opposite trocar. The Grice needle was then removed and reinserted at opposite site of previous puncture at an angle to trocar site. The suture was again grasped with Grice needle and pulled out of the abdomen. After complete removal of trocar, the suture was tied under direct laparoscopic visualization.

Maciol Needles

Contarini[14] used these needles. They are a set of three needles which include two black handled introducers, one straight and one curved, and a golden-handle retriever. The introducer needle is used to pass suture through abdominal wall into peritoneal cavity from subcutaneous tissue. The retriever needle (needle with a barb) is then passed into abdomen on opposite side of the defect to retrieve suture, and then pulled back through tissue. The procedure is performed under direct telescopic visualization before trocar withdrawal and does not require skin incision enlargement.

Vein Catheter, Spinal Needle, and Angiocath

Vein catheter, spinal needle, and angiocath were used by Nadler et al[15] under direct laparoscopic visualization. No.0 polypropylene suture is threaded through a 15 gauze needle and inserted along the umbilicus at an angle of 45° from the distance of 0 to 5 to 1 cm. After piercing an endograsp, forceps is used to pull the free edge of suture edge into abdomen. It goes all around umbilicus, penetrated all layers of subcutaneous tissue including fascia, and create a purse-string suture by continuously running stitches. The whole procedure is repeated three times until the purse-string stitch is made. For use of angiocath, a 14 gauze angiocath is used with a 50 cm no.0 braided polyglactin suture. Angiocath and suture are inserted through all the layers of fascia one on side of port-wound under laparoscopic visualization. The needle and suture are placed exactly in the middle of one side of port-wound. The assistance grasps the suture from another 5 mm port and needle is removed; then suture feeded into abdominal cavity of about 10 to 15 cm length. Then a 5 mm grasping forceps is inserted through subxiphoid or other port and suture removed from abdominal cavity. These four steps are repeated by passing another preloaded angiocath needle and suture through midpoint of other side of trocar-wound. Ends of the suture are tied together with square knots. Knot is then reduced into peritoneal cavity by pulling on one or both ends of tied suture. The fascia is then closed and suture tied under direct vision through laparoscope.

Veress Needle Loop Technique

Hamood and Mishra[16] used it making a loop by passing nylon suture to Veress needle and tied it. Then load the Vicryl suture to Veress needle tip and push the Veress needle with loop through abdominal wall without piercing the skin, 3 mm away from the trocar site. Then remove the Veress needle, leaving the Vicryl inside only by putting a finger on Vicryl, grasped Vicryl by grasper and pass it to other side of trocar to push it inside the Veress loop. Then after piercing the abdominal wall, leave the skin and then remove the trocar close to the wall by knotting.

The 5 mm Trocar Technique

Chapman[17] developed a simple technique using curved needle and sutures for closure of rectus sheath defects at trocar-wounds. First, with 5 mm telescope the defect is inspected from inside of abdomen and then pass a hemostat through the incision. Then under direct laparoscopic vision the peritoneum and rectus sheath are grasped and pulled through incision, thus by facilitating the passage of needle. Chatzipapas et al[18] developed a similar closure technique using standard suture with straight needles, a 5 mm laparoscopic grasper, and a 4 mm hysteroscope.

Second Group

The port to be closed is under direct vision of the surgeon in this group and for this purpose good insufflation of abdomen is a prerequisite. But if desufflation is performed, then a tactile feedback should be used to close the port-wound. These techniques are applicable during insufflation and desufflation. They include suture carrier, the dual hemostat technique, the Lowsley retractor, and application of bioabsorbable hernia plug in trocar sites.[19] It included preliminary fascial stay-suture placement above and below trocar-wound, Foley's catheter threaded

through the port-hole for elevation of fascial edge for traction, fish-hook needle improvised out of a hypodermic needle by bending it to 180°, and a U-shaped purse-string suture placed in the fascia around port-hole.

Suture Carrier

Jorge et al[20] and Li and Chung developed this carrier making use of vertical rather than horizontal space. It is a hook suture carrier modified from a simple hook retractor with an eye drilled into the tip through which suture can be threaded. Its handle is 24 cm long and size approximated to the size of general closure needle (CT needle, Ethicon, etc.). To start closure, the edge of fascia is lifted vertically with a hook retractor and the suture carrier is partially inserted into the wound to catch peritoneum and fascia under direct vision, piercing it from the undersurface. Then 0-polypropylene suture is threaded into the exposed eye of carrier and brought beneath the fascia. Then the suture is passed from the edge of opposite wound with carrier and taking a single stitch from in to out. Then a simple stitch is taken with knot on the surface of port-wound.

Dual-Hemostat Technique

Spalding et al[21] used this technique using two hemostats and a needle holder with suture and needle. First hemostat is placed into the wound. Then the tops are spread open and the fascia is lifted away from underlying viscera. Then second hemostat is used to retract overlying subcutaneous tissue. Then the suture needle is passed through the fascia to exit between the splayed tips. This procedure is repeated at the opposite side of wound also.

Port Plug Technique

In this method the bioabsorbable hernia plug is used in the trocar site with the help of bioabsorbable hernia plug device.[22]

DISCUSSION

Incidence of port-site hernia is about 0.23% at the 10 mm port-site and 1.9% at the 12 mm port-site. This incidence drastically gets increased to 6.3% when patients are obese with body mass index greater than 30 kg/m^2. This complication arises after laparoscopy when there is failure to reapproximate fascial wound edges of the big trocar wounds, infection, and premature suture disruption. A bulge either on coughing or even without it at a previous trocar-site should immediately raise suspicion of a trocar-site hernia.[23]

Hernia at trocar-sites is classified into three types:

1. The early-onset type, which occurs immediately after laparoscopic surgery and with a small bowel obstruction.
2. The late-onset type, which occurs after few months of laparoscopic surgery, mostly with local abdominal bulge and no small bowel obstruction.
3. The special type, which indicates protrusion of intestine and/or omentum.[10]

The Ritcher hernia usually presents few days later and patient experiences delay in realizing its occurrence due to normal bowel function, which causes significant morbidity. It is a rare complication but a dangerous one. The usual symptoms include crampy abdominal pain with nausea and/or vomiting. Treatment is reduction of the bowel which is incarcerated followed by repair of the fascial defect. Some authors advocate open repair of hernia or local exploration combined with laparoscopy, but the minimally invasive approach is an acceptable treatment at the time of diagnosis but only as long as the incarcerated bowel is not ischemic.[24] Risk factors for the development of trocar-site hernia are diameter of the trocar-site, trocar design, preexisting fascial defects, some surgeries, and patient-related factors.[5] Many authors believe that inserting a 10 mm trocar in an oblique fashion or Z-tract will reduce hernia formation by putting the external and internal defects at different levels. So it is recommended that all 10 and 12 mm size trocar wounds must be closed. At the end, the perfection of all closure techniques has proliferated and improvements are continuously being made. But the surgeon must be familiarized with the useful port-closure techniques which he/she feels comfortable with, easy to perform, simple, safe, and effective.[25]

The comparisons among all these techniques are beyond the aim of this literature review. It is suggested that tighter closure of the skin incision may control the leak of ascetic fluid in patients with ascites, but only for a short time. The tight closure of fascia may prevent the ascitic fluid leak.[14] For the closure of skin, the transcutaneous closure with absorbable suture material seems to be the most suitable technique.[26]

REFERENCES

1. Saleem I. Minimal access surgery the port site complication. Technol Today 2003 Jul-Sep;10(3):226.
2. Earle DB. A simple and inexpensive technique for closing trocar sites and grasping sutures. J Laparoendosc Adv Surg Tech A 1999 Feb;9(1):81-85.
3. Brody F, Rehm J, Ponsky J, Holzman M. A reliable and efficient technique for laparoscopic needle positioning. Surg Endosc 1999 Oct;13(10):1053-1054.
4. Felix EL, Harbertson N, Vartanian S. Laparoscopic hernioplasty: significant complications. Surg Endosc 1999 Apr;13(4):321-322.
5. Holzinger F, Klaiber C. Trocar-site hernias: a rare but potentially dangerous complication of laparoscopic surgery. Chirurg 2002 Sep;73(9):899-904.

6. Nezhut C, Nezhut F, Seidman DS, Nezhut C. Incisional hernias after operative laparoscopy. J Laparoendosc Adv Surg Tech A 1997 Apr;7(2):111-115.
7. Di Lorenzo N, Coscarella G, Lirosi F, Gaspari A. Port-site closure: a new problem, an old device. JSLS 2002 Apr-Jun;6(2): 181-183.
8. 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 Aug;61(8):718-720.
9. Matthers BD, Heniford BT, Sing RF. Preperitoneal Ritcher hernia after a laparoscopic gastric bypass. Surg Laparosc Endosc Percutan Tech 2001 Feb;11(1):47-49.
10. 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 Mar;194(3):391-393.
11. Shaher Z. Port closure techniques. Surg Endosc 2007 Aug;21(8):1264-1274.
12. Mishra, R.K. Textbook of practical laparoscopic surgery. 2nd ed. Jaypee Publication Brothers Pvt. Ltd., New Delhi, India.
13. Stringer NH, Levy ES, Kezmoh MP, Walker J, Abramovitz S, Sadowski DL, Keflemariam Y. New closure technique for lateral operative laparoscopic trocar sites: a report of 80 closures. Surg Endosc 1995 Jul;9(7):838-840.
14. Contarini, O. Complication of trocar wounds. In: Meinero, M.; Melotti, G.; Mouret, Ph., editors. Laparoscopic surgery. Milano, Italy: Masson SP A; 1994. pp. 38-44.
15. Nadler RB, McDougall E, Bullock AD, Ludwig MA, Brunt LM. Fascial closure of laparoscopic port sites: a new technique. Urology 1995 Jun;45(6):1046-1048.
16. Hamood MA, Mishra RK. Different port closure techniques in laparoscopy surgery. World J Laparosc Surg 2009 Sep-Dec;2(3):29-38.
17. Chapman WH III. Trocar-site closure: a new and easy technique. J Laparoendosc Adv Surg Tech A 1999 Dec;9(6): 499-502.
18. 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 Apr;9(2):205-209.
19. 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 Oct;183(4):335-344.
20. Jorge C, Carlos M, Alejandro W. A simple and safe technique for closure of trocar wounds using a new instrument. Surg Laparosc Endosc 1996 Oct;6(5):392-393.
21. Spalding SC, Ponsky TA, Oristian E. A new dual-hemostat technique to facilitate the closure of small laparoscopic trocar incisions. Surg Endosc 2003 Jan;17(1):164-165.
22. Sanz CM, Picazo-Yeste J, Manzanera-Diaz M, Tadeo-Ruiz G. Prevention of trocar site hernias. Surg Innov 2008 Jul;15(2): 100-104.
23. Shaher Z. Port closure techniques. Surg Endosc 2007 Aug;21(8):1264-1274. February 8, 2007.
24. Boughe JC, Nottingham JM, Walls AC. Ritcher's hernia in the laparoscopic era: four case reports and review of the literature. Surg Laparoendosc Percutan Tech 2003 Feb;13(1): 55-58.
25. Ng W-T, Luk H-T. Review of techniques for port-closure. Surg Pract 2007 Aug;11(3):115-120.
26. Buchweitz O, Wulfing P, Kiesel L. A prospective randomized trial of closing laparoscopic wounds by transcutaneous vs subcuticular suture or adhesive paper tape. Surg Endosc 2005 Jan;19(1):148-151.