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Endoscopic Right Lobectomy Axillary-breast Approach: Report of Two Cases

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Abstract

Background: We report our two initial experiences in the treatment of thyroid disease with endoscopic thyroidectomy. Minimally invasive video-assisted thyroidectomy (MIVAT) was initially introduced by Miccoli. The modification was made by using axillary and breast approach with CO₂ insufflation.

Method: A young woman patient with 5 cm right lobe thyroid disease, suspected benign. From physical examination, sonography and FNAB findings were categorized as benign case. Thyroid function test was within normal limit. She was operated with endoscopic right lobectomy. The procedure was carried out through incision of 5-10 mm axillary and breast. The right lobectomy procedure was performed by dedicated instrument. No drain needed. The pathology result was follicular carcinoma, so further treatment needed. Other patient, a woman with 4 cm right lobe thyroid cyst. FNAB proved benign, was operated with the same procedure, and pathology result was benign cyst.

Result: Duration of first operation was 300 minutes and the second one was 120 minutes, minimal blood loss, and no major complication. Patients were discharged 24 hours after operation. Cosmetic results and postoperative pain were excellent. Slight swelling on their necks was found and reduced after 48 hours. Pain around shoulder until day-7 postoperation and significantly disappeared after 10 days.

Conclusion: We reported two cases, which were operated by endoscopic right lobectomy as a safe, reproducible technique with an indication in a minority of patients/candidates to thyroidectomy and is characterized by a better postoperative discomfort. The duration of operation would be a curve learning for each surgeon who wishes to perform it.

Keywords: Endoscopic thyroidectomy, Axillary-breast approach.

INTRODUCTION

Neck surgery is one of the newest and most interesting applications of minimally invasive surgery technique in thyroid surgery, particularly with regard to eliminating the unattractive scars.^{1,2}

It is well known that conventional thyroidectomy allows prompt postoperative recovery. In some clinical settings, it is performed as an outpatient procedure. Findings have shown that video-assisted and endoscopic procedure for thyroid surgery have some advantages over conventional surgery in terms of cosmetic result and postoperative recovery. These results support the development of endoscopic and video-assisted thyroid surgery. It should be emphasized that these procedures are technically demanding and require a surgical team skilled in both endocrine and endoscopic surgery. This is particularly true for some endoscopic techniques, such as endoscopic thyroidectomy by breast or axillary approach. The endoscopic and video-assisted procedure requires a significant learning period, which can be time consuming especially at the beginning of a surgeon's experience.³

Minimal access thyroid surgery was conceived primarily in Europe and Asia.¹ Endoscopic neck surgery for the

parathyroid and thyroid was developed by Gagner and Huscher in 1996 and 1997 respectively. Since then, various methods, including axillary, breast, and anterior chest approaches have been introduced by many surgeons. The use of endoscopy for complete thyroidectomy has been viewed with concern, although many surgeons have regarded benign thyroid disease as an indication of endoscopic surgery.⁴⁻⁷

CASE ILLUSTRATION I

A 32-year-old woman with a lump on right anterior neck since a year. The lump was not tender, meat ball size, non growing, and skin over was not red. No other lump was seen around her neck or other part of the body. No other person in her community had the same symptom.

From physical examination, general condition was good. Local status showed lump on anterior neck region with no redness and size around 5 cm in diameter. The lump was firm, not tender, moved upward on swallowing and no lymph node enlargement was seen around the neck. Laboratory finding was within normal limit. Sonography and FNAB findings were concluded as benign case. She was operated with right lobectomy endoscopically. Pathologic result was

follicular carcinoma. Further treatment was needed, and she is now prepared for the completion of thyroidectomy endoscopically.

CASE ILLUSTRATION II

A 34-year-old woman with lump on right anterior neck since 6 months (Fig. 1). The lump was not tender, meat ball size, non growing, and skin over was not red. No other lump was seen around her neck or other part of the body. No other person in her community had the same symptom.

General condition was good. Local status showed lump on anterior neck region with no redness and size around 4 cm in diameter. The lump was firm, not tender, moved upward on swallowing and no lymph node enlargement was seen around the neck. Laboratory finding was within normal limit. Sonography and FNAB findings were concluded as benign cyst. She was operated with right lobectomy endoscopically. Pathologic result was benign cyst of thyroid.

METHOD

Our first two case reports includes the use of axillary-breast approach similar to Tran Ngoc Luong technique to perform endoscopic right lobectomy (Fig. 2). Under general anesthesia, those patients were placed in the supine position with neck moderately extended. The port sites were identified. At first, 10 mm longitudinal incision was made at anterior axillary region then 5 mm incision was made at circumareolar and shoulder. Later, a vascular clamp was used to create a preliminary subfascial space. A 10 mm trocar was placed at the optical port. The operating space was maintained with O₂ insufflation at a gas pressure of 10



Fig. 1: Thyroid lump on right anterior neck

to 11 mm Hg. A 10 mm, 0 degree endoscope was inserted under its guidance. We inserted other 5 mm trocar respectively. The subcutaneous tunnel was further enlarged with bipolar and hook equipment. The lateral border of sternocleidomastoideus was dissected and omohyoid was moved upward. The thyroid gland was exposed. The inferior and superior thyroid arteries were divided using harmonic scalpel. The parathyroid and RLN were routinely identified and preserved. The gland was dissected by harmonic scalpel as well.

RESULT

The duration of first operation was 300 minutes with bleeding 75 cc. We did not have frozen section facility, so we had to wait for definitive pathology result. Postoperatively, there was slight edema on the neck, pain around shoulder, and no hoarseness (RLN paralysis). Calcium level was normal. After 7 days postoperation, the pain and edema reduced. As the pathology result was follicular, the patient needed complete operation after endoscopy. The second patient was operated in 120 minutes with bleeding 30 cc. Postoperatively was bruise on the right shoulder, no hoarseness, and slight pain around shoulder. After 7 days postoperation, she had no complaint (Fig. 3).

DISCUSSION

The history began with the initial experience conducted with MIVAP (minimally invasive video-assisted parathyroidectomy) that led some authors to perform the same surgical approach for thyroidectomy. The first idea that moved to MIVAT (minimally invasive video-assisted thyroidectomy) was the better cosmetic result (an incision of 1.5-2 cm).

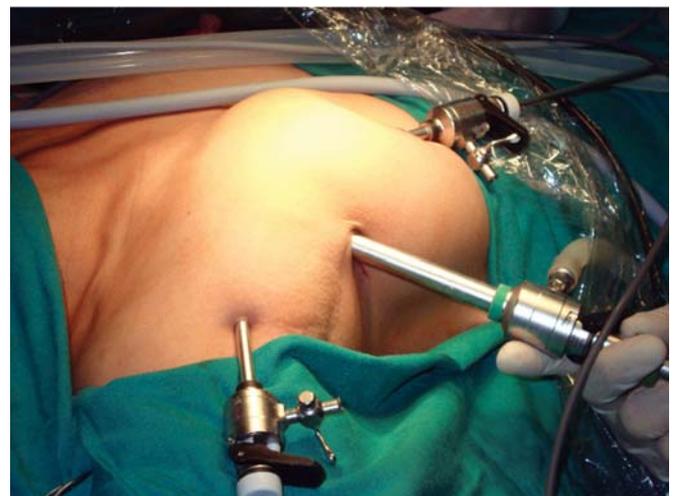


Fig. 2: Axillary approach for thyroidectomy

Miccoli introduced this technique as a three-part procedure starting with an open technique followed by endoscopic component and then completed in an open fashion. According to some data in the literature, any surgeon approaching the MIVAT technique must carefully consider that at the beginning of his or her experience, the procedure will be significantly longer than the standard operation. From then, endoscopic thyroidectomy can be divided in two types with CO₂ insufflation or gasless. Others classified as video-assisted and total endoscopic.^{1,7,8}

Total endoscopic thyroidectomy is a more sophisticated variation of minimally invasive thyroid. Using special instrument and technique, part or all of the thyroid gland can be removed through small puncture site avoiding any incision on the neck whatsoever. In this technique, the skin overlying the collarbone is lifted from the underlying muscle and laparoscopic techniques are used to create a working space.⁸

Various approaches have been devised and improved further to fulfill this goal, mainly including the cervical approach, anterior chest approach, axillary and breast approach. However, none of these approaches is exclusively advantageous and universally accepted. The cervical approach and anterior chest approach are minimally invasive but not cosmetically excellent. The axillary and breast approaches have maximized cosmesis, but meanwhile cause much invasiveness. Furthermore, the axillary approaches are not suitable for bilateral manipulation and even more technically challenging with abnormal anatomic vision. Therefore, an axillary-bilateral-breast approach (ABBA) has been developed, which is actually a combination of the procedure. In comparison, ABBA permits bilateral exploration more space for instrument use and the removal of larger nodule. With this technique, the mean surgical time was

188 minutes, mean blood loss was 53 ml and mean hospital stay was 3.3 days. BABA (bilateral-axillary-breast approach) was introduced later and claimed to be easily applied for thyroid cancer as well.^{3,5-7,9} This technique is now even improved by using da vinci robotic system by Eun Lee et al⁶, which is useful in identification of anatomy and dissection during surgery. The function of EndoWrist instrument is beneficial in doing complex tasks in difficult areas with limited access. The mean operating time without robotic was 165 minutes and with robotic was 218.3 minutes, but there is a tendency of decrease in operation time. They also perform central node dissection and limited lateral node picking. Tran Ngoc Luong¹⁰ in 2004 modified the technique by using axillary-breast-shoulder approach. Using this technique, they can do total and other bilateral procedures, including central neck dissection. The first operating time was 420 minutes and significantly reduced mean time for lobectomy is 15 minutes and total is 30 minutes now.

The first endoscopic surgery, performed transcervically, was employed to treat a 3 mm moderately differentiated papillary microcarcinoma with focal capsular invasion in 1997. The use of a transcervical approach results in small operative scars in the neck.⁴ After this attempt, Ohgami et al¹¹ performed endoscopy via breast approach for thyroid adenoma 5 to 7 cm in diameter. Yamamoto et al¹² applied endoscopy via breast approach for Graves' disease patients. Ikeda et al¹³ applied anterior chest and axillary approach for follicular tumors, Graves' disease and papillary microcarcinoma.

Generally, endoscopic thyroid surgery has been thought to be appropriate for benign thyroid disease. First, it was indicated for nodule not more than 3 cm, benign or low grade follicular lesion and papillary carcinoma. Contra-indications were previous neck surgery, large goiter, locally metastasis, previous neck irradiation, thyroiditis and hyperthyroidism.¹⁴ These indications then slightly change during the development of the technique. Some can even perform for nodule more than 5 cm for Graves' and thyroiditis.^{4,10} The role of endoscopy for carcinoma is still in debate. In other areas of oncologic surgery, such as for gastric or colorectal carcinoma, minimally invasive laparoscopic surgery has been established through clinical experience and technical development. Similarly, endoscopic thyroid surgery can be used for malignant thyroid disease. BABA and axillary-breast approach similar to Tran Ngoc Luong technique can be used as an appropriate method for treating thyroid malignancies.^{4,6,10} Kitano et al¹⁵ reported the treatment of thyroid cancer with anterior chest approach endoscopic surgery. The indications are as follow: Age



Fig. 3: Postoperative appearance

< 45 years, tumor size < 2 cm, and no evidence of lymph node metastasis or local invasion. Miccoli et al¹⁶ showed that the completeness obtained with MIVAT for thyroid cancer not exceeding 3.5 cm in diameter is similar to that obtained with open surgery. As experience accumulates and more techniques are developed, the indication in cases of thyroid malignancy can be expanded.^{4,6}

Postoperative complications are hypocalcemia, recurrent laryngeal nerve (RLN) paralysis, bleeding, infection, and pain.^{4,5} Others, as a complication of using CO₂ insufflation, are hypercapnia, subcutaneous emphysema and severe tachycardia.^{5,17} Gottlieb et al¹⁸ reported severe increase in PaCO₂, subcutaneous emphysema, and severe tachycardia by applied insufflations at relatively high pressure (15-20 mm Hg), whereas Ochiai et al¹⁷ and Ohgami et al¹¹ reported only minimal emphysema with the use of low pressure CO₂ insufflation (6 mm Hg). Tran Ngoc Luong technique used 10 to 11 mm Hg insufflations of CO₂ without severe complication appearance. The study of the appropriate pressure to be used is still under observation.¹⁰

According to the literature, the conversion rate varies from 0 to 13%. The reasons include malignant histological result, bleeding, difficulty of dissection, size of nodule and thyroiditis. In some reports, 5 to 11% patients even required a second operation for definitive malignant pathological result.⁶

We performed our first case using axillary-breast approach similar to Tran Ngoc Luong technique. We did not find any difficulty in identifying the anatomy during operation, so we did not convert to open method. The operation time was relatively faster than the first operation which Tran Ngoc Luong did. There was minimal blood loss and no major complication was found including the effect of CO₂ insufflation. This technique was safe and feasible to perform. It provides excellent view of vital structure and has advantage over open method cosmetically, although it has learning curve. As we get more familiar, the operating time will be shorter and also extending indication for endoscopic thyroid surgery. We proved it with our second patient who was operated faster and with minimal blood loss.

CONCLUSIONS

Since its introduction and establishment in 1997, endoscopic thyroidectomy has yet to become a standard procedure. Thus, this procedure will provide another surgical choice for patients with thyroid tumors and carcinoma.

REFERENCES

1. El-Labban GM. Minimally invasive Video-assisted thyroidectomy: A Single-blinded, randomized trial. *The Internet Journal of Surgery* 2010;22(2).
2. Bellantone R, Pio Lombardi C, Bossola M, et al. Video-assisted vs conventional thyroid lobectomy a randomized trial. *Arch Surg*. 2002;137:301-04.
3. Gal I, Solymosi T, Szabo Z, et al. Minimally invasive Video-assisted thyroidectomy and conventional thyroidectomy: A Prospective Randomized Study. *Surg Endosc* 2008;22:2445-49.
4. Seung Chng Y, Ho Choe J, Ho Kang K, et al. Endoscopic thyroidectomy for thyroid malignancies: Comparison with Conventional Open Thyroidectomy. *World J Surg* 2007;31:2302-06.
5. Lai Park Y, Kon Han W, Gila Bae W. 100 Cases of Endoscopic Thyroidectomy. *Surg Laparosc, Endosc and Percutan Tech* 2003;13(1):20-25.
6. Eun Lee K, Rao J, Kyu Youn Y, et al. Endoscopic Thyroidectomy with the da Vinci Robot System Using the BABA Technique-Our Initial Experience. *Surg Laparosc, Endosc and Percutan Tech* 2009;19(3):e71-75.
7. Lei Wang Y, Yong Zhang G, Xin Wang K. Endoscopic Thyroidectomy by A Modified Anterior Chest Approach: A single institution's 5-year experience. *Min Inv Therapy* 2009;18:297-301.
8. Minimally Invasive Thyroid Surgery. Available from: www.thyroidectomy.com.
9. Barlehner E, Benhidjeb T. Cervical Scarless Endoscopic Thyroidectomy: Axillo-bilateral-breast Approach (BABA). *Surg Endosc* 2008;22:154-57.
10. Ngoc Luong T. Open and Endoscopic Thyroidectomy. Paper Lecture August 2009.
11. Ohgami M, Ishii S, Arisawa Y, et al. Scarless Endoscopic Thyroidectomy: Breast Approach for Better Cosmesis. *Surg Laparosc Endosc Percutan Tech* 2002;21:2166-71.
12. Yamamoto M, Sasaki A, Asahi H, et al. Endoscopic Subtotal Thyroidectomy for Patients with Graves' Disease. *Surg Today* 2001;31:1-4.
13. Ikeda Y, Takami H, Sasaki Y. Comparative Study of Thyroidectomies: Endoscopic Surgery vs Conventional Open Surgery. *Surg Endosc* 2001;16:1741-45.
14. Del Rio P, Sommaruga L, Ferreri G, et al. Preliminary Experience in Minimally Invasive Video-assisted Thyroidectomy (MIVAT). *Acta Bio* 2006;77:27-29.
15. Kitano H, Fujimura M, Kinoshita T, et al. Endoscopic Thyroid Resection Using Cutaneous Elevation in Lieu of Insufflation. *Surg Endosc* 2002;16:88-91.
16. Miccoli P, Berti P, Raffaelli M, et al. Comparison between Minimally Invasive Video-assisted Thyroidectomy and Conventional Thyroidectomy: A prospective randomized study. *Surg* 2001;130:1039-43.
17. Ochiai R, Takeda J, Noguchi J. Subcutaneous Carbon Dioxide Insufflation Does Not Cause Hypercarbia During Endoscopic Thyroidectomy. *Anesth Analg* 2000;90:760-62.
18. Gottlieb A, Sprung J, Zheng XM, et al. Massive Subcutaneous Emphysema and Severe Hypercarbia in a Patient During Endoscopic Transcervical Parathyroidectomy using Carbon Dioxide Insufflation. *Anesth Analg* 1997;84:1154-56.

Laparoscopic Management of Biliary Ascariasis: A Case Report and Review of Literature

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Abstract

Acute pancreatitis due to *Ascaris lumbricoides* is a known etiology but very rare in Qatar. The diagnosis can be difficult because of the low index of suspicion. We report a case of 25-year-old Philippine patient living in Qatar who developed an acute pancreatitis due to *Ascaris lumbricoides* and was diagnosed initially as biliary pancreatitis. We proceeded with laparoscopic cholecystectomy and intraoperative cholangiogram which revealed *Ascaris* in the common bile duct. Transcystic extraction of a living worm from the common bile duct was done. This is the first case report of acute pancreatitis due to *Ascaris lumbricoides* which had laparoscopic transcystic extraction of a living worm from the common bile duct.

Background: *Ascaris lumbricoides* as etiology to acute pancreatitis has never been described in Qatar whereas in developing tropical and subtropical areas, *Ascaris lumbricoides* is found in human gastrointestinal tract with greater prevalence.¹ Although the infection can be asymptomatic, in some cases the adult parasite can invade the biliary or pancreatic ducts and cause obstruction with development of cholecystitis, cholangitis, and pancreatitis and hepatic abscesses.² We report a case of a patient with biliary ascariasis induced acute pancreatitis.

Conclusion: We recommend the use of this laparoscopic approach for treatment of such uncommon pathology, if surgical intervention is needed. The differential diagnosis of pancreatitis should be expanded to include ascariasis in patients who come from population at risk. Knowledge of clinical symptoms, complications, and diagnostic and therapeutic options are of paramount importance for all health professionals.

Keywords: Biliary ascariasis, Laparoscopy in ascariasis, Management of ascariasis.

CLINICAL CASE

A 25-year-old Philippine lady was admitted with right upper quadrant pain of 2 days duration. Pain was accompanied by nausea, vomiting and radiation to the back. Laboratory examinations demonstrated elevation of pancreatic amylase (2980 IU/L), lipase (around 7000 IU/L); liver enzymes were mildly elevated, with no jaundice. Ultrasonography revealed thick-walled gallbladder filled with sludge and stone; common bile duct (CBD) was mildly dilated. Therefore, she was diagnosed as a case of biliary pancreatitis. Medical treatment was started and on the second day, the patient showed clinical and biochemistry improvement, and the plan was to post her for laparoscopic cholecystectomy and intraoperative cholangiogram in our first elective operation list.

During operation, intraoperative cholangiography through the cystic duct revealed a dilation of CBD (8 mm), and a longitudinal filling defect in the common bile duct, which raised the suspicion of presence of *Ascaris* (Fig. 1). Therefore, small extension of cystic duct incision was made at junction with the common bile duct, and the living worm

was extracted carefully, placed in a plastic bag and removed from the body (Fig. 2). A biliary drainage tube was not used and the cystic duct incision was sutured and cholecystectomy was finished laparoscopically. The

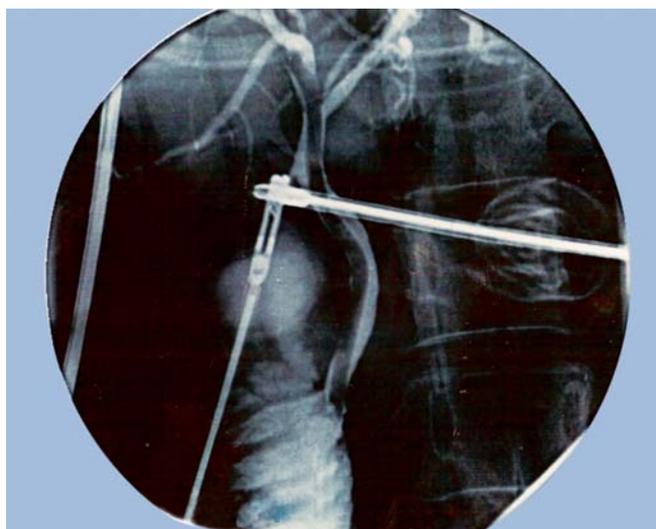


Fig. 1: Intraoperative cholangiogram showing *Ascaris* worm inside the CBD

postoperative period was uneventful and the patient was discharged fit on the fourth postoperative day after the full course of anthelmintic therapy (mebendazole) for three days. Patient was seen in surgical clinic and doing well.

DISCUSSION

Ascariasis is a helminthic infection of global distribution with more than 1.4 billion persons infected throughout the world.³ The majority of infections occur in the developing countries of Asia and Latin America. It is estimated that around 20,000 deaths occur per year because of severe clinical disease caused by ascariasis.^{4,5}

Khuroo et al reported 500 cases in India of hepatobiliary and pancreatic diseases due to *Ascaris lumbricoides* from one center over the period from June 1983 to November 1989. Since then hepatobiliary and pancreatic ascariasis (HPA) has been reported more often than ever before from many centers in endemic areas.⁶ Another 300 cases of HPA were reported in Syria by Sandouk et al.⁷ *Ascaris* causes pancreatitis due to obstruction of papilla of Vater, invasion of common bile duct, or invasion of pancreatic duct and can occur with abdominal pain, back pain, emesis, fever, or jaundice.⁸ However, the disease is now encountered with increased frequency in the western countries.^{9,10}

The diagnosis of ascariasis pancreatitis requires a high degree of suspicion in population at risk. Ultrasonography is a simple, noninvasive test and the characteristic sonographic findings of worms in the ducts have been well described.^{8,11,12} The worms move freely in and out of the biliary tree and ultrasonography cannot diagnose ascariasis in the duodenum, therefore more than half of the patients with HPA would be missed.^{6,7} In our case, the ultrasound

was not helpful because of unfamiliarity of our radiology department staff with such conditions.

Anthelmintic therapy with mebendazole or albendazole is a part of conservative management, reported by some authors with a success rate upto 80% of patients and considered as the first line of treatment in the first few days.^{13,14} The rationale for initial administration of anthelmintics is to paralyze the parasites within the intestinal lumen then worms are expelled by normal gastrointestinal peristalsis.^{6,8} However, it is not advisable to have dead worms inside the ductal system, which might lead to stricture formation as a result of severe inflammatory reaction. In addition, the liberated ova or existence of fragmented *Ascaris* might act as a nidus for stone formation.^{1,15} Therefore, for the above-mentioned reasons and in failed medical treatment of confirmed biliary ascariasis, endoscopic intervention is indicated.

ERCP has an advantage as a diagnostic tool as well as therapeutic modality. It allows better identification of worms in the duodenum and those across the papilla, and can be used for worm extraction from the ampullary orifice, biliary duct or pancreatic duct in 98% of patients.^{7,16} Most worms were extracted by flushing the bile ducts, grasping forceps, or balloon catheters. Thus, ERCP has now become the investigation modality of choice. Surgical intervention with worm extraction from CBD combined with cholecystectomy should be advised for patients for whom conservative and endoscopic management has failed or complicated by cholangitis.¹³

Until recently, the conventional open method is the standard surgical treatment for biliary ascariasis involving a combination of cholecystectomy, extraction of parasites, and T-tube drainage.^{6,13} Yoshihara S et al reported the first case in 2000 of a laparoscopic extraction of living worm from CBD through a conventional choledochotomy with primary suture of CBD opening without using drain.¹⁷ Astudillo AJ et al¹⁸ had a series of 13 patients diagnosed with biliary ascariasis diseases between February 1992 and February 2007. Six of those patients needed laparoscopic cholecystectomy and extraction of worms from CBD with insertion of T-tube, only one patient had primary closure of CBD. There is another reported case of laparoscopic extraction of worm without the need for T-tube drainage reported by Moirangthem GS et al.¹⁹

In our case, this is a first reported case of living worm being extracted laparoscopically through a cystic duct opening using intraoperative cholangiography with a few millimeters extension to the junction between cystic duct and CBD. In this case, the T-tube was not used and primary



Fig. 2: Extraction of *Ascaris* worm from CBD laparoscopically

closure was done for the cystic duct opening. Although the worm was incidentally discovered in CBD, our approach showed better advantages than conventional methods by shortening hospital stay, decreasing morbidity, and early return to normal activities. Care is required to keep the live worm in a laparoscopic visual field as it has tendency to move to narrow spaces, and to avoid a granulomatous reaction which might occur around *Ascaris* and fertilized eggs in peritoneal cavity.¹

REFERENCES

1. Khuroo MS. Ascariasis. *Gastroenterol Clin North Am* 1996;25:553-77.
2. De Silva NR, Chan MS, Bundy DAP. Morbidity and mortality due to ascariasis. *Trop Med Int Health* 1997;2:519-28.
3. Crompton DWT. The prevalence of ascariasis. *Parasitol Today* 1988;4:162.
4. Crompton DWT, Hesheim MC, Pawlowski ZS (Eds). Ascariasis and its public health significance. London, Taylor and Francis 1985.
5. Pawlowski ZS, Davies A, Crompton DWT, Nesheim MC, Pawlowski ZS (Eds). Morbidity and mortality in ascariasis. In: Ascariasis and its Prevention and Control. London, Taylor and Francis 1989;45-69.
6. Khuroo MS, Zargar SA, Mahajan R. Hepatobiliary and pancreatic ascariasis in India. *Lancet* 1990;335:1503.
7. Sandouk F, Haffar S, Zada M, et al. Pancreaticbiliary ascariasis: Experience of 300 cases. *Am J Gastroenterol* 1997;92:2264-67.
8. Khuroo MS, Zargar SA, Yattoo P, et al. Ascaris-induced acute pancreatitis. *Br J Surg* 1992;79:1335-38.
9. Maddern GJ, Dennison AR, Blumgart LH. Fatal *Ascaris* pancreatitis: An uncommon problem in the west. *Gut* 1992;33:402-03.
10. Baldwin M, Eiseman RE, Prelipp AM, et al. *Ascaris lumbricoides* resulting in acute cholecystitis and pancreatitis in the Midwest. *Am J Gastroenterol* 1993;12:2119-21.
11. Khuroo MS, Zargar SA, Mahajan R, et al. Sonographic appearances in biliary *Ascaris*. *Gastroenterology* 1987;93:267-72.
12. Larrubia JR, Ladero JM, Mendoza JL, et al. The role of sonography in the early diagnosis of biliopancreatic *Ascaris* infestation. *J Clin Gastroenterol* 1996;22:48-50.
13. Shah OJ, Zargar SA, Robbani I. Biliary ascariasis: A review. *World J Surg* 2006;30:1500-06.
14. Gonzalez AH, Regalado VC, Van den Ende J. Non-invasive management of *Ascaris lumbricoides* biliary tract migration: A prospective study in 69 patients from Ecuador. *Trop Med Int Health* 2001;6:146-50.
15. Khuroo MS, Zargar SA. Biliary ascariasis: A common cause of biliary and pancreatic disease in an endemic area. *Gastroenterology* 1985;88:418-23.
16. KhurooMS, Zargar SA, Yattoo GN, et al. Worm extraction and biliary drainage in hepatobiliary and pancreatic ascariasis. *Gastrointest Endosc* 1993;39:680-85.
17. Yoshihara S, Toyoki Y, Takahashi O, Sasaki M. Laparoscopic treatment for biliary ascariasis. *Surg Laparosc Endosc Percutan Tech Apr* 2000;10(2):103-05.
18. Astudillo JA, Sporn E, Serrano B, Astudillo R. Ascariasis in the hepatobiliary system: Laparoscopic management. *J Am Coll Surg* Oct 2008;207(4):527-32. Epub 2008 Jul 14.
19. Moirangthem GS, Singh CA, Lokendra K, Singh LD. Laparoscopic common bile duct exploration for extraction of a round worm. *Trop Gastroenterol Oct-Dec.* 2006;27(4):169-71.

Severe Hemobilia from Hepatic Artery Pseudoaneurysm after Laparoscopic Cholecystectomy: A Case Report and Review of Literature

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Abstract

Background: Hemobilia is a rare, jeopardizing complication of laparoscopic cholecystectomy coming upon patients generally within 4 weeks from surgery. The first line management is angiographic coil embolization of hepatic arteries, which checks the majority of bleedings whereas in a minority of cases, a second embolization or even laparotomy is needed.

Case presentation: We describe the case history of a patient who had laparoscopic cholecystectomy complicated three weeks later by massive hemobilia. The cause of hemorrhage was a pseudoaneurysm of a right hepatic artery branching off the superior mesenteric artery. This complication was managed successfully by one stage angiographic embolization with full recovery of the patient.

Keywords: Hemobilia, Laparoscopic cholecystectomy, Angiographic embolization, Thermal damage, Ultrasonic dissection.

INTRODUCTION

Severe hemobilia complicating laparoscopic cholecystectomy (LC) is a rare, unpredictable, life-threatening vascular complication commonly occurring within four weeks from surgery. In the literature, more than 60 cases have been reported by now.¹⁻²⁴ Pre-existing aneurysms^{22,25} and postsurgical pseudoaneurysms of hepatic arteries are the cause of hemobilia in 10% of cases. LC related iatrogenic pseudoaneurysms of right hepatic artery (RHA) account for around 60% of cases, of common hepatic artery for around 30%, of cystic artery for around 10%.^{6,15,21,23} Pseudoaneurysms are often close to surgical clips and may reach 7 cm in size;^{12,14,15,22,31} bile duct leaks may be associated, but clear visualization of presence of an arterobiliary fistula by imaging radiologic techniques is seldom obtained. In more than 80% of cases, transarteriographic embolization (TAE) is the first and definite treatment; in some cases re-embolization is necessary,^{2,4,10,18} while open or laparoscopic surgery ought to be chosen only in case of unsuccessful coil embolization or when embolization is impossible to accomplish.^{7,12,25} The pathogenesis of this uncommon but sometimes fatal complication^{9,11} still remains unclear. Mechanical or thermal injuries have been considered responsible, but at the moment

precise suggestions to prevent hemobilia after LC are still lacking. We report the clinical history of a 55-year-old woman who presented severe hemobilia with anemia three weeks following a LC with uneventful immediate postoperative course.

CASE PRESENTATION

A 55-year-old woman from Eastern Asia who had been living in Europe for many years underwent LC for cholecystitis. Her past medical history included only asthma, no previous laparotomy. She had been suffering from abdominal pain for five months and 20 days before LC. She was admitted to a medical unit for jaundice where abdominal percutaneous ultrasound examination showed the gallbladder was thick walled (9 mm) with an obstructing gallstone impact in the infundibulum without dilation of intra- and extrahepatic bile ducts. The last time she had been to her native country was one year before. Biochemical tests demonstrated that the alanine aminotransferase (AST) level was within the normal range of 3 to 45 U/L, the total bilirubin level was 4 mg/dl (nonconjugated bilirubin 3.3 mg/dl), coagulation tests and platelets were normal. The markers of hepatitis B and C were negative, the white blood cells count was normal (8.000/mm³), the eosinophiles count was normal and

Entamoeba histolytica was absent in stool. Consequently, no infectious disease was found and the cause of jaundice remained unexplained. Endoscopic percutaneous cholangiopancreatography (ERCP) with endoscopic papillotomy had definitely ruled out obstruction of the biliary tree while laboratory tests confirmed the persistence of nonconjugated bilirubin values comprised between 3 and 3.5 mg/dl, insofar as her jaundice was attributed to Gilbert's disease. Besides, she became asymptomatic in a fortnight and was discharged. Elective LC was scheduled, but another 20 days later she complained again of abdominal pain in the upper right quadrant and was admitted to our surgical unit where we decided to perform LC in emergency. Because the walls of gallbladder were thick and cohesive, dissection by monopolar coagulation from liver bed was demanding and took longer time than usual, although no intraoperative complication occurred. After excision of the gallbladder, an intraoperative cholangiography was carried out by laparoscopy confirming the complete patency and normality of the biliary tree, and the absence of stones in bile ducts. The early postoperative course of operation was uneventful and the patient was discharged five days after surgery. The histologic examination was consistent with acute inflammation arisen in the context of lithiasis chronic cholecystitis. Oral feeding continued at home, the patient remained asymptomatic for two weeks until she referred a mild epigastric pain irradiated to the right quadrant, although she did not see a doctor. One week later she experienced sudden hypotension with melena and was admitted to our emergency service. Blood pressure was 100/60 mm Hg, pulse rating was 86 beats/minute, hemoglobin level was 8 gr/dl, hematocrit level 23%, white blood count was 9.700/mmc, alanine aminotransferase (ALT) level was increased to 838 U/L (normal values 3-45), aspartate aminotransferase (AST) level was elevated to 190 U/L (normal values 0-40), alkaline phosphatase level was within the normal ranges of 35 to 129 U/L, coagulation tests and platelets were normal, total bilirubin level was 3.5mg/dl. Digestive endoscopy showed the presence of blood in the upper gastrointestinal tract without evidence of ulcers or other diseases causing bleeding from stomach or duodenum. Abdominal computed tomography (CT) showed a small hematoma of 3 cm in the gallbladder bed with no hemoperitoneum or any other peritoneal fluid collection and iatrogenic pseudoaneurysm of RHA beside titanium clips sized 4 mm without arterial blushing. Resuscitation with transfusional support (3 units of packed red blood cells) allowed the patient to reach hemodynamic stability then she was sent to our surgical ward. Hemoglobin level increased

to 12 gr/dl and hematocrit level to 36%. We excluded surgical primary repair because of the high risks related to possible misinterpretation of anatomy after three weeks of local inflammation. Further intermittent episodes of melena occurred in the following days with hemodynamic stability and minimal decrease of Hb and Ht levels. White blood cells count was 11.000/mmc, alanine aminotransferase (ALT) level lowered to 192 U/L and aspartate aminotransferase to 141 U/L while the total bilirubin level raised to 12 mg/dl with 2.6 mg/dl of nonconjugated bilirubin. Since the patient persisted stability in her hemodynamic parameters without fever or abdominal pain and tenderness, we planned to perform angiography only in case of rebleeding, so much more because CT had not shown any arterial blushing which could make angiography inconclusive. The patient underwent ERCP that demonstrated a biliary leak in the gallbladder bed at the level of biliary branch for the V segment, therefore a nasobiliary drainage (NBD) was placed. Two days later occurred another episode of severe melena with hemodynamic instability, hence transfemoral angiography was performed revealing the presence of pseudoaneurysm sized 2 cm sited on a replaced RHA with extravasation between the V and VIII segmental branches (Figs 1A and B) RHA was an arterial branch arising from the superior mesenteric artery; TAE was achieved by filling the entire artery and pseudoaneurysm with coils of 3 and 4 mm (Fig. 2). The patient had an uneventful clinical course without rebleeding, NBD was removed and she started oral intake. CT scan proved revascularization of the right hepatic arterial branches with no ischemia of right liver lobe. The patient was discharged two weeks later with no impairment of liver function tests and a magnetic resonance cholangiography showed a normal biliary tree.

DISCUSSION

The case, herein presented of LC-related hemobilia, has been the only one we have registered over the last 10 years accounting for 0.001% of patients with acute cholecystitis operated on in emergency (within 72 hours of admission) and including elective surgery accounting for 0.0003% of all the patients undergoing LC over the same span. Hemobilia complicating LC has become a well-known serious event reported in a plenty of issues. The onset of symptoms and signs is within four weeks from LC in 80% of cases,¹⁹ and only in three cases this complication has occurred one year after surgery or even later.^{12,19,21} Upper gastrointestinal bleeding with melena is the commonest sign of hemobilia and observed in 90% of cases whereas abdominal pain is



Figs 1A and B: (A) The angiogram shows the sac of 2 cm pseudoaneurysm, with no radiologic evidence of arterobiliary fistula. (B) A few days before, the CT scan revealed a vascular lesion of 4 mm, successively enlarging to the size reached at the moment of bleeding (smaller arrow). The pseudoaneurysm was located on a replaced right hepatic artery branching off the superior mesenteric artery (greater arrow)

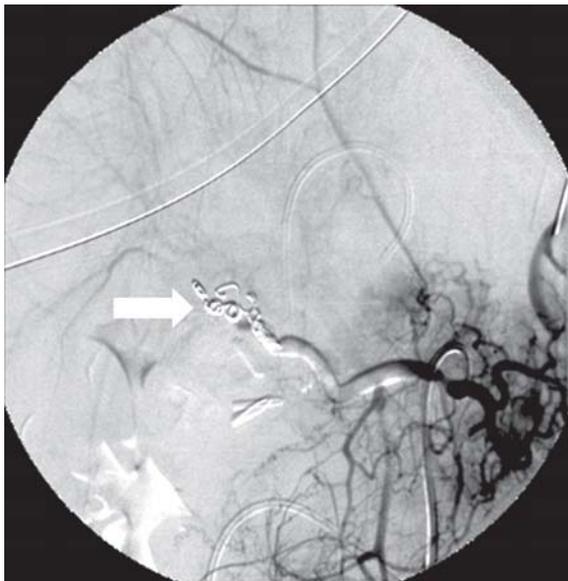


Fig. 2: After embolization, the arteriogram shows 3-4 mm coils obstructing the replaced right hepatic artery with complete disappearance of pseudoaneurysm

present in 70% and jaundice in 60% of patients. The classic Quincke's triad comprehending melena, pain in the right upper quadrant and jaundice is present in 20 to 40% of patients. In the case hereby described, a nonobstructive jaundice was present even before LC, and therefore this sign could not be used for diagnostic suspicion. In around 60% of cases, a pseudoaneurysm of RHA is found. In some cases branching off the superior mesenteric artery,¹² less

frequently false aneurysms of common hepatic artery or cystic artery are found.^{6,15,21} In the present case, small pseudoaneurysm of RHA arising from the superior mesenteric artery was the cause of hemobilia, ERCP could show a biliary leak in the hepatic bed, the existence of an arterobiliary fistula remained unvisualized by the imaging techniques. Allegedly the incidence of vascular injuries during LC ranges between 0.25 and 0.8%^{18,19} whereas the incidence of biliary injuries ranges between 0.2 and 1%.^{18,20} LC related hemobilia due to pseudoaneurysm accounts for 4.5% of biliary lesions that is around 0.0004% of LC procedures,²⁰ nearly the same as in our experience. TAE of hepatic branches is the first line procedure whereas open or laparoscopic surgery should be advocated only in case of unsuccessful coil embolization. TAE may be followed by rebleeding and requires a second embolization or emergency laparotomy.^{2,4,7,10,12} In the case presented, one single coil embolization of RHA could obtain the definite management of hemorrhage. To date, no definite pathogenetic explanation of hemobilia following LC has been given, but titanium clips are often found in the vicinity of pseudoaneurysms and generally monopolar coagulation is adopted by laparoscopic surgeons, hence mechanical and thermal injuries both to biliary and vascular structures have been considered responsible for this complication. If an inadvertent thermal damage occurs, a char of biliary duct may ensue followed weeks later by its detachment. Bile

erosion of a vascular char may also play a role in the pathogenesis of bleeding while fistulization into the biliary tree explains hemobilia. Hemobilia may also occur after elective hepatobiliary surgery and emergency, open or converted cholecystectomy during which clips are never or seldom employed; instead, severe local inflammation may entail difficult dissection and thermal damage must be the real causes of inadvertent vascular injuries in such cases.²⁶⁻³⁰ Pseudoaneurysms of hepatic or cystic artery can be even secondary to acute or chronic cholecystitis,³¹⁻³³ and perhaps in some cases this vascular lesion was present even before LC. The size of pseudoaneurysms increases with the time and may reach the noticeable size of 7 cm as observed when cholecystitis is managed nonoperatively for long time^{22,31} or less frequently, when the vascular lesion complicates LC and becomes symptomatic much time later.¹⁹ In the case presented, the patient had been suffering for months from abdominal pain, the histologic examination showed a thick-walled gallbladder with acute inflammation and chronic cholecystitis but the pseudoaneurysm was tiny (4 mm), hence inadvertent thermal damage must have been the only real cause of vascular complication herein described. The cases reported in the literature often refer to surgical histories of difficult, time consuming LC carrying the risk of inadvertent vascular injuries and pseudoaneurysm thereafter. Suggestions about prevention of such events cannot be found in the specific literature on this complication, but we have enough data to argue that the adoption of bipolar coagulation or better of ultrasonic dissection when dealing with thick-walled gallbladders represents a good piece of advice, especially when dissection digs deep into the liver bed. Under such circumstances, possible thermal damages may be prevented by employing ultrasonic coagulation, since the potential carbonization to surrounding tissues is minimal compared to laser,¹ monopolar and even bipolar coagulation.³⁴⁻³⁷ Hence, the consequences of inadvertent injuries to biliary structures should be minimized by using ultrasonic instrumentation, and hemostasis in the hepatic bed should be achieved by absorbable hemostat products rather than by coagulation. When the cystic artery arises low in Calot's triangle, below the cystic duct, the surgeon can suspect the presence of a replaced or aberrant RHA branching off the superior mesenteric artery, which can be found in 5 to 25% of subjects.

A replaced RHA is an artery supplying the right hepatic lobe whereas an aberrant RHA is an additional branch of RHA.³⁸ If the suspicion of such anatomical variations is present, the surgeon ought to be particularly cautious with

coagulation in that area and ultrasonic dissection should be preferred. Determining if thermal damage is transmitted or not through the clips, is impossible, and it is unlikely either, since dissection in Calot's triangle is commonly carried out before firing clips whereas dissection in the gallbladder bed requires no clip application. Other causes of vascular lesion after LC have been described in a case occurring in a child, the pseudoaneurysm of 8 mm arose in a branch of RHA that had been ligated during LC.¹⁷ Some authors speculate that laparoscopic titanium clips are often found near the pseudoaneurysms and may be partially responsible for arterial or biliary injuries.^{12,14,15,19,22} If surgeons share this opinion, the cystic artery and cystic duct may be interrupted by a clip and ligated by an endoloop then the clips may be gently removed to avoid contacts with surrounding vascular or biliary structures. Obviously, there is no evidence that this strategy is effective in preventing chars of arterial or biliary structures. Adopting these strategies or not is quite upto each surgeon's choice.

CONCLUSION

The occurrence of severe hemobilia following LC is a life-threatening vascular complication that can be managed successfully by TAE. Nevertheless, a means to prevent this unpredictable vascular complication has not yet been indicated. Within the purpose of minimizing lateral thermal damage, the adoption of ultrasonic devices during difficult dissections might be proposed to be evaluated in further studies.

REFERENCES

1. Zilberstein B, Ceconello I, Ramos AC, Sallet JA, Pinheiro EA. Hemobilia as a complication of laparoscopic cholecystectomy. *Surg Laparosc Endosc* 1995;4:301-03.
2. Genyk YS, Keller FS, Halpern NB. Hepatic artery pseudoaneurysm and hemobilia following laser laparoscopic cholecystectomy. *Surg Endosc* 1994;8:201-04.
3. Stewart BT, Abraham RJ, Thomson KR, Collier NA. Post-cholecystectomy hemobilia: Enjoying a renaissance in the laparoscopic era? *Aust NZJ Surg* 1995;65:185-88.
4. Bloch P, Modiano P, Foster D, Bouhot F, Gompel H. Recurrent hemobilia after laparoscopic cholecystectomy. *Surg Laparosc Endosc* 1994;4:375-77.
5. Ibrarullah MD, Singh B, Mehrotra P, Kaushik SP. Right hepatic artery pseudoaneurysm after laparoscopic cholecystectomy. *Am J Gastroenterol* 1997;92:528-29.
6. Lennard TWJ, Plusa SM, Forsythe JLR, Richardson DL. Treatment of right hepatic artery injury by percutaneous embolization. *Lancet* 1994;344:1306-07.
7. Porte RJ, Coherkamp EG, Koumans RKJ. False aneurysm of a hepatic artery branch and a recurrent subfrenic abscess. *Surg Endosc* 1996;10:161-63.

8. Bergey E, Einstein DM, Herts BR. Cystic artery pseudoaneurysm as a complication of laparoscopic cholecystectomy. *Abdom Imaging* 1995;20:75-77.
9. Yelle JD, Faifull Smith R, Rasuli P, Lorimer JW. Hemobilia complicating elective laparoscopic cholecystectomy: A case report. *Can J Surg* 1996;39:240-42.
10. Siablis D, Tepetes K, Vasious K, Karnabaditis D, Perifanos S, Tzorakoleftherakis E. Hepatic artery pseudoaneurysm following laparoscopic cholecystectomy: Transcatheter intraarterial embolization. *Hepatogastroenterology* 1996;43:1343-46.
11. Kapoor R, Agarwal S, Calton R, Pawar G. Hepatic artery pseudoaneurysm and hemobilia following laparoscopic cholecystectomy. *Indian J Gastroenterol* 1997;16:32-33.
12. Ribeiro A, Williams H, May G, Fulmer JT, and Spivey JR. Hemobilia due to hepatic Artery Pseudoaneurysm Thirteen Months After Laparoscopic Cholecystectomy. *J Clin Gastroenterol* 1998;26:50-53.
13. Nicholson T, Travis S, Ettles D, Dyet J, Sedman P, Wedgewood K, Royston C. Hepatic Artery Angiography and Embolization for Hemobilia Following Laparoscopic Cholecystectomy. *Cardiovasc Intervent Radiol* 1999;22:20-24 doi: 10.1007/s002709900323.
14. Tola M, Yurdakul P, Cumhuri, Sahin B, Hilmioglu T. Treatment of laparoscopic cholecystectomy complication of hemobilia by selective arterial embolization. *Turk J Gastroenterol* 2001;12: 308-10.
15. Bulut T, Yamaner S, Bugra D, Akyuz A, Acarli K, Poyanli A. False Aneurysm of the Hepatic Artery after Laparoscopic Cholecystectomy. *Acta chir belg* 2002;102:459-63.
16. Hewes JC, Baroni MI, Kressat J, Bhattacharya S. An unusual presentation of hepatic aneurysm as a complication of laparoscopic cholecystectomy. *Eur J Surg* 2002;168:566-68.
17. Chigot V, Lallier M, Alvarez F, Dubois J. Hepatic artery pseudoaneurysm following laparoscopic cholecystectomy. *Pediatr Radiol* 2003;33:24-26.
18. Roche-Nagle G, Mac Eanane, Harte P. Pseudoaneurysm of the hepatic artery after laparoscopic cholecystectomy: A case report. *J Min Access Surg* 2006;2:73-75.
19. Milburn JA, Hussey JK, Bachoo P, Gunn IG. Right Hepatic Artery Pseudoaneurysm Thirteen Months Following Laparoscopic Cholecystectomy. *EJVES Extra* 2007;13:1-3 doi: 10.1016/j.ejvesextra.2006.09.005.
20. Madanur MA, Battula N, Sethi H, Deshpande R, Heaton N, Rela M. Pseudoaneurysm following laparoscopic cholecystectomy. *Hepatobiliary Pancreat Dis Int* 2007;6:294-98.
21. Heyn J, Sommerey S, Schmid R, Hallfeldt K, Schmidbauer S. Fistula Between Cystic Artery Pseudoaneurysm and Cystic Bile Duct Cause of Acute Anemia One Year After Laparoscopic Cholecystectomy. *J Laparoendosc Adv Surg* 2007;16:609-12. doi: 10.1089/lap.2006.16.609.
22. Srinivasaiah N, Bhojak M, Jackson M, Woodcock S. Vascular emergencies in cholelithiasis and cholecystectomy: Our experience with two cases and literature review. *Hepatobiliary Pancreat Dis Int* 2008;7:217-20.
23. Nakase Y, Takagi T, Fukumoto K, Kassai K, Yamagami T, Itami K, Miyagaki T. Hemobilia and Cystic Artery Stump Pseudoaneurysm Associated with Liver Abscess After a Laparoscopic Cholecystectomy. *Surg Today* 2008;38:567-71.
24. Yao CA, Arnell TD. Hepatic artery pseudoaneurysm following laparoscopic cholecystectomy. *Am J Surg* 2010;199:e10-e11 doi: 10.1016/j.amjsurg.2009.03.014.
25. Burns L, Slakey DP. Laparoscopic Management of Massive Hemobilia From an Intrahepatic Aneurysm. *JLS* 2009;13: 60-63.
26. Peng Z, Yan S, Zhou X, Xu Z. Hepatic artery angiography and embolization for hemobilia after hepatobiliary surgery. *Chin Med J* 2001;114:803-06.
27. Masannat YA, Al-Naser S, Al-Tal Y, Al-Koteesh J, Sharaf UI. A rare complication of a common operation : Hepatic artery pseudo aneurysm following cholecystectomy report of a case. *Ir J Med Sci* 2008;177:397-98.
28. Vernadakis S, Christodoulou E, Treckenam J, Saner F, Paul A, Mathe Z. Pseudoaneurysmal Rupture of the Common Hepatic Artery into the Biliodigestive Anastomosis. A Rare Cause of Gastrointestinal Bleeding. *JOP. J Pancreas* 2009;10:441-44.
29. Napolitano V, Cirocchi R, Spizzirri A, Cattorini L, La Mura F, Farinella E, Morelli U, Migliaccio C, Del Monaco P, Trastulli S, Di Patrizi MS, Milani D, and Sciannameo F. A severe case of hemobilia and biliary fistula following an open urgent cholecystectomy. *World J Emerg Surg* 2009;4:37 doi: 10.1186/1749-7922-4-37.
30. Iannelli A, Karimjee BS, Fabien P, Benizri EI, Converset S, Medjoubi SA, Bornet P, Gugenheim J. Hémobilie par pseudoanéurysme de la branche droite de l'artère hépatique après cholécystectomie coelioscopique. *Gastroenterol Clin Biol* 2003;27:341-43.
31. Akatsu T, Tanabe M, Shimizu T, Handa K, Kawachi S, Aiura K, Ueda M, Shimazu M, and Kitajima M. Pseudoaneurysm of the cystic artery secondary to cholecystitis as a cause of hemobilia: Report of a case. *Surg Today* 2007;37:412-17.
32. Saluja SS, Ray S, Gulati MS, Pal S, Sahni P, Chattopadhyay TK. Acute cholecystitis with massive upper gastrointestinal bleed: A case report and review of the literature. *BMC Gastroenterol* 2007;7:12 doi:10.1186/1471-230X-7-12.
33. Lee JK, Kim MY, Suh CH. CT of acute lower GI bleeding in chronic cholecystitis: Concomitant pseudoaneurysm of cystic artery. *Clin Radiol* 2006;61:634-36.
34. Capelluto E, Champault G. Variations de la température intrapéritonéale au cours de la cholécystectomie laparoscopique. *Ann Chir* 2000;125:253-62.
35. Power C, Maguire D, Mc Anena OJ, Calleary J. Use of the ultrasonic dissecting scalpel in laparoscopic cholecystectomy. *Surg Endosc* 2000;14:1070-73.
36. Janssen IMR, Swank DJ, Boostra O, Knipscheer BC, Klinkenbijn JHG, van Goor H. Ultrasonic dissection versus electrocautery in laparoscopic cholecystectomy. *Br J Surg* 2003;90:799-803. doi: 10.1002/bjs.4128.
37. Matthews B, Nalysnyk L, Estok A, Fahrbach K, Banel D, Linz H, Landman J. Ultrasonic and Nonultrasonic Instrumentation. A Systematic Review and Meta-analysis. *Arch Surg* 2008;143: 592-600.
38. Moon T, Wijdicks CA, Williams JM. Right hepatic artery branching off the superior mesenteric artery. *IJAV* 2009;143-45.

Ureteric Injuries during Laparoscopic Gynecological Operations

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Abstract

Objective: To review the literature regarding ureteral injuries that occurred during laparoscopic gynecological operations and determine preventive methods.

Material and methods: We have evaluated all the articles related with ureteral injuries of laparoscopic operations between the years 2000 and 2010, and selected 14 of them.

Results: The rate of injury is 0.093 to 1.1%. Most of the injuries occurred at distal third of ureter due to close proximity to uterine artery. Unfortunately, most of the injuries were diagnosed postoperatively. The most common injury type was thermal injury, and the treatment of choice was often by laparotomy, particularly ureteroneocystostomy. The best way to prevent injury is a through knowledge of pelvic anatomy and principles of electrosurgery together with enough expertise.

Conclusion: Ureteric injury prevention and if occurred, timely diagnosis is prudent to prevent serious morbidities.

Keywords: Ureteral injury, Laparoscopic gynecologic operation, Prevention.

INTRODUCTION

Nowadays, as the laparoscopic gynecological surgeries have become more popular, concerns about safety and complications aroused as well. Although, the complications of gynecological laparoscopic surgeries are supposed to be low occurring in 3-6/1000¹ till date, there has not been any agreement about whether laparoscopy increases the rate of ureteral complications or not.

Overall, the incidence of ureteral injury is estimated to be 0.03 to 2.0% for abdominal hysterectomy, 0.02 to 0.5% for vaginal hysterectomy and 0.2 to 6.0% for laparoscopic hysterectomy.²

Pappala et al³ evaluated 72 ureteral injuries over 21 years and reported that 64% of ureteral injuries were caused by gynecological operations. And the most common operation responsible for this complication was hysterectomy (49%).

The most common injury type was thermal injury in most of the articles where injury types were mentioned.⁴⁻⁹

The other injury types include:^{3,8,10}

- Ligation or kinking by suture
- Stapling devices
- Lacerations
- Complete or partial transections.

Most of the ureteral injuries occurred at distal third portion where it is close to uterine artery and uterosacral ligaments due to close proximity.^{3,4,6}

The other places of injury are pelvic brim and infundibulopelvic ligaments.⁶

Leonard et al after 13 years of experience have suggested that as long as the surgeons are experienced enough at laparoscopic surgeries, the ureteric injury rate may be comparable with open hysterectomies, i.e. 0.2 to 0.4%. They reported in their own studies this rate to be 0.3%. In other words, they concluded that laparoscopic hysterectomy does not increase the risks of ureteral complications.⁴

They drew attention to predisposing risk factors, now that all of the injuries happened to patients with predisposing factors. These were previous abdominal surgery, endometriosis and big myoma in broad ligament, all of which may distort the normal anatomic pathway of ureter rendering it to injury.

The risk of ureteral injuries elevate in the presence of predisposing factors, such as endometriosis, pelvic adhesions or large pelvic masses where the anatomy as well as the course of ureter have distorted. But it is imperative to note that half of the injuries in laparoscopic hysterectomy happen during simple cases.^{4,6}

One of the most important points regarding ureteral injuries is that they are often diagnosed postoperatively. Particularly thermal injuries are more difficult to detect, now that heat-induced necrosis takes time to develop.^{1,3,4}

Riberio et al¹¹ evaluated 278 patients who underwent hysterectomies. They performed perioperative cystoscopy to determine its use in order to detect ureteral injuries intraoperatively.

They conclude that intraoperative cystoscopy allows early recognition and treatment of all obstructive ureteral injuries and may reduce the postoperative rate of complications during advanced laparoscopic procedures.

But Elvis et al⁷ state that although screening with cystoscopy confirms bladder integrity and can exclude ureteric occlusive lesions, one of the main drawbacks is that it may miss ischemic injury or tear at ureter. That is why, they suggest this procedure for complicated cases only, not routinely.

Leonard et al also recommended cystoscopy after injection of indigo carmine to check for bladder and ureter integrity for difficult cases. They consider the value of this procedure to be much higher at surgeries in which suture rather than bipolar coagulation is used for uterine artery hemostasis. The major drawback of cystoscopy is that it may not detect some other injuries especially the ones caused by electrosurgical instruments.^{1,4,6}

If diagnosed intraoperatively, these injuries should immediately be repaired with experienced surgeon accompany. Minor injuries, such as small hole caused by a sharp instrument or just a blanched area of thermal damage may be treated conservatively with stenting and continuous bladder drainage only while major cases should be managed according to extent, type and location of injuries.^{1,3}

The mode of injury for most of the repairs was surgery with laparotomy.^{3,4,6,8,9,11-13} In only two articles, the operations were done by laparoscopic route and were uneventful.^{10,13} Historically, these repairs have been performed by laparotomy like resection, reanastomosis, and reimplantation to urinary bladder. But nowadays, these procedures have begun to be done by laparoscopic approach and yield good results.¹ Ricco et al¹⁰ reported four patients with ureter injury who were treated laparoscopically and all of them had good outcomes. Then they stated that laparoscopic management of ureteral injuries should be the first method of choice and reported that removal of a suture or stricture, stent insertion, suturing for laceration, reanastomosis over a stent, and even reimplantation have become feasible with laparoscopic approach.

Now that most of the lesions are recognized postoperatively, the surgeon should have high degree of suspicion whenever the patient has signs and symptoms of

abdominal and flank pain, abdominal tenderness, abdominal distension, fever, watery discharge from vagina, nausea and vomiting, and request blood tests and radiological investigations in the form of intravenous pyelogram or contrast-enhanced computed tomography.^{1,4,6,8}

Pappala et al³ evaluated 72 ureteric injuries during 21 years of time period and stated that the predominating factor determining the prognosis regarding ureteric injuries was the time of diagnosis. Whenever surgeon suspects any injury during operation, he or she should explore the ureter immediately.

PREVENTIVE MEASURES^{4,6-8}

- Appropriate patient selection preoperatively, determining risk factors if possible.
- Knowledge of pelvic anatomy, especially the entire course of ureter.
- Knowledge of electrosurgical principles and using them appropriately (depth, penetration, spread).
- Adequate visualization.
- Ureteral identification at all times during surgery.
- For high-risk patients, adhesiolysis, ureterolysis and retroperitoneal approach.
- For difficult and suspicious cases, perioperative cystoscopy with intravenous injection of indigo carmine dye to look for spillage from ureteral orifice, ensure bladder integrity and rule out ureteral obstruction.
- Bipolar coagulation of uterine arteries should be performed only at the level of ascending branch to remain as far from ureter as possible.
- Surgeon's experience is an important factor that determine the complication rate.
- Collaboration with urological surgeon.
- Leonard et al have not been in favor of ureteral stent placement because they thought that this procedure may cause some complications. They suggested that every surgeon should have the ability to gain access to retroperitoneal space and perform ureterolysis in difficult cases. If bleeding occurs during this process, hemostasis should be performed by endoscopic clips rather than bipolar coagulation to avoid thermal injuries.
- Monash et al¹⁴ evaluated complications of laparoscopic injuries, and as a preventive measure, suggested uterine morcellation for large fibroid before taken out from vagina, not to tear the walls. This avoids potential excessive bleeding and its complications like ureter injury due to suturing for hemostasis adjacent to the ureter.

CONCLUSION

Although laparoscopic pelvic surgery gained a lot of acceptance and popularity; actually it is still a relatively new way of approach. The most important factor related with its success is experience. Whether laparoscopic approach increases ureteric complications or not, is not very clear. The most important point we want to emphasize is prevention. A good knowledge of pelvic anatomy, the entire course of ureter during operation, and basic principles of electrosurgery are mandatory. Now that recognition mostly is possible some time after operation, we should be very cautious when the consequences of these injuries are concerned, such as impairment of renal function and even loss of entire kidney. Finally, we want to draw attention to the mode of injury repair. Many of the articles favor laparoscopic route as the mode of treatment and we think that this approach will gain popularity in a short time period.

REFERENCES

1. Makai G, Isaacson K. Complications of gynecologic laparoscopy. *Clin Obstet Gynecol* Sep 2009;52(3):401-11.
2. Tanaka Y, Asada H, Kuji N, Yoshimura Y. Ureteral catheter placement for prevention of ureteral injury during laparoscopic hysterectomy. *J Obstet Gynaecol Res.* Feb 2008;34(1):67-72.
3. Parpala Sparman T, Paananen I, Santala M, Ohtonen P, Hellström P. Increasing numbers of ureteric injuries after the introduction of laparoscopic surgery. *Scand J Urol Nephrol.* 2008;42(5):422-27.
4. Leonard F, Fotso A, Borghese B, Chopin N, Foulot H, Chapron C. Ureteral complications from laparoscopic hysterectomy indicated for benign uterine pathologies: A 13-year experience in a continuous series of 1300 patients. *Hum Reprod* Jul 2007;22(7):2006-11.
5. Lim MC, Lee BY, Lee DO, Joung JY, Kang S, Seo SS, Chung J, Park SY. Lower urinary tract injuries diagnosed after hysterectomy: Seven-year experience at a cancer hospital. *L Obstet Gynaecol Res.* Apr 2010;36 (2):318-25.
6. Siow A, Nikam YA, Ng C, Su MC. Urological complications of laparoscopic hysterectomy: A four-year review at KK Women's and Children's Hospital, Singapore. *Singapore Med J.* Mar 2007;48(3):217-21.
7. Elvis I. Seman, Robert T. O'Shear, Simon Gordon and John Miller. Routine cystoscopy after laparoscopically assisted hysterectomy: What's the point?
8. Michael S. Urinary Tract Injuries Secondary to Gynecologic Laparoscopic Surgery: Analysis of 75 Cases. *Baggish. Journal of Gynecologic Surgery* 2010;26(2).
9. Uccella S, Laterza R, Ciravolo G, Volpi E, Franchi M, Zefiro F, Donadello N, Ghezzi F. A comparison of urinary complications following total laparoscopic radical hysterectomy and laparoscopic pelvic lymphadenectomy to open surgery. *Gynecol Oncol.* Oct 2007;107 (1 Suppl 1):S147-49.
10. De Cicco C, Schonman R, Craessaerts M, Van Cleynenbreugel B, Ussia A, Koninckx PR. Laparoscopic management of ureteral lesions in gynecology. *Fertil Steril* Oct 2009;92(4): 1424-27.
11. The value of intraoperative cystoscopy at the time of laparoscopic hysterectomy. Sergio Riberio, Harry Reich, Jay Rosenberg, Enrica Guglielminetti, and Andrea Vidali. *Human Reprod* July 1999;14(7):1727-29.
12. Gao JS, Leng JH, Liu ZF, Shen K, Lang JH. Ureteral injury during gynecologic laparoscopic surgeries: Report of twelve cases. *Chin Med Sci J* Mar 2007;22(1):13-16.
13. Choi KM, Choi JS, Lee KW, Park SH, Park MI. Laparoscopic Ureteroureteral Anastomosis for Distal Ureteral Injuries during Gynecologic Laparoscopic Surgery. *J Minim Invasive Gynecol.* Jul 2010;17(4):468-72.
14. Tan JJ, Tsaltas J, Hengrasme P, Lawrence A, Najjar H. Evolution of the complications of laparoscopic hysterectomy after a decade: A follow-up of the Monash experience. *Aust NZJ Obstet Gynaecol* Apr 2009;49(2):198-201.

The Role of Laparoscopy in the Management of Gynecologic Surgical Emergencies: A Review of Literature

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Abstract

Minimal access surgery is increasingly becoming the preferred approach to surgical treatment. Experience in the last 15 to 20 years has established the efficacy and indeed safety of laparoscopic surgery in general surgical and gynecologic practice.

Laparoscopic treatment in acute gynecologic emergencies raises questions of safety and feasibility when compared to open laparotomy.

The objective of this study was to review the literature on the use of laparoscopy in the treatment of gynecologic emergencies so as to determine its role in current and future practice.

The findings of this study indicate that laparoscopic surgery for gynecologic emergencies is feasible and safe. Further studies are needed to establish the safety of laparoscopic surgery for nonobstetric emergencies in late pregnancy.

Keywords: Laparoscopy in gynecological emergency, Abdominal injury, Abdominal trauma.

INTRODUCTION

Traditionally, the use of laparoscopy in gynecology had been restricted to the diagnosis of chronic pelvic pain, infertility and sterilization procedures. Later, its use in the diagnosis and treatment of ectopic pregnancy became firmly established. More recently, in the last 15 years or so, with the infectious popularity of minimal access surgery, laparoscopy is becoming the preferred method of surgery for an even wider range of gynecologic conditions, from tubal reconstructive surgery to radical hysterectomy for cervical cancer. There is almost no gynecologic surgery that has not been attempted laparoscopically. The main advantages of laparoscopic surgery are smaller, cosmetically acceptable wounds, less pain, less morbidity, and shorter hospitalization.

Laparoscopy is increasingly being used in the diagnosis and treatment of gynecologic surgical emergencies, including those involving trauma and critically ill patients when diagnosis is not obvious.

Minimal access in managing an acute abdomen, invariably raises questions about its feasibility, safety and efficacy. These must be judged against standard open surgery.

The challenges posed by minimal access surgery in acute surgical emergencies include the hemodynamic status of the patient, potential for complications related to abdominal entry techniques and anesthetic considerations in these situations. Severe abdominal distension and the

presence of previous multiple abdominal surgical scars make the laparoscopic approach extremely risky while hemodynamic instability may present enormous challenges for anesthesia.

This paper aims at reviewing the current status of laparoscopic surgery in the management of gynecologic surgical emergencies, its efficacy, indications, challenges involved, and future trends in its use.

OBJECTIVES

The objectives of this study were to review the medical literature on the use of laparoscopic surgery for the treatment of gynecologic surgical emergencies.

Specifically, this paper will review work that has been done on the feasibility, efficacy and complications of the laparoscopic approach, so as to define its role in the current management of gynecologic emergencies.

METHODS

Review of the literature using the springerLink and PubMed searches.

FINDINGS/RESULTS

There are many reported studies and case reports looking at the management of a wide range of acute gynecological surgical emergencies in laparoscopic approach. While case

reports have highlighted ground-breaking surgeries, the larger studies have looked at many areas related to applicability of laparoscopic approach in the general gynecologic practice. These areas include feasibility of the laparoscopic surgery in these clinical settings, its accuracy and efficacy, and the complications and challenges involved.

FEASIBILITY OF EMERGENCY LAPAROSCOPY

Several studies have demonstrated the feasibility and safety of laparoscopic surgery for the acute abdomen in the setting of general surgical practice¹⁻³ as well as in gynecology.⁴⁻⁷

In an extensive evidence-based review of the literature on the role of laparoscopy for acute surgical abdominal conditions, Dimitrios Stefanidi and his colleagues concluded that laparoscopy could be performed safely in the majority of cases and that it was associated with a low morbidity and mortality.⁸

Majority of these studies agree that patients for laparoscopic management need to be hemodynamically stable. However, there are recent case reports of patients presenting with life-threatening massive hemoperitoneum, where laparoscopy was life saving.^{12,13}

INDICATIONS FOR EMERGENCY LAPAROSCOPY

The commonest indication for the laparoscopic approach has been acute nonspecific lower abdominal pain where laparoscopy is undertaken in favor of clinical observation. This reflects the established role of diagnostic laparoscopy in providing accurate diagnosis, and hence expediting definitive treatment.^{2,8}

Equally there are other studies in which laparoscopy has been undertaken as the primary route of surgical management for clinically established surgical emergency. These include adnexal torsion, tubo-ovarian abscess, peritonitis and ectopic pregnancy.^{4,9,10}

There are studies suggesting that subsequent fertility is significantly higher in laparoscopically treated women presenting with gynecologic emergencies, making need for future fertility an emerging indication for laparoscopic treatment.^{9,11}

The use of laparoscopy in management of nonobstetric complications in pregnancy is another recent addition to the increasing use of minimal access surgery. Laparoscopy has been done as late as third trimester of pregnancy.^{12,13,19,20} These early indications do not suggest untoward effects to the mother or baby.

EFFICACY AND ACCURACY

Most studies agree that laparoscopy has a very high diagnostic accuracy, even when compared to open laparotomy. Laparoscopy also provides a better view of the abdominal cavity and when used in the nonspecific acute abdomen, it reduces delay to treatment and morbidity.

Studies looking at laparoscopic treatment of general surgical acute abdomen including gynecologic conditions reports diagnostic accuracy ranging from 88 to 99%.^{1,3,8}

Majority of underlying causes of the acute abdomen in gynecologic and general surgery are amenable to laparoscopic treatment. Conversion rates to open laparotomy in most studies ranged from as low as 4 to 33%.^{1-3,14}

The main predictor for conversion appear to be surgeons' inexperience, obesity, and a large free peritoneal fluid on ultrasound scanning.¹⁰

In younger women, wishing fertility conservation, laparoscopy was shown to be superior to open laparotomy in ovarian conservation, especially in the treatment of ovarian torsion.¹⁰

MORBIDITY AND COMPLICATIONS

Treatment using the laparoscopic approach appears to be associated with reduced morbidity, early recovery and a shorter hospitalization.^{1,3,5,15} Interestingly, conversion to open laparotomy does not appear to increase morbidity.

Complications reported are mainly related to access of technique and devices. Those reported include visceral and vascular injuries, and those related to the incision area like acute herniation.^{8,16,17}

Other infrequent complications include prolonged ileus, intra-abdominal abscess, pneumonia and pulmonary embolism.

One case is reported of aortic puncture with a portclosure device following laparoscopically assisted vaginal hysterectomy.¹⁸

DISCUSSION

Minimal access surgery has evolved enormously in the last 20 years and is now frequently being used in the treatment of gynecologic emergencies, diagnostic and therapeutic procedures. Studies reviewed here demonstrate that laparoscopic surgery for almost all gynecological surgical emergencies is not only feasible but safe and effective. Its widespread use is still being restricted by the necessity of special expertise in minimal access surgery, issues related to its cost-effectiveness and the necessary infrastructural

facility adjustments to the apparent high-tech equipments and operating room setup.

Expertise requires training, and one study has demonstrated that it is feasible to integrate well-structured laparoscopic surgery training into a residency program.²¹

Unfortunately, the apparent benefits of laparoscopic surgery, in terms of reduced morbidity and quicker recovery, have not been associated with lower cost. The two studies cited here show that there are added costs to treatment compared to open surgery.^{2,8} This must be related to the cost of equipment, supplies and professional fees associated with the treatment.

Technically, the major advantages of laparoscopic surgery are that it provides adequate visualization of the entire abdominal cavity and localization of pathology, and allows more precise irrigation of peritoneal cavity under pressure. It also averts delays in instituting appropriate surgical management and avoids extensive preoperative studies. These, with reduced morbidity, smaller, cosmetically acceptable wounds and early recovery will continue to be a major driving force to its widespread use and demand.

The laparoscopic approach appears to be the most appropriate for women in childbearing age because of their high frequency of negative appendicitis and improved fertility preservation.^{9,15}

Complications associated with minimal access surgery need specific strategies, which should include training of surgeons, modification of techniques and newer entry devices in the setting of the acute abdomen.¹⁶ The use of target incision is helpful in difficult cases and when necessary, surgeons should not resist converting to open surgery.

An emerging role for laparoscopic surgery is in the management of life threatening acute abdominal conditions with inconclusive preoperative studies. In the two case reports cited here, laparoscopic treatment was successful even though both patients were hemodynamically unstable.^{12,13}

Equally impressive is the use of laparoscopy for gynecologic emergencies during pregnancy. This is an area that needs further studies.

CONCLUSION

In conclusion, there is undeniable evidence that laparoscopic surgery for the management of gynecological emergencies is a feasible, safe and effective challenging alternative to open surgery. Its added value in reduced morbidity, shorter hospital stay and cosmesis has helped to establish its place in contemporary and future gynecologic practice.

The use of laparoscopy in pregnancy needs further studies to establish safety for both the baby and pregnant woman.

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REFERENCES

1. Kirshtein B, A Roy Shapira, A Lantsberg, Mandel S, Avinoach E, Mizrahi S. The use of laparoscopy in abdominal emergencies. *Surg Endosc* July 2003;17(7).
2. Chung RS, Diaz JJ, Chari V. Efficacy of routine laparoscopy for the acute abdomen. *Surg Endosc* March 1999;12(3).
3. Majewski W. Diagnostic Laparoscopy for the acute abdomen. *Surg Endosc* Oct. 2000;14(10).
4. Gaitan H, Angel E, Sanchez J, Gomez I, Sanchez L, Aqudolo C. Laparoscopic diagnosis of acute lower abdominal pain in women of reproductive age. *Int J Obstet Gynecol* Feb. 2002;76(2).
5. Promecene PD. Laparoscopy in gynecologic emergencies. *Semin Laprosc Surg* March 2002;9(1):64-75.
6. Agresta F, Mazzarolo G, Gardo L F, Bedin N. The laparoscopic approach in abdominal emergencies, has the attitude changed: A single centre review of a 15-year experience. *Surg Endosc* May 2006;22(5):1255-62.
7. Ou CS, Rowbotham R. Laparoscopic diagnosis and treatment of acute abdominal pain in women. *J Laparoendosc Adv Surg Tech A* Feb 2000;10(1):41-45.
8. Dimitrios Stefanidis, William S Richardson, Lily Chang, David B Earle, Robert D. Faneli. The Role of Diagnostic Laparoscopy for Acute abdominal conditions. *Surg Endosc* 2009;23:16-23.
9. Atef M. Darwish, Mahmoud Zhakera, A Alaa. Youssef. Fertility after Laparoscopic management of gynecologic emergencies: The experiences of a developing country. *Gynecol Surg* June 2007;4(2).
10. Peter Takacs, Greg Latchaw, Lucia Gaitan, Nahida Chakhtoura, Timothy De Santis. Risk Factors for conversion to Laparotomy during laparoscopic management of an ectopic pregnancy. *Archives of Gynecology and Obstetrics* Nov 2005;273(1).
11. Parul J Shukla, Ravi Maharaj, Abe Fingerhut. Ergonomics and Technical Aspects of Minimal Access Surgery in Acute Surgery. *European Journal of Trauma and Emergency Surgery* Feb 2010;36(1).
12. Pezzuto A, Pomini P, Steinkasserer M, Nardeilli GB, Minlli L. Successful Laparoscopic management of spontaneous hemoperitoneum at 15 weeks pregnancy: Case report and review of literature. *J Minim Invasive Gynecol* Nov-Dec 2009; 16(6):792-94.
13. Takeda A, Sakai K, Mitsui T, Nakamura H. Management of ruptured corpus luteum cyst of pregnancy occurring in a 15 years old girl by laparoscopic surgery with autologous blood transfusion. *J Pediatr Adolesc Gynecol* April 2007;20(2):97-100.

14. Aulestia SN, Cantele H, Leyba JL, Navarrete M, Liapia SN. Laparoscopic Diagnosis and treatment in gynecological emergencies. *JSL* July-Sept 2003;7(3):239-42.
15. Lim Lo, Chang SD, Homg SG. Laparoscopy versus laparotomy for surgical intervention for ovarian torsion. *J Obstet Gynecol Res* Dec 2008;34(6):1020-25.
16. Munro MG. Laparoscopic Access: Complications, Technologies and Technique *Curr Opin Obstet Gynecol* Aug 2002;14(4): 365-74.
17. Gayer G, Apter S, Garniek A, Portnoy O, E Schiff. Complications after Laparoscopic gynecologic. *Procedures Abdominal Imaging* March 2000;25(4).
18. Lee G, Nguyen A, Kivnick S, Marshall JP. Aortic Puncture with a laparoscopic port closure device. *Obstet Gynecol* Aug. 2007;110(2pt2):533-35.
19. Gurbuz AT, Peetz ME. The acute abdomen in the pregnant abdomen: Is there a role for laparoscopy? *Surg Endosc* Feb 1997;11(2):98-102.
20. Upadhyay A, Stanten S, Horoupian R, Kazantsev G. Laparoscopic management of a non-obstetric emergency in the third trimester of pregnancy. *Surg Endosc* Aug 2007;21(8):1344-48.
21. Minig L, Velasco A, Lamm M, et al. Evaluation of laparoscopic management of gynecologic emergencies by residents. In press, *Int J Obstet Gynecol*, On line publication 28.06.2010.

Reproductive Performance in Hysteroscopic Metroplasty

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Abstract

Background: This study was to ascertain reproductive better outcome in hysteroscopic metroplasty, the literature to support that removal of septum improves pregnancy rates in women with bad obstetric history. However, its role in patients with otherwise unexplained infertility is still not clear due to paucity of enough evidence.

Objective: To assess reproductive performance in women with septate uterus and otherwise unexplained infertility after hysteroscopic metroplasty.

Materials and methods: Eight women with septate uterus and otherwise unexplained primary infertility were included in the study. All these women underwent hysteroscopic septal resection. Reproductive performance of these women within one year of surgery was studied and analyzed.

Result: Forty women (45.83%) conceived within one year of surgery. Only six women (12%) had spontaneous abortions and only five (15%) had preterm delivery.

Conclusion: Hysteroscopic metroplasty in women with septate uterus significantly improves the reproductive performance. Septate uterus is not a primary factor of infertility. Hysteroscopic metroplasty restores normal uterine cavity with a good uterine vascularization to have better reproductive outcome.

Keywords: Hysteroscopy, Metroplasty, Open metroplasty, Septate uterus, Bicornuate uterus.

INTRODUCTION

Congenital anomalies of the reproductive tract are common, which alters the outcome and are seen in approximately 3 to 5% of the general population and approximately 3% of infertile women.¹ These are usually asymptomatic,² but are sometimes associated with recurrent pregnancy loss or infertility.^{3,4} Among these anomalies, septate uterus (class V, American Fertility classification, based on the study by Buttram and Gibbons)^{5,6} is the most common anomaly to be associated with obstetric complications and infertility. Müllerian anomalies account for 15 to 25% of spontaneous abortions.⁷ Resection of the septum helps to improve pregnancy outcome in these women. A recent study performed by Paces et al demonstrated an improvement in uterine perfusion following hysteroscopic metroplasty based on uterine artery velocimetry indices.

In the era before the advent of hysteroscopy the correction of such defects required laparotomy, which involved long tedious surgeries. However, now with the development of new techniques, hysteroscopic resection of the septum has become the primary modality of treatment with advantages of shorter operative time, short hospital stay, and decreased incidence of complications. There is enough evidence in the literature to support the fact that

removal of septum improves pregnancy rates in women with bad obstetric history.^{8,9} However, its role in patients with otherwise unexplained infertility is still not clear due to the paucity of enough evidence. A few retrospective small studies have reported increased pregnancy rates in women after septal resection. Hysteroscopic metroplasty may be performed using versapoint bipolar needle device; a resectoscopic knife electrode with cutting current as well as Nd:Yag laser. Yang et al (2006) revealed use of laser in hysteroscopic septal resection with main advantage of a less cervical dilation, reducing chances of uterine perforation. Reduced risk of bleeding so increases effectivity of procedure.

This prospective observational study was designed to assess the reproductive performance after hysteroscopic metroplasty in patients with septate uterus and primary infertility.¹⁰⁻¹²

EMBRYOLOGY

Uterus is formed from two müllerian ducts. The caudal two thirds of these ducts form the uterus whereas upper third gives rise to fallopian tubes. Failure or arrest of development during any of the three stages will lead to uterine malformation.

AT 14-18 WEEKS

Normally, resorption of medial septum initially separates the caudal parts of the müllerian ducts to form uterovaginal channel.

Failure of resorption of the midline septum leads to septate uterus. Normally septate uterus is never combined with other anomaly of genitourinary tract.

Septate uterus can be complete septate, partial septate, or simple fundic spurs.

Patient Selection

Study patients were recruited from the population of infertile women aged between 18 and 35 years, who attended our infertility clinic. Women over 35 years of age were excluded from the study to eliminate any age related factors impairing conception. All women underwent a detailed work-up to exclude any known cause of infertility. In addition to a detailed history and thorough clinical examination, work-up for sexually transmitted diseases (STD), hormonal profile, assessment of ovulation, and semen analysis was performed. Any woman with any abnormality in these tests was excluded from the study. The preliminary diagnosis of septate uterus was made on a hysterosalpingogram (HSG), after which hysteroscopy was planned for these women. All women were counseled thoroughly and a written informed consent was taken before surgery. The surgery was performed under general anesthesia. The women with pelvic lesions seen on laparoscopy were excluded from the study. This was followed by the hysteroscopic resection of the septum. Figure 1 shows the original findings at hysteroscopy.

Surgery

In the initial years of the study, metroplasty was performed with 26 French resectoscope fitted with a cutting knife

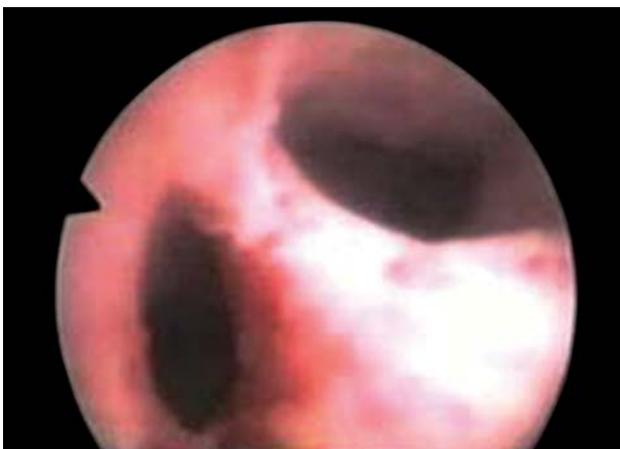


Fig. 1: Original hysteroscopy

electrode with 0 degree endoscope. Subsequently, with the introduction of Versapoint, metroplasty was performed using bipolar Versapoint with saline as the distension media. Cutting current was 60-90W. Uterine cavity was distended with fluid and a record of inflow and outflow fluid was kept. Figure 2 shows the septum being cut using Versapoint. The septum was divided in an upward direction till both tubal ostia were visualized. Figure 3 shows the uterine cavity after septal resection. Hemostasis was ensured at the end of the procedure and any bleeding points were electrodesiccated.

SEPTATE UTERUS

Postoperative Follow-up

The patients were put on cyclic hormonal therapy (estradiol valerate and medroxyprogesterone acetate). A second-look hysteroscopy was scheduled after two months to assess the surgical outcome.

RESULTS

One hundred and eighteen women were detected to have septate uterus on HSG. These 118 women were initially enrolled for the study. Of these, 38 women were diagnosed with pelvic pathology at laparoscopy and were excluded from the study. The remaining 80 with septate uterus (Fig. 1) and other unexplained infertility were included in the study. On hysteroscopy, 28 women were diagnosed with complete septa (type Va) and the remaining 44 had incomplete septa (type Vb).

All 80 women underwent second-look hysteroscopy after two to three months of primary surgery (Fig. 2). A hysteroscopic examination revealed an entirely normal cavity in 15 (21%) women (Fig. 3). Another 40 women (55%) had a small fundal notch (less than one centimeter). A repeat procedure was carried out in 17 (24%) women wherein the hysteroscopy revealed a septal remnant more than one centimeter.

These women were then subsequently followed up for a period of 12 months and counseled to have unprotected sexual intercourse for this period. Eight women were lost to follow-up. Of the remaining 64 women, 33 women conceived naturally within 12 months of metroplasty. There was only one twin pregnancy, the rest were all singletons.

Four women had spontaneous first trimester abortions. Ultrasonographic examination between 14 and 18 weeks of gestation revealed cervical shortening and funneling in seven women. McDonald's cervical encircage was performed for



Fig. 2: Metroplasty with versa

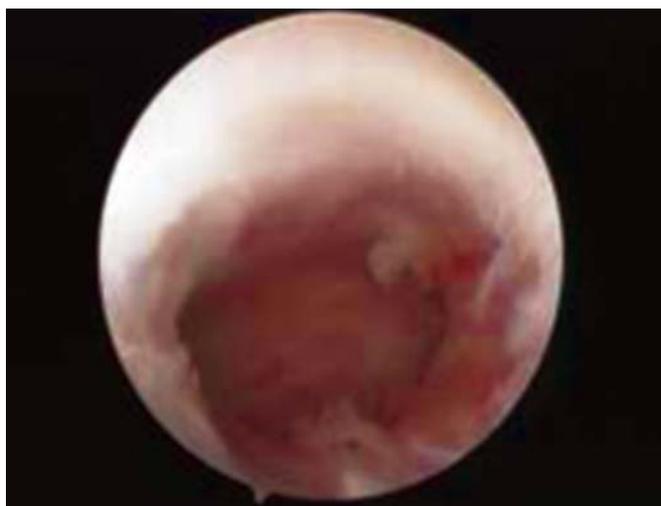


Fig. 3: UT cavity after metroplasty

these women with cervical incompetence. Five women delivered preterm. Of these, two women had undergone cervical encirclage and the other three were without encirclage. The reproductive performance after metroplasty in these women is summarized.

DISCUSSION

Septate uterus is the most common uterine anomaly to be associated with poor reproductive performance. The exact mechanism by which this anomaly causes recurrent abortions or infertility is not clearly established. Also controversial is the matter whether a septate uterus actually causes infertility or not.

Diminished size of the uterine cavity and cervical incompetence, associated with septate uterus, may be the factors involved in causing a poor reproductive

outcome.^{13,14} Ultrastructural alterations in the septal wall compared to the lateral uterine wall could be the cause of infertility in women with septate uterus. Fedele et al reported that the septal wall consists of fibroelastic tissue with alterations in the endometrial-myometrial blood vessels, which cause a negative impact on placental development.¹⁵

Metroplasty is an accepted method of treatment in women with recurrent abortions and septate uterus, and it significantly improves the subsequent reproductive outcome. Homer et al in a review on septate uterus, combined data from several published series and reported that the incidence of spontaneous abortion and preterm delivery rate decreases significantly after metroplasty whereas the incidence of term delivery rate increases.¹⁶

However, as far as infertility is concerned, there is still a huge difference of outlook as to whether infertility is an appropriate indication for metroplasty or not. Some investigators recommend surgery while some others do not.^{17,18} There is scarcity of randomized data. In a study conducted by Pabuccu et al¹² 41% spontaneous pregnancy rates were found after metroplasty in women with primary unexplained infertility except septate uterus.¹⁹ Of late, in a prospective controlled trial by Mollo et al¹¹ it was observed that hysteroscopic resection of the septum improved fecundity rates in women with septate uterus and otherwise unexplained infertility.²⁰ These findings were observed once more in the current study. Thirty-three out of 64 (51.5%) women conceived naturally within a year of surgery and the incidence of spontaneous abortions were very low (12%).

Although the current data does not give any definite proof of a causal relationship between septate uterus and infertility, considering the simplicity of the procedure with low associated morbidity and the reported outcomes, the procedure should be undertaken in women with longstanding infertility with septate uterus and otherwise unexplained infertility.

REFERENCES

1. Acien P. Incidence of Müllerian defects in fertile and infertile women. *Hum Reprod* 1997;12:1372-76.
2. Ashton D, Amin HK, Richart RM, Neuwirth RS. The incidence of asymptomatic uterine anomalies in women undergoing transcervical tubal sterilization. *Obstet Gynecol* 1988;72:28-30.
3. Heinonen PK, Saarikoski S, Pystynen P. Reproductive performance of women with uterine anomalies. *Acta Obstet Gynecol Scand* 1982;61:157-60.
4. Acien P. Reproductive performance of women with uterine malformations. *Hum Reprod* 1993;8:122.
5. Buttram VC (Jr), Gibbons WE. Müllerian anomalies: A proposed classification (an analysis of 144 cases). *Fertil Steril* 1979;32:40-48.

6. American Fertility Society. Classification of müllerian anomalies. *Fertil Steril* 1988;49:944-55.
7. Portuonodo JA, Camara MM, Echanojauregui AD, Calonge J. Müllerian abnormalities in fertile women and recurrent aborters. *J Reprod Med* 1986;31:616-19.
8. Grimbizis GF, Camus M, Tarlatzis BC, Bontis JN, Devroey P. Clinical implications of uterine malformations and hysteroscopic treatment results. *Hum Reprod Update* 2001;7:161-74.
9. Acien P, Acien M. Evidence based management of recurrent miscarriage. Surgical management. *Int Congr Series* 2004;1266:335-42.
10. Perino A, Mengacchia L, Hamou J, Cittadini E. Hysteroscopy for metroplasty of uterine septa: Report of 24 cases. *Fertil Steril* 1987;48:321-23.
11. Colacurci N, Placido G, Mollo A, Carravetta C, Franciscis P. Reproductive outcome after hysteroscopic metroplasty. *Eur J Obstet Gynecol Reprod Biol* 1996;66:147-50.
12. Pabuccu R, Atay V, Urman B, Ergun A, Orhon E. Hysteroscopic treatment of septate uterus. *Gynaecol Endosc* 1995;4:213-15.
13. Fedele L, Bianchi S. Hysteroscopic metroplasty for septate uterus. *Obstet Gynecol Clin N Am* 1995;22:473-89.
14. Marcus S, Al-Shawaf T, Brinsden P. The obstetric outcome of in vitro fertilization and embryo transfer in women with congenital uterine malformation. *Am J Obstet Gynecol* 1996;175:85-89.
15. Fedele L, Bianchi S, Marchini M, Franchi D, Tozzi L, Dorta M. Ultrastructural aspects of endometrium in infertile women with septate uterus. *Fertil Steril* 1996;65:750-52.
16. Homer HA, Li TC, Cooke ID. The septate uterus: A review of management and reproductive outcome. *Fertil Steril* 2000;73:1-14.
17. Mencaglia L, Tantini C. Hysteroscopic treatment of septate and arcuate uterus. *Gynaecol Endosc* 1996;5:151-54.
18. Corson SL. Operative hysteroscopy for infertility. *Clin Obstet Gynecol* 1992;35:229-41.
19. Pabuccu R, Gomel V. Reproductive outcome after hysteroscopic metroplasty in women with septate uterus and otherwise unexplained infertility. *Fertil Steril* 2004;81:1675-78.
20. Mollo A, Franciscis P, Colacurci N, Cobellis L, Perino A, Venezia R, et al . Hysteroscopic resection of the septum improves the pregnancy rate of women with unexplained infertility: A prospective controlled trial. *Fertil Steril* 2008 in press.

Inguinodynia after Laparoscopic Inguinal Hernia Repair

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Abstract

Objectives: The objective of this literature review is to see if changing the site of the mesh from outside to inside has any effect on the occurrence of posthernia repair pain. And also to review different author's opinion about causes occurrence and management of post-mesh inguinal pain.

Materials and methods: Literature review conducted using Google search engine, Google books, HighWire press, using keywords like postinguinal hernia pain, complications of hernia surgery, laparoscopic mesh repair.

Results: Chronic pain after surgery has been recently a neglected topic. The extent of the problem first came to light in a survey of patients attending pain clinics in Scotland and the north of England. This survey showed that about 20% of patients attending chronic pain clinics implicated surgery as one of the causes of their chronic pain, and in about half of these; it was the sole cause.¹ Inguinal hernia repair is a common surgical procedure performed worldwide with an annual procedural rate of 2,800 per million people in the United States alone. In England and Wales, 70,322 primary inguinal herniorrhaphies were performed in National Health Service Hospitals between 1998 and 1999. Inguinal herniorrhaphy is often performed as a daycase procedure with minimum postoperative morbidity. After inguinal hernia repair, patients can return to work early and enjoy a good quality of life. Since modern surgical thinking concerning inguinal hernia repair was established by Bassini in 1884, various modifications have been developed to improve outcome. Despite the fact that recent meta-analyses have suggested that laparoscopic surgery is associated with less postoperative pain and more rapid return to normal activity, open mesh repair is still recommended by the National Institute for Clinical Excellence.

Keywords: Inguinodynia, Laparoscopic, Inguinal hernia, Complication of Inguinal hernia.

CAUSES

There are many causes for the persistent, postoperative hernia area pain including, but certainly not limited to:

- Nerve damage (directly at the time of surgery)
- Nerve entrapment in scar tissue, mesh or sutures
- Postoperative benign nerve tumors
- Scar tissue itself or tissue damage
- Misplaced mesh
- Contracted, scarified and hardened mesh plugs
- Infection usually noted early postoperatively
- Recurrent hernia.

Constriction or narrowing of the internal inguinal ring around the spermatic cord.

Periostitis of pubic bone due to the presence of permanent suture material inadvertently placed into this layer resulting in chronic inflammation and pain.

Pain from unrelated causes associated with neither the prior inguinal hernia nor its operative repair (i.e. nonhernia musculoskeletal, intra-abdominal, intrapelvic, neurologic, genitourinary, infectious or vascular origin etc.).

Pain after placement of mesh in the parietal compartment of proportional space presents special problem, the main trunk of genitofemoral nerve, the preperitoneal segment of

its genital branch and its femoral branch located in the parietal compartment without protection from direct contact to the mesh.²

Laparoscopy is no better than open surgery at reducing recurrence or chronic pain according to a meta-analysis by British researchers. With laparoscopy, however, patients do have less postoperative pain and return to work more quickly, and although operating times are longer, patients have fewer superficial wound infections. Operating time was significantly longer for laparoscopy (weighted mean difference: 0.68 min), but return-to-work time was shorter (weighted mean difference: 0.82 days).³

Laparoscopic inguinal hernia repair, which requires the use of mesh, became popular because of a claimed reduction of postoperative pain and early return to normal activity. Liem et al described fewer recurrences and more rapid recovery compared to conventional anterior repair. The EU Hernia Trialists Collaboration included 34 (quasi-) randomized trials in a systematic review. It was confirmed that laparoscopic repair of inguinal hernias results in less recurrences when compared with open non-mesh repair. No difference was found between laparoscopic repair and open mesh repair with regard to recurrences.

Severe chronic pain following hernia repair is usually due to ischemia or neuropathy. Ischemia induced in musculofascial tissues by a repair done under tension is the most common cause of undue postoperative pain. In this situation, the sutures slowly cut through the tissues relieving the pain but setting the stage for recurrence. The other major cause of ischemia-induced pain is tight closure of either the deep or superficial inguinal ring during repair. Most often, ischemia in the ring is partly due to edema following operative dissection, and resorption of edema postoperatively leads to gradual resolution of pain; rarely does testicular atrophy supervene.

Neuropathy is widely recognized as a cause of chronic postoperative pain. It can be induced by nerve trauma during dissection, neuroma formation after partial or complete transection, entrapment by sutures or by postoperative adhesions. The implantation of mesh, which induces scar formation through increased inflammation, also has been suggested as a cause of neuropathic pain.²

DISCUSSION

More than a decade ago, it was true that chronic disabling pain was rare after hernia repair. It is also true that the reported incidence of this problem has been increasing in recent years,³ although the reasons for this change are not entirely settled. It is important to know the true incidence of chronic, disabling pain after hernia repair, so that patients can make an informed choice of whether or not to undergo repair and can receive an acceptable informed consent. Generally, problems with an incidence of less than 1% are thought not to need specific mention in discussing with patients the potential complications of an operation.

The report from the Danish Hernia Data Base group⁴ suggests that in current practice the incidence of chronic pain, a year after groin hernia repair, may be approximately 29%. This number is unexpectedly high, and certainly will gain the attention of all surgeons who repair hernias. It is important to know if the incidence is truly so high, and if so, to learn what causes the pain. If the incidence truly exceeds one percent then pain will need to be specifically mentioned in preoperative discussions with patients.

The Danish report is based on two questionnaires mailed 1 year postoperatively to 1,443 patients having hernia repair during 2 months period in 1998. More than 80% of patients responded to each questionnaire. The first time around, patients were asked whether they had pain or not; 29% said they had pain and 11% indicated that their pain was disabling to some degree. The second questionnaire was sent to those reporting pain asking about specific pain characteristics;

58% of those experiencing pain indicated that their pain impaired specific activities. There was no correlation of postoperative pain with the type of hernia or the method used for repair.

These data need to be interpreted in terms of limitations of the study methodology. Self-reporting, especially of the severity of such a subjective matter as pain, is confounded by variable perceptions of pain between patients, varying definitions of impairment, and similar limitations. In essence, the severity data from this study are not completely reliable. And there was no evaluation by a physician, preferably a blinded one, of the patient's complaints. I am not trying to denigrate the study, for it reports important data and raises important questions. But it does not provide final answers.

This study suggests that something in the currently employed methods of groin hernia repair is associated with an increase in postoperative pain, and it provides a hypothesis for future investigations. These provocative results should stimulate additional effort and prospective clinical trials by the Danish Data Base group and others to elucidate the exact causes in current surgical practices of postoperative groin pain. Could it be that the major change in the technique of hernia repair that has evolved over the most recent two decades—the widespread use of implanted prosthetic mesh, whether needed or not—is a cause?⁵

The overall incidence of chronic pain after herniorrhaphy was 12% (18% in patients having open surgery [range 0-75.5%] and 6% in patients treated laparoscopically [range 1-16%]). The follow-up and method of pain assessment, along with the study design and definition of chronic pain varies to such a degree that these numbers should be interpreted cautiously. No final conclusion should be made regarding the exact incidence of chronic groin pain in relation to the type of surgery.

Single center trials of less than 300 patients generally reported lower rates of chronic pain compared with larger studies except for one study. None of the studies that used an objective pain measurement, for instance a VAS for pain assessment, found an incidence below 5%. A study of 400 patients found an incidence of moderate or severe pain of 2% after laparoscopy compared with 10% after open surgery, but the follow-up rate was only 61%. A comparative study between total extraperitoneal (TEP) and open mesh herniorrhaphy using a retrospective questionnaire in 560 patients showed that after a mean follow-up period of 21 months, 22.5% of laparoscopic patients had pain/discomfort compared with 38.3% of those treated by open mesh repair.⁶

There are reports about mesh repair of inguinal hernia and its effect on testicular vasculature, and hence effect on testicular size and on sexual function as fibrotic healing causes hardening and shrinking of the mesh that is in direct contact with spermatic cord. A report describes a beneficial effect on sexual function that improved postoperatively while another describes postoperative chronic inguinal pain with subsequent sexual dysfunction. Inguinal hernioplasty with mesh repair is associated with improvement in both quality of life and sexual function. Improvement of sexual function is attributed to improvement of quality of life. Also, inguinal hernia may be associated with increased vascular resistance that is reversed after surgery with increase of testicular perfusion.⁷

Various systems exist for prosthesis fixation in hernia repair. These techniques vary in terms of postoperative complications and pain. This study compares prosthesis fixation techniques employed in laparoscopic transabdominal preperitoneal (TAPP) hernioplasty using a visual analog scale (VAS) to quantify postoperative pain. We found differences in postoperative pain among different laparoscopic TAPP prosthesis fixation methods. The use of the biocompatible fibrin sealant 'Tissucol' seems to significantly reduce postoperative pain, complications, and resumption to work times compared with other systems.⁸

Recent literature on laparoscopic inguinal hernia repair (LIHR) has shown that laparoscopic hernioplasty is associated with reduced postoperative pain and wound infection, and an earlier return to normal daily activities.⁹ Inguinal hernia repair can result in significant complications. Among these is postherniorrhaphy neuralgia, a potentially disabling condition. It is important to determine whether the patient had groin pain prior to hernia repair and whether the preoperative pain was the same in character as the postoperative pain. In addition, it is appropriate to determine how long after hernia repair the patient's inguinodynia began and whether the patient can differentiate postoperative surgical pain from the pain of inguinodynia or not. Patients should be informed of the remote possibility of central and differentiated pain.

In order not to raise a red flag, we avoid such terms as "nerve entrapment" for compression of the nerve(s) caused by "perineural fibrosis," a naturally occurring condition after inguinal hernia repair. Similarly, it is important not to use the term "mesh inguinodynia," which implies chronic pain caused by the mesh itself. In a published series of 234 patients with postherniorrhaphy neuralgia in which the term "mesh inguinodynia" was used, seven i.e. only one-third of the patients had previous mesh repair; the remainder had

undergone repair with no mesh. This confusion in terms suggested that the term "mesh inguinodynia" was not supported by the data presented.

The recommended surgical treatment for chronic neuropathic pain after herniorrhaphy has been a two-stage operation that includes ilioinguinal and iliohypogastric neurectomies through an inguinal approach and genital nerve neurectomy through a flank approach. Equally effective is a one-stage procedure involving the resection of all 3 nerves from an anterior approach. Simultaneous resection of the ilioinguinal, iliohypogastric, and genital nerves is performed with implantation of their proximal ends and without mobilization of the spermatic cord.

Although inguinodynia is a potentially disabling condition, it remains an underrated complication of inguinal hernia repair. Surgeons are able to pay more attention to addressing pain because of the reduced recurrence rate caused by advances in hernia surgery.

The pain complex syndrome of postherniorrhaphy neuropathic inguinodynia includes pain (neuralgia), burning sensation (paresthesia), hypoesthesia, and hyperesthesia, with radiation of the pain to the skin of the corresponding hemiscrotum, labium majus, and Scarp's triangle. Symptoms are frequently triggered or aggravated by walking, stooping, or hyperextension of the hip, and can be decreased by recumbency and flexion of the thigh. These aspects of the pain syndrome suggest that traction of the involved nerve plays a major role in the postherniorrhaphy pain syndrome, an issue that must be addressed in the surgical treatment of neuropathic inguinodynia.

The neuropathic pain complex can also be reproduced by tapping the skin, medial to the anterosuperior spine of the iliac bone or over an area of localized tenderness (Tinel's test). It is extremely difficult, if not impossible, to pinpoint the involved nerve for several reasons. First, peripheral communication between the ilioinguinal, iliohypogastric, and genital branch of the genital femoral nerve is very common and results in an overlap of their sensory innervation. Second, the innervation fields of the 3 nerves overlap. Third, at the spinal level both ilioinguinal and iliohypogastric nerves derive from the 12th thoracic and first lumbar nerve, and both the genital and ilioinguinal nerves receive communication from the first lumbar nerve. Fourth, more than one involved nerve can cause postherniorrhaphy pain syndrome.

TREATMENT

Peripheral nerve block or differential paravertebral root block, although helpful for differentiating neuropathic from nonneuropathic pain, is often inconclusive in the differential

diagnosis of the involved nerve. Magnetic resonance neurography was helpful in few cases of this series pain related to neuropraxia, which may last for upto 6 months postoperatively and is usually self-limiting and does not require surgical intervention. Surgery is required, however, for per neural fibrosis; nerve entrapment by suture, staple, or prosthetic device; and neuroma formation as a result of axonotmesis, neurotmesis, or complete nerve transection.

Central and peripheral communication, and frequent multiple nerve involvement can make it extremely difficult, if not impossible, to discern which nerve is involved. Therefore, surgical treatment of post herniorrhaphy neuralgia should not be limited to a grossly involved nerve, but should address all 3 nerves. Furthermore, the triggering or aggravation of the neuropathic pain complex by walking or hyperextension of the hip and its alleviation by recumbency and flexion of the thigh suggests that traction of the involved nerve due to its adherence to the aponeurotic tissue of the groin plays a major role in postherniorrhaphy pain syndrome.

The surgical treatment of postherniorrhaphy neuralgia should include the insertion of the proximal cut ends under the internal oblique muscle fibers to avoid recurrent neuralgia triggered by adherence of the cut ends of the resected nerves to the aponeurotic elements of the groin. Surgical treatment for periosteal reaction or osteitis pubis consists of removing suture materials, staples, bulky suture knots, and bulk-forming or wadded mesh material from the inguinal region. Injection of 80 mg of methylprednisolone acetate under direct vision during the operative procedure may also be helpful.

Surgical treatment of neuropathic pain consists of resection of the involved nerves. Neurolysis is not recommended because it does not address neuromas or inevitable secondary scarification. Similarly, simple division of the nerves without complete resection is not recommended.

The recommended procedure is neurectomy. In this procedure, as suggested by Starling et al, the entire length of the nerves should be resected as proximally and distally as possible to include the involved segment and account for the numerous neural communications that inevitably exist among the 3 nerves. The transected nerve ends should be ligated to prevent neuroma formation. Any staple, suture, or prosthetic material along the course of the nerve should be included with the resected portion of the nerve. Complete removal of mesh is not necessary. We found, as other

investigators had, that previous mesh repair did not predispose patients to neuropathic pain.

In addition, we suggest the following measures:

Resecting the genital nerve from the same anterior approach to avoid a second-stage operation through the flank and the possibility of an associated lumbar incisional hernia.

Implanting the ligated proximal ends of the ilioinguinal and iliohypogastric nerves within the fibers of the internal oblique muscle, and allowing proximal cut ends of the genital nerve to retract into the internal ring. This step prevents the cut ends of the nerves from adhering (via scarification) to the inguinal ligament and/or external oblique aponeurosis, which subjects the nerve to traction on walking or moving the hip joint and once again sets the stage for postoperative neuralgia.

Resecting and submitting any tissue fibers resembling a nerve as well as grossly evident nerve trunks for histologic verification to ensure that the resected specimens are neural tissues. With exploration and experience, intraoperative frozen section may not be necessary, although it can be helpful.

CONCLUSION

Still there is no enough data to support superiority of laparoscopic mesh repair over conventional open mesh repair regarding postinguinal hernia surgery pain. But it is superior regarding wound infection and early return to work.

REFERENCES

1. Anaesth J. Chronic pain after surgery. *British Journal of Anesthesia* Jul 2001;87(1):88-98.
2. Nigam VK. *Essentials of Abdominal Wall Hernias*.
3. Laparoscopic and Open Repair of Recurrent Hernia have similar Long-Term Outcome News, Reuters Health Information, December 2009.
4. Vrijland WW, Jeekel J. Prosthetic Mesh Repair should be used for any Defect in the Abdominal Wall. *Curr Med Res Opin* 2003;19(1) ©2003 Libra pharm Limited.
5. Robert E Condon. Groin Pain after Hernia Repair. *Ann Surg* Jan 2001;233(1):8.
6. Aasvang E, Kehlet H. Chronic postoperative pain: The case of inguinal herniorrhaphy. *British journal of anesthesia*, Feb 2008;19(1).
7. Saleh EA , Ayman AM. Mansoura Faculty of Medicine. Department of Surgery and Dermatology, Andrology and STDs. *Surgery volume*. July 2007;142(1):40-46.
9. Philip Wai-Yan Chiu, Sol-Fa Hon, Paul. *Surgical practice* Feb 2005;9(1):25-27.

A Review of the Role of Laparoscopic Biopsy in Cases of Abdominal Lymphadenopathy

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Abstract

Lymphadenopathy, identified incidentally during computed tomography, is a common clinical scenario faced by clinicians, and often poses a diagnostic challenge mandating a tissue diagnosis. In the absence of palpable peripheral nodes, tissue has to be obtained from the abdominal nodes by image guided biopsy or surgery. In this context, a laparoscopic biopsy avoids the morbidity of a laparotomy.

Keywords: Abdomen, Biopsy, Laparoscopy, Lymph node, Lymphoma, Tuberculosis.

INTRODUCTION

The lymphatic system is an important component of the immune system. It includes lymphatic fluid, lymphatic vessels, lymph nodes, spleen, tonsils, adenoids, Peyer's patches, and the thymus.¹

Lymph nodes are composed of follicles and contain an abundance of lymphocytes. Lymph is filtered through the lymph node sinuses where particulates and infectious organisms are detected and removed. Because of the exposure to immune challenges, antibody and cell immunity is mediated. As a result of such normal processes, the lymph nodes can enlarge by proliferation of normal cells or infiltration by abnormal cells.

Lymphadenopathy is defined as the enlargement of one or more lymph nodes as a result of normal reactive effects or a pathologic occurrence. While size is the most common reference, others include an abnormal number or alteration in consistency as a pathologic change that requires investigation.¹

Currently, computed tomography (CT) is increasingly widely utilized for vague abdominal symptoms due to its high sensitivity. The result of this technological trend is an increased incidence of unexpected retroperitoneal and mesenteric lymphadenopathy. The diagnosis of mediastinal and intra-abdominal lymphadenopathy is sometimes difficult, especially in patients without any other primary lesions and without any specific serological findings. This may be caused by primary lymphoproliferative disorders, metastasis, sarcoidosis, tuberculosis and so on.² Until recently, enlarged lymph nodes identified on CT scan have usually required open biopsy through a laparotomy incision. As technology has improved, CT/ultrasound-guided fine-needle aspiration

(FNA) or core biopsy has developed into dependable and minimally invasive alternatives for acquiring tissue. Oftentimes, however the tissue obtained is not sufficient for histological evaluation or the location of the adenopathy is not amenable to a CT/ultrasound (US)-guided biopsy.³⁻⁶ While laparotomy remains the gold standard for retroperitoneal lymph node biopsy, it is an invasive procedure associated with prolonged hospital stay and subsequent recovery time. The laparoscopic approach to adenopathy offers the potential benefit of decreased recovery time and postoperative morbidity compared with open techniques as well as increased likelihood of obtaining adequate tissue.

AIM

This is a retrospective analysis of laparoscopic biopsy of abdominal lymph nodes. The objective of this study is to assess the safety, efficacy, and diagnostic accuracy of laparoscopic biopsy.

MATERIALS AND METHODS

It is a retrospective review of 87 cases from four different sources:

1. From January 1999 to June 2001, 19 laparoscopic biopsies were performed for 18 patients with intra- or retroperitoneal lymphadenopathy at Ospedale San Martino di Genova, Genova. In 15 patients, the biopsy was performed in order to achieve the diagnosis. In the other four cases, laparoscopic biopsy was required to confirm a relapse or the evolution of a lymphoma during treatment or follow-up.⁷
2. This study evaluated all patients undergoing laparoscopic retroperitoneal lymph node biopsy from 2001 to 2007

at the Cleveland Clinic. Patient records were retrospectively reviewed for age, sex, pathologic diagnosis, conversion to laparotomy, and perioperative complications. A total of 30 cases were reviewed. In this group, 67% were males and 33% were females; mean age was 48 years. Ten patients underwent mesenteric lymph node sampling and 20 (67%) underwent retroperitoneal tumor resection.⁸

Data collected from patient charts, which included demographics, conversion rates, ability to obtain adequate tissue for pathologic evaluation, and treatment based on biopsy results were evaluated. Preoperatively, all patients underwent a CT of the abdomen which was used for evaluation of the location and extent of the adenopathy and operative planning. If deemed appropriate by radiology, CT/US-guided biopsies were attempted prior to any consideration of surgical intervention. In multiple cases, pathology was determined based on such core biopsies. If image guided biopsy was unsuccessful in establishing a diagnosis then surgical intervention was recommended. Preoperatively, all patients were carefully examined in order to evaluate for any palpable lymphadenopathy which may have been approached much more easily, such as in the axillary or inguinal regions. CT scans were also carefully reviewed with staff radiologists in order to optimize our operative approach. Surgical plans were discussed at length with the patients and consent was obtained.

3. Between October 2000 and November 2005, 28 patients with abdominal lymphadenopathy underwent laparoscopic biopsy at PD Hinduja Hospital, Mumbai, India. Preoperative radiological imaging studies had identified a nodal mass in 20, a solitary node in 1, a cold abscess in 1, and a mesenteric cystic lesion in 1 patient. In five patients with chronic right lower abdominal pain and normal ultrasonographic findings, mesenteric nodes were identified and biopsied during diagnostic laparoscopy.⁹

There were nine men and 19 women with a median age of 27 years (range 6-77 years). The presenting features included chronic abdominal pain (7), pain, weight loss and fever (10), pain and weight loss (3), abdominal lump (2), pyrexia of unknown origin (5), and backache (1). None of these patients had palpable peripheral lymph nodes suitable for biopsy. In 23 patients, preoperative ultrasound scan and/or computerized tomography scan had identified the site of lymphadenopathy. One patient was shown to have a lesion suspected to be a mesenteric cyst. Ten patients had an earlier image-

guided needle biopsy; in nine, the tissue obtained was nondiagnostic and in the one patient in whom the biopsy revealed lymphoma, the tissue was considered inadequate for subclassification. Eleven patients were considered poor candidates for image-guided biopsy as the enlarged lymph nodes were present in unsuitable locations (7) or small (4). In five patients presenting with chronic right lower abdominal pain and having normal imaging studies, mesenteric lymph nodes were identified at diagnostic laparoscopy. In one patient who was empirically started on antitubercular therapy upon identification of mesenteric nodal mass, a biopsy became necessary four months later when the response was found to be poor.

4. The diagnostic features of 11 cases hospitalized for abdominal tuberculosis in the Pediatric Surgery Department of Fattouma Bourguiba Hospital in Monastir for a 6-year period (2001-2006) were evaluated retrospectively. The diagnosis of abdominal tuberculosis was substantiated histopathologically by laparoscopy in all cases. The epidemiological and clinical characteristics along with the laboratory, radiological and histological data were studied.¹⁰

The diagnosis was suspected according to the epidemiological, clinical, biological and radiological findings. The final diagnosis was established by abdominal laparoscopy and a histological study. The epidemiological data included age, sex, BCG vaccination, raw milk intake, and family or personal history of tuberculosis or immunodeficiency. The general signs (fever, weight loss, night sweating, anorexia, abdominal pain and bowel movement disorder) and the clinical signs (abdominal swelling, abdominal mass, ascites and lymph nodes) were noted. The laboratory tests done were erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) (to screen for an inflammatory syndrome) with blood cell counts (to search for hyperleukocytosis). The bacteriological tests included a skin test (Mantoux test), *Mycobacterium tuberculosis* search in biological liquids (sputum, pleural effusion, ascites liquid), and polymerase chain reaction (PCR). A chest X-ray was taken for all patients to search for a pulmonary localization. In all cases, the abdominal imaging included an ultrasound examination to search for ascites and abnormal lymph nodes, explore palpable abdominal masses and rule out any surgical emergencies. A computerized tomography (CT) scan was performed in only five cases.

All operations were carried out under general endotracheal anesthesia with the patients placed in modified Lloyd-Davis, left lateral, right lateral or

trendelenburg positions to optimally expose the site of identified lymphadenopathy. A nasogastric tube and foley catheter were inserted, when appropriate both were removed at the end of surgery.

For upper abdominal procedures, a 10 mm camera port was placed slightly above the umbilicus and a 5 mm working port in each midclavicular line. In addition, a self-retaining retractor was set up to retract the left lobe of liver. The para-aortic nodes were biopsied by placing the camera port to the right of the midline at the level of umbilicus and two working ports in the midline on either side. For biopsy of the external iliac lymph nodes, the camera port was placed at the umbilicus along with two 5 mm port in pararectus positions. After carbon dioxide insufflation begun, a thorough exploration was performed. After identifying the lymph node, the peritoneum overlying the node was carefully incised using the hook cautery. The specimen was grasped and isolated circumferentially from surrounding tissues using blunt dissection, electrocautery or the harmonic scalpel. The base of the node was then clipped and the specimen removed. The abdomen was irrigated and hemostasis was verified.

RESULTS

The final diagnosis for the patients was as follows:

Diagnosis	No. of patients
Tuberculosis	33
Lymphoma	25
Reactive lymphadenitis	18
Metastatic adenocarcinoma	2
Castleman's disease	2
CLL	1
Seminoma	1
Retroperitoneal sarcoma	1
Recurrent carcinoma cervix	1
Peritoneal inclusion cyst	1
Lymphocele	1
Sarcoidosis	1

Seven patients (8%) required conversion to laparotomy. Two patients were converted due to difficulty in identifying the mass laparoscopically; one patient was converted because of the inability to obtain an adequate tissue sample after frozen analysis, one patient was opened for uncontrolled bleeding, one for appendicular, pseudotumor aspect of an intestinal loop in another case, and because of their pathological aspect appendicectomy and cecum biopsy in the seventh.

Additional studies were required in six cases (6.9%) to reach a final diagnosis.

There were no major operative and postoperative complications. The average duration of hospital stay was 2.5 days ranging from 1 to 6 days.

DISCUSSION

Although, ultrasonography and CT are useful in identifying abdominal lymphadenopathy, imaging findings may not always be disease specific. Nodes with low density centers, although characteristic of tuberculosis, are not pathognomonic and nodal calcification suggestive of tuberculosis can also be observed in metastases from testicular teratoma and non-Hodgkin's lymphoma.¹¹ Thus, the diagnosis of mesenteric or retroperitoneal masses requires adequate tissue for histological evaluation as well as the possible need for immunophenotyping, cytogenetic studies, and sometimes molecular genetics.

Image-guided biopsy is often the first line method for obtaining diagnostic tissue. In skilled hands ultrasonographically-guided FNAC¹² or CT-guided needle biopsy can yield tissue samples adequate for diagnosis.¹³ While not detailed in this review, a significant number of patients referred for surgical biopsy underwent successful CT-guided percutaneous biopsy, avoiding the need for surgery altogether. In a study of PFNA biopsies in 1,103 patients by Steel et al, 3.4% yielded false-negative results and 0.9% false-positive results.¹⁴ These studies confirm that when image-guided PFNA is able to provide sufficient tissue, histological analysis is of high diagnostic value. Radiographically guided biopsy, when feasible, is clearly the most appropriate first step in trying to determine the etiology of abdominal lymphadenopathy.

However, while numerous techniques have been defined to perform percutaneous biopsy, intervening structures and high-risk locations make some lesions unapproachable by percutaneous means.¹⁵ Surgical intervention becomes necessary when patients are poor candidates for image-guided needle biopsy or inadequate samples are obtained. Historically, laparotomy was the only means to obtain tissue diagnosis in such patients with mesenteric and retroperitoneal lymphadenopathy; however, laparoscopy is now proving to be a useful modality that avoids the need for a major open procedure in a large percentage of patients. Asoglu et al attempted laparoscopic biopsy in 94 patients and completed it successfully in 78.¹⁶ A laparotomy was required in 16 patients (17%) due to inadequate exposure, insufficient tissue, or postoperative adhesions. Lymphoma was diagnosed in 69 patients—in 55 (80%) via laparoscopy, in 9 (13%) via laparotomy, and in 5 (7%) with later procedures. Of the remaining 25 patients, 7 had non-

lymphomatous disease and 18 had benign lymphadenopathy. The false-negative rate for the laparoscopic procedures was 6%. One patient required conversion to laparotomy for intraoperative hemorrhage. This compares favorably with our review in which the conversion rate was 8%, and laparoscopic biopsy provided diagnosis in 81(93%) cases, while 6 required further work-up. Reported complications for laparoscopic biopsy are low. Mann et al reported no operative deaths with an 8% postoperative rate of complications.¹⁷ In our series, there were no postoperative complications.

In the developing world, lymphadenopathy is a common manifestation of abdominal tuberculosis. The incidence of tuberculosis infection has risen significantly in recent years due to several factors, such as poor socioeconomic status, misdiagnosis or improper treatment and the human immunodeficiency virus (HIV) pandemic.^{18,19} The abdominal form is seen in 25% of patients affected with pulmonary tuberculosis.²⁰ Starting patients diagnosed with AL on empirical antituberculous therapy is a practice fraught with the danger of missing out on or delaying the diagnosis of a more sinister pathology. Obtaining a substantial sample is mandatory in patients suspected to have lymph nodal tuberculosis resistant to the first line antitubercular drugs for bacteriological culture and antibiotic sensitivity. Pus in cold abscesses developing in relation to abdominal nodes is often thick and loculated, thus making it unsuitable for image-guided drainage. Traditional therapy involves laparotomy and drainage but laparoscopic drainage allows clearing up of all loculi as it also confers upon the patient all the benefits of a minimally invasive approach.²¹

Few studies have been published regarding laparoscopic biopsy for mesenteric and retroperitoneal adenopathy, and the majority is related to the diagnosis and staging of lymphoma.^{16,22,23} The ability to excise a complete lymph node without having to resort to laparotomy stands out as the single significant benefit of laparoscopic biopsy in the clinical setting of suspected lymphoma.

Lymph nodes, identified on imaging studies in patients being investigated for pyrexia of unknown origin (PUO), form yet another indication for laparoscopic lymph node biopsy. Arch Ferrer et al reported 15 patients with PUO who underwent diagnostic laparoscopy.²⁴ Tissue samples were obtained from liver, spleen and lymph nodes, which allowed an etiologic diagnosis to be reached in 10 patients and in ruled out abdominal pathology as cause for the PUO in four others. Thus, 93% of the patients undergoing laparoscopy were benefited by the procedure.

CONCLUSION

Laparoscopic retroperitoneal and mesenteric lymph node biopsy is a safe and effective, minimally invasive alternative to open biopsy. It is a useful technique for obtaining tissue for histological evaluation when image-guided PFNA biopsy is either unsuccessful, unable to be performed, and when previously unsuspected lymphadenopathy is identified during diagnostic laparoscopy. With its easy availability, early and judicious use of laparoscopic biopsy should be considered in the work-up of patients with abdominal lymphadenopathy.

REFERENCES

1. Kenneth William Gow. Lymph Node Disorders: eMedicine.
2. Ichiro Yasuda. Unknown Lymphadenopathy Diagnosing Using an Endoscopic Ultrasound-Guided Fine-Needle Aspiration Biopsy; Prognosis, Volume 7.
3. Balestreri L, Morassut S, Bernardi D, et al. Efficacy of CT-guided percutaneous needle biopsy in the diagnosis of malignant lymphoma at first presentation. *Clin Imaging* 2005;29(2):123-27.
4. Gupta S. New techniques in image-guided percutaneous biopsy. *Cardiovasc Intervent Radiol* 2004;27(2):91-104.
5. Ojalehto M, Tikkakoski T, Rissanen T, Apaja-Sarkkinen M. Ultrasound-guided percutaneous thoracoabdominal biopsy. *Acta Radiol* 2002;43(2):152-58.
6. Silverman SG, Tuncali K, Adams DF, et al. CT fluoroscopy-guided abdominal interventions: Techniques, results, and radiation exposure. *Radiology* 1999;212(3):673-81.
7. Cavaliere D, Torelli P, Casaccia M, Panaro F, Ghinolfi D, Valente U. Role of laparoscopic biopsy in the management of intra-abdominal lymphadenopathy. *Chir Ital.* Jul-Aug 2003;55(4):511-17.
8. Diulus L, Chalikhonda S, Pitt T, Rosenblatt S. Efficacy of laparoscopic mesenteric/retroperitoneal lymph node biopsy. *Surg Endosc* 2009;23:389-93.
9. Bhandarkar DS, Shah RS, Katara AN, Shankar M, Chandiramani VA, Udawadia TE. Laparoscopic biopsy in patients with abdominal lymphadenopathy. *J Min Access Surg* 2007;3:14-18.
10. Chahed J, Mekki M, Mansour A, Brahim MB, Maazoun K, et al. Contribution of laparoscopy in the abdominal tuberculosis diagnosis: Retrospective study of about 11 cases; *Pediatric Surg Int* 2010;26:413-18.
11. Cohan RH, Dunnick NR. The retroperitoneum. In : Haaga JR, Lanzeiri CF, Sartoris DJ, Zerhouni EA (Eds). *Computed tomography and magnetic resonance imaging of the whole body* (3rd ed). Mosby-Year Book Inc: St Louis 1994;1292-326.
12. Bret PM, Fond A, Casola G, et al. Abdominal lesions: A prospective study of clinical efficacy of percutaneous fine-needle biopsy. *Radiology* 1986;159(2):345-46.
13. Steel BL, Schwartz MR, Ramzy I. Fine needle aspiration biopsy in the diagnosis of lymphadenopathy in 1,103 patients. Role, limitations and analysis of diagnostic pitfalls. *Acta Cytol* 1995;39(1):76-81.
14. van Sonnenberg E, Wittenberg J, Ferrucci JT (Jr), et al. Triangulation method for percutaneous needle guidance: The angled approach to upper abdominal masses. *AJR Am J Roentgenol* 1981;137(4): 757-61.

15. Asoglu O, Porter L, Donohue JH, Cha SS. Laparoscopy for the definitive diagnosis of intra-abdominal lymphoma. *Mayo Clin Proc* 2005;80(5):625-31.
16. Mann GB, Conlon KC, LaQuaglia M, et al. Emerging role of laparoscopy in the diagnosis of lymphoma. *J Clin Oncol* 1998;16(5):1909-15.
17. Shakil AO, Korula J, Kanel JC, et al. Diagnostic features of tuberculous peritonitis in the absence and presence of chronic liver disease: A case control study. *Am J Med* 1996;100:179-85.
18. Sharma SK, Kadiraven T, Banga A, et al. Spectrum of clinical disease in a cohort of 135 hospitalized HIV infected patients from north India. *BMC infect Dis* 2004;4:52.
19. Uygur Bayramicli O, Dabak G, Dabak R. Clinical dilemma: Abdominal tuberculosis. *World J Gastroenterol* 2003;9:1098-1101.
20. Bhandarkar DS, Bhanushali P. Laparoscopic drainage of a peripancreatic tuberculous abscess. *Surg Endosc* 2003;17:831.
21. Cowles RA, Yahanda AM. Laparoscopic biopsy of abdominal retroperitoneal lymphadenopathy for the diagnosis of lymphoma. *J Am Coll Surg* 2000;191(1):108-13.
22. Porte H, Copin MC, Eraldi L, et al. Retroperitoneoscopy for the diagnosis of infiltrating retroperitoneal lymphadenopathy and masses. *Br J Surg* 1997;84(10):1433-36.
23. Strickler JG, Donohue JH, Porter LE, Habermann TM. Laparoscopic biopsy for suspected abdominal lymphoma. *Mod Pathol* 1998;11(9):831-36.
24. Arch Ferrer JE, Velazquez Fernandez D, Sierra Madero J, Lopez-Karpovitch X, Angeles-Angeles A, Gamino R, et al. Laparoscopic approach to fever of unknown origin. *Surg Endosc* 2003;17:494-97.

Hydrosalpinx: Functional Surgery or Salpingectomy

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Abstract

Background: Hydrosalpinx is a common cause of female infertility¹ and adversely affects the outcomes of *in vitro* fertilization (IVF). Although IVF is the main treatment, alternative treatments, such as salpingectomy and functional tubal surgery have been suggested.² Previously, hydrosalpinx was diagnosed using tubal patency tests (transvaginal ultrasound, TVUS; hysterosalpingography, HSG; and laparoscopy), which do not assess tubal function hydrosalpinx, and salpingectomy was the main surgical treatment for hydrosalpinx prior to IVF.³ However, with modern tubal endoscopy (salpingoscopy and fertiloscopy)⁴⁻⁷ and their ability to assess tubal functional mucosa, functional tubal surgery can be considered for thin-walled hydrosalpinx and a healthy mucosa and salpingectomy performed for thin-walled hydrosalpinx with mucosal adhesions and thick-walled hydrosalpinx with absent mucosal folds.⁸

Aims and objectives: The aim of the review is to highlight the use of appropriate tubal function tests to help in making a choice between either salpingectomy or functional tubal surgery as the treatment for hydrosalpinges.

Materials and methods: A literature search was performed using the search engine Google, HighWire press, PubMed and SpringerLink. Selected papers were taken for further references. All articles, including randomized controlled trial (RCT) were included for the review.

Results: Vasquez et al⁸ suggested that mucosal adhesions are the most important factors in determining fertility outcomes especially in thin-walled hydrosalpinges. Several studies on hydrosalpinges have also shown that the absence of mucosal adhesions on salpingoscopy can identify patients who can benefit from advantages offered by reconstructive surgery.³⁻⁷ Boer Meisel et al⁹ showed that patients with thin-walled hydrosalpinges and well preserved mucosa had an intrauterine pregnancy rate of 77% and a tubal pregnancy rate of 4% following reconstructive surgery.⁹ Vasquez et al⁸ in their prospective study showed that thin-walled hydrosalpinges with a normal or flattened mucosa, but without mucosal adhesions were associated with a 58% pregnancy rate and low risk of tubal pregnancy.⁸ Their study also found that thick-walled hydrosalpinges with mucosal adhesions have a statistically significant lower intrauterine pregnancy rate.⁸ Dechaud et al¹⁰ showed that salpingectomy for thick-walled hydrosalpinges improved the outcome of IVF.

Conclusion: An appropriate tubal mucosal assessment should be a routine prior to deciding upon further management of hydrosalpinx. Functional tubal surgery should be preferred in mild forms of hydrosalpinx and salpingectomy reserved for severe forms of hydrosalpinx.

Keywords: Hydrosalpinx, Salpingectomy, Functional tubal surgery, Fimbrioplasty, Salpingostomy, Uterine tubal anastomosis, Tubal function tests, Salpingoscopy and Fertiloscopy.

INTRODUCTION

Hydrosalpinx, also known as fallopian tube obstruction, is defined as a fluid filled distension of the fallopian tube in the presence of distal tubal occlusion.¹¹ It is one form of tubal disease and may involve the proximal, distal or the entire fallopian tube.¹¹ The occlusion is almost secondary to pelvic inflammatory diseases (PID), endometriosis, fimbrial serosal obstruction following an adjacent appendicular inflammation and previous surgery (either tubal, pelvic or abdominal).¹² PID being the most common cause of hydrosalpinx results in a severe inflammatory process obstructing the distal end of the fallopian tube.^{12,13} This inflammatory process combined with the natural transitional cell mucosa production produce a swollen nonfunctioning hydrosalpinx fluid.¹³ Hydrosalpinx can be classified according to severity of tubal damage into: Mild/grade I, moderate/grade II and severe/grade III.¹⁴

Hydrosalpinx is a common cause of female infertility¹ and accounts for between 26 and 30% of patients with infertility treated with IVF.¹⁵

HYDROSALPINX EFFECTS ON PREGNANCY OUTCOMES

Women with hydrosalpinges have lower implantation rates of 2.9% and lower pregnancy rates of 9.2%,¹ as well as higher ectopic pregnancy rate and early pregnancy losses of 70%.^{16,17}

The exact mechanism of such low pregnancy outcomes is unclear with many postulated hypotheses.¹⁶ Mechanical and chemical factors as well as endometrial receptivity dysfunction have been implicated and shown to adversely impair IVF outcomes. Andersen et al¹⁶ postulated that the low pregnancy outcomes might be due to leakage of fluid into the uterine cavity which disturbs the receptivity of the

endometrium and/or the developing embryo.¹⁶ The toxic substances contained in hydrosalpinx fluid drain into the uterine cavity and dilute the endometrial secretion, and thus generate an unfavorable uterine milieu.¹⁸⁻²⁰ Mukherjee et al²¹ showed that the hydrosalpinx fluid enters into the uterine cavity.²¹ Sonography done during the luteal phase in patients with hydrosalpinx showed uterine cavity fluid distension and none of these patients obtained an ongoing intrauterine pregnancy after IVF treatment.²²

DIAGNOSIS OF HYDOSALPINX USING IMAGING TECHNIQUES

Hydrosalpinx can be diagnosed using various imaging techniques.² Most of these investigations can only assess the tubal patency with few assessing the tubal function (functional status of tubal mucosa).^{2,3}

Tubal patency tests, such as HSG, hysterosalpingo-contrast ultrasonography (HyCoSy), TVUS and laparoscopy are not good at assessing tubal function.^{2,3}

Tubal function tests, such as falloscopy, salpingoscopy and fertiloscopy are the main tests that should be utilized to assess the functional status of the tubal mucosa. These tests are new interventions utilizing tubal endoscopy.^{4,5} Salpingoscopy can be used to classify hydrosalpinx into four types (Table 1).

Table 1: Classification of hydrosalpinges based on salpingoscopy^{2,6}

<ul style="list-style-type: none"> • Thin-walled hydrosalpinx with a healthy mucosa • Thin-walled hydrosalpinx with flattened mucosal folds without mucosal adhesions (hydrosalpinx simplex) • Thin-walled with mucosal adhesions (hydrosalpinx follicularis) • Thick-walled hydrosalpinx with absent mucosal folds.
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Thin-walled hydrosalpinx and a healthy mucosa have good results postsurgery.⁸

Tubal function tests play an important role in choosing patients suitable for tubal surgery (functional tubal surgery or salpingectomy).²

HYDOSALPINX TUBAL SURGERY

Although IVF is the main treatment for tubal factor infertility related to hydrosalpinx, surgical treatment plays a crucial role prior to IVF, and scientific evidence has shown it to improve pregnancy outcomes by removing the toxic effects of hydrosalpinx that impair IVF outcomes.²³ The performance of surgical interventions, such as salpingectomy and functional or reconstruction surgery (fimbrioplasty, salpingostomy and microsurgical tubocornual anastomosis),

prior to the IVF procedure in women with hydrosalpinges has been shown to improve the likelihood of successful outcome.²³⁻²⁶ These procedures can be performed via laparoscopy as well as laparotomy since, both routes are equally effective although laparoscopy is the preferred route.^{15,27}

SALPINGECTOMY

Laparoscopic salpingectomy prior to IVF is usually performed in women who have unilateral hydrosalpinx with normal contralateral tube as well as those with bilateral hydrosalpinges, and results in significant improvement in pregnancy and implantation after surgery.²⁷ Evidence suggests that laparoscopic salpingectomy should be performed only when hydrosalpinges are beyond repair or in cases of IVF failure.³⁰⁻³² Thin-walled hydrosalpinges with mucosal adhesions and thick-walled hydrosalpinges with absent mucosal folds diagnosed using salpingoscopy are indications for salpingectomy.³³

FUNCTIONAL OR RECONSTRUCTIVE TUBAL SURGERY

Functional or reconstructive tubal surgery remains another important tubal surgical treatment, complement to assisted reproductive techniques (ARTs).^{33,34} This surgery should be considered as first-line treatment when the correction of infertility pathology is achievable and good results are expected.³³ It should be preferred to salpingectomy in mild forms of hydrosalpinges, especially those with preserved tubal mucosa without adhesions (diagnosed using salpingoscopy) as these hydrosalpinges are amenable to surgical repair and have good prognosis.⁸

Fimbrioplasty

Fimbrioplasty is the incision of any fibrous or scar tissue covering the terminal end of the tube, thus freeing the agglutinated fimbriae and lysis of peritubal adhesions.³⁴ Fimbrioplasty is, thus, indicated in patients with fimbrial occlusion usually with concurrent periadnexal adhesions.^{35,36}

Salpingostomy or Neosalpingostomy

Salpingostomy is the procedure whereby a stoma is fashioned in the distal fallopian tube using scissors, electrosurgery or laser.³⁵ The procedure can be performed using laparoscopy or laparotomy with microsurgical technique.^{36,37} When the procedure is performed for mild hydrosalpinges, it is associated with better pregnancy rates.³⁴

Microsurgical Tubocornual Anastomosis

Microsurgical tubocornual anastomosis is a procedure where the patent portion of the distal tube is joined to the uterine cavity under magnification. This procedure has been regarded as the standard treatment for proximal tubal occlusion.³⁵ However, some spontaneous intrauterine pregnancies have been seen in women with proximal tubal obstruction. This type of surgery is more effective for women with mild hydrosalpinges and should be considered especially in centers where appropriate expertise is available.³⁵

The aim of the review was to highlight the use of appropriate tubal function tests to help in making a choice between either salpingectomy or functional tubal surgery as treatment for hydrosalpinges.

A literature search was performed using the search engine Google, HighWire press, PubMed and SpringerLink. Selected papers were taken for further references. All articles, including randomized controlled trial (RCT) were included for the review.

RESULTS

Salpingoscopy

Puttemans et al² utilized translaparoscopic salpingoscopy to evaluate the ampullary segment of the fallopian tube in patients suffering from infertility. Their study compared this technique with HSG in a series of 32 patients with hydrosalpinges and demonstrated the superiority of salpingoscopy in the evaluation of tubal mucosa. This diagnostic approach allows a more accurate selection of patients for microsurgical repair.⁷

Valentini et al⁵ performed a prospective study to identify radiographic signs of mucosal damage by comparing HSG with salpingoscopy. Forty-one candidates for laparoscopy underwent HSG and preoperative salpingoscopy; at both, tubal patency was noted. Radiographic criteria for mucosal abnormality were rounded filling defects (i.e. the cobblestone pattern) and the absence of longitudinal radiolucent bands in the ampullary tract. At salpingoscopy, tubal mucosa was categorized by means of inspection into five classes of fold pattern: Classes I and II, normal; classes III-V, abnormal. Seventy-four tubes were evaluated. At HSG, 31 tubes were distally non-patent. Of these, 26 showed a distal obstruction at salpingoscopy. None of the patent tubes at HSG showed obstruction at salpingoscopy. The agreement between HSG and salpingoscopy in detecting abnormal mucosal pattern was 89.2% (κ , 0.73; $P < 0.001$). The cobblestone pattern always corresponded to intraluminal adhesions at salpingo-

scopy. The absence of radiolucent bands corresponded to abnormal mucosa at salpingoscopy in four of six cases. The cobblestone pattern was found only in hydrosalpinges and never in patent tubes. Six normal patent tubes at HSG showed intraluminal adhesions at salpingoscopy.⁵

Salpingectomy

Strandell et al³¹ performed a randomized control trial that analyzed the effect of salpingectomy on birth rates and IVF cycles. A total of 186 women underwent 452 IVF cycles. Among these, 77 women had no surgical intervention and 24 had salpingectomy after 1 or 2 failed IVF cycles. Salpingectomy group had a significantly increased birth rate (HR 2.1, 95% CI 1.6-3.6, $P = 0.014$) and higher implantation rates (27.2% versus 20.2%, $P = 0.0331$).

A systematic review that included six studies, comparing pregnancy outcomes after laparoscopic surgery with that of open or conventional microsurgical technique was done by Ahmad et al.¹⁵ In this review, there was no significant difference observed in the intrauterine pregnancy rate between the two groups, combined OR (odds ratio) 1.32 (95% confidence interval [CI], 0.58-3.02). For patients with mild tubal disease, there was no significant difference in the intrauterine pregnancy rate between treatment and control group, OR 1.06 (95% CI, 0.42-2.70). For patients with severe tubal disease, there was a significantly increased intrauterine pregnancy rate in the laparotomy group, OR 0.34 (95% CI, 0.14-0.86).¹⁵

Sagoskin et al²⁹ reported on their retrospective observational study of 25 infertility patients with known unilateral hydrosalpinges and a patent contralateral fallopian tube. Eighteen of these women subsequently had spontaneous pregnancies after laparoscopic salpingectomy without IVF treatment. Pregnancies occurred in an average of 5.6 months with a range of 1 to 21 months. There were no ectopic pregnancies in the study population.²⁹

Another study performed by Kontoravdis et al²⁸ that evaluated and compared the clinical impact salpingectomy, when performed before IVF in patients with hydrosalpinges, found that patients who underwent proximal tubal occlusion before IVF demonstrated significantly increased implantation, clinical pregnancy, and ongoing pregnancy rates compared to those with no surgical intervention and demonstrated implantation, clinical pregnancy, and ongoing pregnancy rates comparable to those who underwent salpingectomy.²⁸

A Cochrane systematic review was performed by Johnson et al²⁷ to highlight evidence that laparoscopic salpingectomy for women with hydrosalpinges enhances

the success of IVF. Three randomized controlled trials were included in the review. The results showed that the odds of pregnancy [odds ratio (OR) = 1.75, 95% confidence interval (CI) 1.07-2.86] and of ongoing pregnancy and live birth (OR = 2.13, 95% CI 1.24-3.65) were increased with laparoscopic salpingectomy for hydrosalpinges prior to IVF. There were no significant differences in the odds of embryo implantation (OR = 1.34, 95% CI 0.87-2.05), ectopic pregnancy (OR = 0.42, 95% CI 0.08-2.14), miscarriage (OR = 0.49, 95% CI 0.16-1.52) or treatment complications (OR = 5.80, 95% CI 0.35-96.79).²⁷

The latest Cochrane review, performed by Johnson et al²⁵ on surgical treatment for tubal disease in women due to *in vitro* fertilization is also available. In this review, five randomized controlled trials involving 646 women were included. Four studies assessed salpingectomy versus no treatment. The odds of ongoing pregnancy (Peto OR 2.14, 95% CI 1.23 to 3.73) and of clinical pregnancy (Peto OR 2.31, 95% CI 1.48 to 3.62) however, were increased with laparoscopic salpingectomy for hydrosalpinges prior to IVF.²⁵

Fimbrioplasty

Donnez and Casanas Roux³⁴ studied the prognostic factors of fimbrial microsurgery. They operated upon 257 women and found that after fimbrioplasty for occlusion of degree I the term pregnancy rate was > 50%.³⁴ On systematic review of eight RCTs and 14 observational studies, found no difference in pregnancy rates between the different techniques used such as CO₂ laser adhesiolysis versus diathermy adhesiolysis (53% with laser versus 52% with diathermy; OR = 1.04; 95% CI 0.65 to 1.67).¹⁵ The review of 14 observational studies did not detect a difference between laparoscopic adhesiolysis and microsurgical adhesiolysis in improving outcome.³⁸ Audebert et al³⁹ in a prospective study reported 51% clinical pregnancy rate and 23% ectopic pregnancy rate in 35 patients with severe fimbrial occlusion treated by laparoscopic fimbrioplasty.

Salpingostomy or Neosalpingostomy

Donnez and Casanas Roux³⁴ operated upon 257 women and found that after salpingostomy for degree II, III and IV fimbrial tube occlusion, the term pregnancy rate was > 50%, 25% and 22%, respectively. On systematic review of eight RCTs and 14 observational studies evaluating various surgical techniques for treating tubal infertility, found no difference in pregnancy rates between laser salpingostomy versus diathermy salpingostomy (35% with laser versus

27% with diathermy; OR = 1.30; 95% CI 0.77 to 2.19).¹⁵ A review of 10 case series in women who underwent neosalpingostomy for distal tubal occlusion (n = 1128) reported a cumulative ectopic pregnancy rate per pregnancy of 23%.⁶

Microsurgical Tubocornual Anastomosis

A review of nine other case series studies reported that about 50% of women with proximal tubal blockage who had microsurgical tubocornual anastomosis achieved a term pregnancy.⁴⁰ Case series and cohort studies have demonstrated high pregnancy rates in women who underwent this type of surgery.³⁵ A case series study reported live birth rates of 27%, 47% and 53% within one, two and 3.5 years of surgery respectively.⁴¹

DISCUSSION

Data available in the literature strongly suggest that surgical treatment of hydrosalpinges improves the pregnancy rate in IVF.¹¹ However, surgery is not without risks and the need to avoid the practice of indiscriminant salpingectomy in all women with hydrosalpinges who are undergoing IVF, makes the ability to identify women at risk for suboptimal IVF success increasingly important.¹¹ Hence, preoperative patient selection is an essential step in surgical treatment for hydrosalpinx.¹¹ Tubal patency test utilizing tubal endoscopy plays an important role in selection of hydrosalpinges for different surgical treatments.⁴⁻⁷ Valentini et al⁵ in their study showed intraluminal disease in patent tubes might not always be excluded on normal HSG.⁵ Their study together with several other studies have shown that tubal patency tests are not appropriate for assessing tubal function.⁴⁻⁸ Hence, this emphasizes the importance of utilization of tubal function tests. However, tubal function tests are still unpopular and not performed routinely in many countries.

The main advantages of laparoscopic surgery over microsurgery in the treatment of hydrosalpinx are that the laparotomy incision is avoided leading to less postoperative discomfort and pain, shorter hospitalization, and quicker resumption of normal activities.^{11,36,37} However, the reproductive outcomes after laparoscopic surgery are similar to that of open microsurgery.¹¹

Several studies have shown that laparoscopic salpingectomy improves IVF outcomes.^{2-4,31} However, this procedure is not ideal for every woman with hydrosalpinx.¹¹ Laparoscopic salpingectomy should be performed only when hydrosalpinges are beyond repair or in cases of IVF failure.⁸

There had been reports about adverse effects associated with salpingectomy, especially if performed close to the uterus as it might disrupt the normal blood flow to the ovary resulting in fewer oocytes being retrieved from the side of the operation during IVF cycles in comparison with intact adnexa.¹⁸ NICE guidelines suggested that the evidence of impairment of ovarian response in subsequent IVF was inadequate but emphasize that laparoscopic salpingectomy should be done with care not to compromise ovarian blood supply.³⁵

Reconstructive tubal surgery should be preferred to salpingectomy in mild forms of tubal disease.^{34,36,40,41} Preserved tubal mucosa indicates a good prognostic for tubal surgery.^{34,36} The distinction of hydrosalpinges that can be treated with functional surgery can be achieved by utilization of tubal endoscopy tests.^{4,5} Therefore, an appropriate mucosal assessment should be routine prior to deciding upon further management of hydrosalpinges.¹¹ Fimbrioplasty should be performed in patients with mild periadnexal adhesions and patent hydrosalpinx mucosa as this improves pregnancy outcomes.^{35,36} Salpingostomy is an ideal procedure for mild hydrosalpinges with normal mucosa as it is associated with better pregnancy rates.³⁴ Microsurgical tubocornual anastomosis is the standard treatment for proximal tubal occlusion.³⁵ This type of surgery is more effective than no treatment for women with mild hydrosalpinges and should be considered especially in centers where appropriate expertise is available.³⁵

CONCLUSION

Proper assessment of hydrosalpinges tubal mucosa utilizing tubal endoscopy tests should be routine prior to decision about the choice of surgical treatment as this will prevent mis-management of patients.

REFERENCES

- Bontis JN, Theodoridis TD. Laparoscopic management of hydrosalpinx. *Ann N Y Acad Sci* 2007;1092:199-210.
- Puttemans P, Campo R, Gordts S, Brosens I. Hydrosalpinx-functional surgery or salpingectomy. *Hum Reprod* 2000;15(7):1427-30.
- Dechaud H, Dures JP, Hedon B. Prospective evaluation of falloposcopy. *Hum Reprod* 1998b;13:1815-18.
- Puttemans P, Brosens L, Delattin P, et al. Salpingoscopy versus hysterosalpingography in hydrosalpinges. *Hum Reprod* 1987;2:535-40.
- Valentini AL, Muzii L, Marana R, Catalano GF, Felici F, Destito C, Marano P. Fallopian tube disease: The cobblestone pattern as a radiographic sign. *Radiol* 2000;217:521-25.
- Marana R, Catalano GF, Muzii L, et al. The prognostic role of salpingoscopy in laparoscopic tubal surgery. *Hum Reprod* 1999;14:2991-95.
- Surrey ES. Micro-endoscopy of the human fallopian tube. *J Am Gynecol Laparosc* 1999;6:383-89.
- Vasquez G, Boecks W, Brosens I. Prospective study of tubal mucosal lesions and infertility in hydrosalpinges. *Hum Reprod* 1995;10:1075-78.
- Boer-Meisel ME, te Velde ER, Habbema JDF, Kardaun JWPF. Predicting the pregnancy outcome in patients treated for hydrosalpinx: A prospective study. *Fertil Steril* 1986;45:23-29.
- Dechaud H. Hydrosalpinges suitable for salpingectomy before IVF. *Hum Reprod* 2000;16(12):2464-65.
- Aboulghar MA, Mansour RT, Serour GJ. Controversies in the modern management of hydrosalpinx. *Hum Reprod Update* 1998;4:882-90.
- Puttemans PJ, Brosens IA. Salpingectomy improves in vitro fertilization outcome in patients with a hydrosalpinx; blind victimization of fallopian tube. *Hum Reprod* 1996;11:2079-81.
- Coughlan C, Li T C. Surgical management of tubal disease. *Obst gynaecol Reprod Med* 2008;19(4):98-105.
- Akande VA, Cahill DJ, Wardle PG, Rutherford AJ, Jenkins JM. The predictive value of the 'Hull and Rutherford' classification for tubal damage. *Br J Obstet Gynaecol* 2004;111:123-41.
- Ahmad G, Watson AJ, Metwally M. Laparoscopy or laparotomy for distal tubal surgery? A meta-analysis. *Hum Fertil* 2007;10(1):43-47.
- Andersen AN, Meng FJ, Petersen. Low implantation rates after IVF in patients with hydrosalpinges diagnosed by ultrasonography. *Hum Reprod* 1994;9:1935-38.
- Katz E, Akman MA, Damewood MD, Garcia JE. Deleterious effect of the presence of hydrosalpinx on implantation and pregnancy rates with in vitro fertilization. *Fertil Steril* 1996;66:122-25.
- Strandell A, Naldenstrom U, Nilsen L, Hamberger L. Hydrosalpinx reduces in vitro fertilization/embryo transfer pregnancy rate. *Hum Reprod* 1994;9:861-63.
- Vandrome J, Chasse E, Lejeline B, et al. Hydrosalpinges in in vitro fertilization; an unfavourable prognostic feature. *Hum Reprod* 1995;10:576-79.
- Bindirici I, Bukulmez O, Ensari A, Yarali H, and Gurgan T. A prospective evaluation of the effect of salpingectomy on endometrial receptivity in cases of women with communicating hydrosalpinges. *Hum Reprod* 2001;16(11):2422-26.
- Mukherjee T, Copperman AB, McCaffrey C, et al. Hydrosalpinx fluid has embryotoxic effect on murine embryogenesis: A case for prophylactic salpingectomy. *Fertil Steril* 1996;66:851-53.
- Akman MA, Erden HF, Bahaci M. Endometrial fluid visualized through ultrasonography during ovarian stimulation in IVF cycles impairs the outcome in tubal factor but not PCOS patients. *Hum Reprod* 2005;20(4):906-09.
- Pandian Z, Akande V A, Harrild K, Bhattacharya S. Surgery for tubal infertility. *Cochrane Database Syst Rev* 2009;1:1-12.
- Posaci C, Camus M, Osmanoglu K, Devroey P. Tubal surgery in the era of ART: clinical options. *Hum Reprod* 1999;14: 120-36.
- Johnson N, van Voorst S, Sowter MC, Strandell A, Mol BW. Surgical treatment for tubal disease in women due to undergo in vitro fertilisation. *Cochrane Database Syst Rev* 2010;20(1): CD002125.

26. Seli E, Kayisli U, Cakmak H, Bukulmez O, Bildirici I, Guzeloglu-Kayisli IO, Arici A. Removal of hydrosalpinges increases endometrial leukaemia inhibitory factor (LIF) expression at the time of the implantation window. *Hum Reprod* 2005;20(11): 3012-17
27. Johnson NP, Mak W, Sowter MC. Laparoscopic salpingectomy for women with hydrosalpinges enhances the success of IVF: A Cochrane review. *Hum Reprod* 2002;17(3): 543-48.
28. Kontoravdis A, Makrakis E, Pantos K, Botsis D, Deligeoroglou E, Creatsas G. Proximal tubal occlusion and salpingectomy result in similar improvement in in vitro fertilization outcome in patients with hydrosalpinx. *Fertil Steril* 2006;86(6): 1642-49.
29. Sagoskin AW, Lessey BA, Mottla GL, Richter KS, Chetkowski RJ, Chang AS, Levy MJ, Stillman RJ. Salpingectomy or proximal tubal occlusion of unilateral hydrosalpinx increases the potential for spontaneous pregnancy. *Hum Reprod* Dec 2003;18(12): 2634-37.
30. Strandell A, Lindhard A. Salpingectomy prior to IVF can be recommended to a well-defined subgroup of patients. *Hum Reprod* 2000;15(10):2072-74.
31. Strandell A, Lindhard A, Waldenstrom U, Thorburn J. Hydrosalpinx and IVF outcome: Cumulative results after salpingectomy in a randomized control trial. *Hum Reprod* 2001;16(11):2403-10.
32. Sagoskin A W, Lessey BA, Mottla GL, Richter KS, Chetkowski RJ, Chang AS, Levy MJ, Stillman RJ. Salpingectomy or proximal tubal occlusion of unilateral hydrosalpinx increases the potential for spontaneous pregnancy. *Hum Reprod* 2003;18(12): 2634-37.
33. Saravelos HG, Li TC, Cooke ID. An analysis of the outcome of microsurgical and laparoscopic adhesiolysis for infertility. *Hum Reprod* 1995;10:2887-95.
34. Donnez J, Casanas-Roux F. Prognostic factors of fimbrial microsurgery. *Fertil Steril* 1986;46:200-04.
35. Fertility assessment and treatment for people with infertility problems. NICE: Clinical guidelines 2004, www.rcog.org.uk.
36. Gomel V. From microsurgery to laparoscopic surgery. *Fertil Steril* 1995;63:464-68.
37. Gomel V. Salpingostomy by laparoscopy. *J Reprod Med* 1995;18:265-68.
38. Ahmad G, Watson A, Vandekerckhove P, Lilford R. Techniques for pelvic surgery in subfertility. *Cochrane Database Syst Rev* 2006;19(2):CD000221.
39. Audebert AJM, Pouly JL, Theobald PV. Laparoscopic fimbrioplasty: An evaluation of 35 cases. *Hum Reprod* 1998;15:1496-99.
40. Marana R, Quagharello J. Proximal tubal occlusion: Microsurgery versus IVF: A review. *Int J Fertil* 1988;3:334-40.
41. Patton PE, Williams TJ, Coulam CB. Microsurgical reconstruction of proximal oviduct. *Fertil Steril* 1987;47:35-39.

Single Access Laparoscopic Nephrectomy

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Abstract

Laparoscopic nephrectomy has assumed a central role in the management of kidney diseases. Laparoscopy, inspite of its less morbidity than open surgery, still requires several incisions. These incisions carry risks of bleeding, ventral hernia, damage to internal organs and decreased cosmesis.

An alternative to laparoscopy is the single access or keyhole surgery. This keyhole surgery utilizes the new laparoscopy access port (R-Port), single port access (SPA) procedure, one port umbilical surgery (OPUS), the "belly button" entry, natural orifice transluminal endoscopic surgery, and the magnetic anchoring and guidance system (MAGS) technology.

Keywords: SILS, SILS nephrectomy, Laparoscopic nephrectomy.

INTRODUCTION

Open nephrectomy performed through the muscle splitting flank incision was the gold standard therapy for many kidney diseases. This was replaced by the less morbid procedure, the laparoscopic nephrectomy. Since the first laparoscopic nephrectomy by Clayman and colleagues in 1991, minimally invasive urologic surgery has gained significant momentum. In an effort to reduce the sequelae of laparoscopic nephrectomies, single access or keyhole surgeries have developed.

ARTICULATING LAPAROSCOPIC INSTRUMENTATION

This involves using articulating instrumentation via a single large caliber trocar or small/adjacent trocars. Advances in technology have led to the development of new access port (R-Port, Advanced Surgical Concepts, Wicklow, Ireland and Uni-X single port, P navel systems, Cleveland, OH, USA) capable of allowing multiple instruments to be inserted through different cannulas of a single port. Alternatively, adjacent 5 mm trocars can be utilized with skin trocars connected at the time of specimen extraction.

Currently, articulating laparoscopic graspers, endoshears and laparoscopic needle drivers are commercially available for clinical use.

In conjunction with articulating instrumentation, the development of novel intra-abdominal retractor will further facilitate evolution of laparoscopic procedures. One such device is the pardon endoscopic exposing retractor (PEER). Another important component is 45 degrees 5 mm rigid laparoscope with an end light source (karl storz) or a 5 mm

deflectable tip video laparoscope (Olympus, Orangeburg, NY, USA).

CLINICAL EXPERIENCE

Raman and colleagues reported their experience with keyhole nephrectomy in a porcine model and human subjects. In their series, keyhole nephrectomy was completed successfully in 8 porcine renal units and in all three human subjects. The mean operative time for the porcine nephrectomies was 49 minutes with a mean blood loss of 20 cc. Incision size ranged from 3 to 5 cm. The mean operative time for the human nephrectomy cases was 133 minutes, estimated blood was 30 cc and the kidneys were extracted through a solitary 2 to 4.5 cm periumbilical incision. There were no perioperative complications and all three patients were discharged from hospital on day 2.

The attractiveness of keyhole umbilical nephrectomy is multifaceted. First, it improves cosmesis by allowing a single umbilical incision. Second, it is within a surgeon's comfort range since specimen extraction occurs via the abdomen. Third, the learning curve appears to be much shorter than for NOTES. Finally, keyhole umbilical surgery provides a "familiar" anatomical view of the kidney.

NOTES

Natural orifice transluminal endoscopic surgery approaches abdominal surgery through natural orifices (mouth, vagina, and rectum). Animal models have been used to demonstrate the potential application of NOTES, including transgastric and transvesical peritoneoscopy, transvaginal tubal ligation, hysterectomy, and cholecystectomy.

Gettman and colleagues reported in 2002 on the successful completion of six laparoscopic transvaginal nephrectomies using conventional instrumentation in a porcine model. Clayman et al also performed single-port NOTES transvaginal nephrectomy using the purpose-built multi-lumen operating platform.

There were drawbacks in both the above procedures in which the operative duration was longer than the conventional laparoscopy.

MAGNETING ANCHORING AND GUIDANCE SYSTEM (MAGS)

An alternative to conventional laparoscopy and NOTES is single access or keyhole surgery utilizing a magnetically

anchored guidance system, articulating laparoscopic instruments, and/or specialized trocars.

Park and colleagues have recently developed a novel adjunct laparoscopic system consisting of a movable, "lockable" platform that is positioned intra-abdominally and stabilized by an external permanent magnet on the abdominal skin. MAGS can be used to actively control an intra-abdominal camera and working instruments through a single trocar.

Zeltser et al have subsequently described the first successful completion of two porcine nephrectomies via a single 15 mm transumbilical trocar using a prototype MAGS camera and a magnetically anchored robotic arm cauterizer.

Prior to widespread adoption of the MAGS platform, both clinical and engineering limitations must be addressed.

To Evaluate the Efficacy of Laparoscopic versus Open Surgical Management of the Tubal Pregnancy and its Effects on Future Pregnancy

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Abstract

Ectopic pregnancy is the most common cause of maternal death in early pregnancy and its incidence is rising. Most of the ectopic pregnancies occur in the young age group and subsequent fertility is an important issue. There is no consensus in the literature regarding conservative laparoscopic versus radical treatment of tubal pregnancy in terms of future reproductive performance. There are no randomized controlled trials of sufficient power, and meta-analysis of studies has shown different results with different investigators. But in certain studies laparoscopic surgery has advantages over open surgery and results in higher rates of subsequent intrauterine pregnancies and a lower rate of ectopic pregnancy.

Background: In the treatment of tubal ectopic pregnancy (EP), laparoscopic surgery remains the cornerstone of treatment (Cochrane Database 2007). In the absence of randomized data, the question as to whether surgical treatment should be performed either conservatively (salpingostomy) or radically (salpingectomy) in women with desire for future pregnancy is subject to ongoing debate (Mol et al 2008).

Since the first study demonstrated the potential effectiveness of salpingostomy, this treatment has been compared with salpingectomy in numerous nonrandomized studies (Stromme et al 1962, Mol et al 2008). Pooled data showed no beneficial effect of salpingostomy on intrauterine pregnancy (IUP) whereas there is an increased risk of repeat EP (Clausen 1996, Yao et al 1997, Mol et al 2008). Based on these findings, the Royal College of Obstetricians and Gynecologists guideline advises salpingectomy as the preferred standard surgical approach for tubal EP (RCOG 2004). However, there are good reasons to question this advice. Interpretation of the pooled data is troublesome, since many of the original studies failed to report essential details, e.g. time to pregnancy, presence of the desire for future pregnancy, and whether subsequent pregnancies occurred either spontaneously or after fertility treatment, such as *in vitro* fertilization (IVF). Only a few nonrandomized studies have taken these matters into account and came to different conclusions (Silva et al 1993, Job spira et al 1996, Mol et al 1998, Bouyer et al 2000, Bangsgaard et al 2003, Tahseen et al 2003, Mol et al 2008). The IUP rates were higher and the time to an IUP was shorter after salpingostomy compared to salpingectomy. Especially in women with history of bilateral tubal pathology, salpingostomy offered better IUP rates than salpingectomy, albeit at the cost of an increased risk for repeat EP (Silva et al 1993, Job spira et al 1996, Mol et al 1998, Bangsgaard et al 2003, Mol et al 2008). In women without history of tubal pathology, this benefit was less clear and also in these women there was an increased risk of repeat EP (Mol et al 1998, Mol et al 2008). In view of these data, it has been felt that the most effective type of surgery for women with a tubal EP in the presence of contralateral tubal pathology with desire for future pregnancy is salpingostomy. In women without contralateral tubal pathology, the most optimal surgical treatment is currently unknown.

Keywords: Ectopic pregnancy, Operative laparoscopy, Laparoscopic, Laparotomy salpingectomy, Surgical treatment, Minimal access surgery, Future pregnancy.

INTRODUCTION

Lawson Tait, the father of gynecologic surgery reported the first successful operation for ectopic pregnancy in 1883. His main difficulty lay in establishing the diagnosis (Tait RL 1884).

Until little more than a decade ago, little change had occurred in the diagnosis and management of ectopic pregnancy. The clinical use of sensitive pregnancy testing, transvaginal ultrasonography, and diagnostic laparoscopy has had a major impact on the preoperative diagnosis of this condition. The rate of ectopic rupture has declined,

and the option of conservative surgical management of an unruptured fallopian tube is now a viable alternative.

INCIDENCE AND RISK FACTORS

Ectopic pregnancy is the most common cause of maternal death in early pregnancy (RCOG 1997-1999) and its incidence is on rise. Most of the ectopic pregnancies occur in the young age group, and subsequent fertility is an important issue. Ectopic pregnancy is the one in which the fertilized ovum implants outside the uterine cavity. Its incidence has increased from 0.5 per 100 pregnancies

30 years ago, to the present day of 2 per 100 pregnancies (Hankins et al 1995, Lehner et al 2000). The Center for Disease Control (CDC) reports that the incidence of ectopic pregnancies is 1 in 70 pregnancies (Hill et al 1993).

Further, an increased incidence of sexually transmitted infections, early diagnosis of pelvic inflammatory disease resulting in tubal damage but not complete blockage, complications of infections, including therapeutic abortions, the wide clinical use of reconstructive tubal surgery, exposure to diethylstilbestrol and the conservative surgical treatment of ectopic pregnancy, and the rise in the number of ectopic pregnancies resulting from assisted reproductive technologies (ART) may account for the overall increase (Westrom et al 1991, Chung et al 1992, Majumdar et al 1983, Wolf et al 1980, DeCherney et al 2008). The incidence of tubal pregnancy after oocyte retrieval/embryo transfer may be as high as 4.5%, although this may be due to already existing tubal pathology in these patients and not solely due to ART intervention. The incidence of heterotopic pregnancy is now believed to be about 1:4,000 in the general population and 1 to 3% in *in vitro* fertilization (IVF) pregnancies, much higher than the originally described prevalence of 1:30,000 in the late 1940s (Symonds et al 1998, Seeber et al 2006).

Critical review of the relative contributions of these factors is pertinent. It is widely accepted that when pregnancy occurs in a woman using an IUD, there is an increased likelihood of ectopic pregnancy. Indeed, the ratio of ectopic pregnancy to intrauterine pregnancy has been reported to have increased sevenfold (Lehfold et al 1970, Vesset et al 1974, Mol et al 2008).

MANAGEMENT

For most tubal ectopic pregnancies (EP), surgery is the treatment of choice. Whether surgical treatment should be performed conservatively (salpingostomy) or radically (salpingectomy), and also laparoscopically or by laparotomy in women wishing to preserve their reproductive capacity, it is subject to debate. Salpingostomy preserves the tube but bears the risks of both persistent trophoblast and repeat ipsilateral tubal EP. Salpingectomy avoids these risks, but leaves only one tube for reproductive capacity (Mol et al 2008).

In first trimester, ectopic pregnancy is the most important cause of maternal mortality and morbidity (Akbar et al 2002). Prior to 1883, no woman ever underwent a deliberate and successful operation for a ruptured ectopic pregnancy when Trait did it for the first time. Surgical treatment may either be an open laparotomy or laparoscopy

depending on the surgeon's skill, equipment availability, and condition of the patient (Braun et al 2005). Over the past few decades, the management of ectopic pregnancy has been revolutionized. This has resulted in the emergence of several nonsurgical options to what had once been thought to be a solely surgically treatable condition. An earlier diagnosis can be made with transvaginal (TVUS) ultrasound and quantitative β -hCG. This increases the chances of success of medical treatment and minimizes the morbidity, mortality, and financial burden created by this health problem (Sawter et al 2001, Braun et al 2005). Nonsurgical management, like treatment with methotrexate has an established role in the treatment of ectopic pregnancy (Grudzinskas et al 1999, RCOG 2004), but little data are available on international scale.

AIMS AND OBJECTIVES

The aim of the review is to summarize the role of minimal access surgery in the management of tubal pregnancy and its management options, and further its effect on future pregnancy.

MATERIAL AND METHODS

A literature search was performed using the search engines PubMed, Yahoo, Wikipedia, Google, HighWire press, and SpringerLink. Selected papers were taken for further references. All articles, RCT (randomized controlled trial) following predominantly laparoscopic and open surgical protocol were included for review. The articles, also reviewed on the elements like study of follow-up on subsequent fertility explored in terms of intrauterine pregnancy, recurrence of ectopic pregnancy and sterility or cumulative intrauterine pregnancy rates, were comparable or superior to that of principle series treated by laparotomy whether radical or conservative and using or not using microsurgical techniques. Also, comparison between the therapeutic techniques (laparotomy or laparoscopy) has been made in view of present and future pregnancy outcome.

The techniques evaluated during the review were:

1. Laparoscopic
 - Linear salpingotomy (tubal aspiration)
 - Salpingectomy
 - Fimbrial expression.
2. Laparotomy.

LAPAROTOMY VERSUS LAPAROSCOPY

A number of early studies documented the appropriateness of laparoscopic treatment of ectopic pregnancies (Shapiro

et al 1973, Bruhat et al 1980, DeCherney et al 1981, 2008). Rates of conception of an intrauterine pregnancy after the procedure were as high as 70% in these cases. Pouly and associates (Pauly et al 1986) reported on 321 women with ectopic pregnancies who underwent conservative laparoscopic treatment. Of the women who did not have a history of infertility or previous ectopic pregnancy, 86% had a subsequent intrauterine pregnancy.

The advantages of laparoscopic removal of an ectopic pregnancy are a shortened operating time, convalescence, and hospital stay. It is imperative, however that proper case selection be exercised (Brumsted et al 1988, DeCherney et al 2008). If laparoscopic therapy is to be warranted, the first criterion is the expertise of the operator in performance of a laparoscopic surgical procedure. Patients must be stable without evidence of a significant hemoperitoneum.

One of the complications of conservative surgery via laparoscopy, persistent ectopic pregnancy, appears to be higher with laparoscopy (5-20% vs 2-11%). This is thought to be associated with the learning curve seen with laparoscopy. Optimally, the ectopic pregnancy should be confined to the ampullary portion of the tube and should be at least 2 cm in size (Lipscomb et al 2005, DeCherney et al 2008).

DISCUSSION

The incidence of ectopic pregnancy has remained static in recent years, i.e. 11.1/1000 pregnancies (RCOG 2004, Bangesh et al 2004, Wasim et al 2004, Lozean et al 2005). In this study, the rate was found to be 10/1000 deliveries, which is comparable. Ectopic pregnancy affects young women. The mean age was found to be 28 years and majority of them were multigravida. The commonest presenting symptom was abdominal pain (100%). These results are comparable with other studies (Bangesh et al 2004, Wasim et al 2004, Ben et al 2006).

Historically, the treatment of ectopic pregnancy was emergency laparotomy and salpingectomy. Nowadays, laparoscopic treatment is being considered the gold standard in hemodynamically stable patients, particularly where expertise is available. To minimize the morbidity, mortality and financial burden created by this rapidly growing health problem, nonsurgical alternatives are increasingly being investigated (Korhoren et al 1996, Lozean et al 2005).

Minimal access surgery, as an operative choice for management of life-threatening condition like ectopic pregnancy, leads to increased quality of life in terms of shorter hospital stay, speedy postoperative recovery,

reduced need of postoperative analgesia, cosmetically good scar and less psychological trauma to the patients.

Karsten et al (1990) also favored the laparoscopy over the laparotomy. He concluded that endoscopic management of ectopic pregnancy is recommended due to low postoperative morbidity rates and short time of hospitalization, and also positive effect on future pregnancy.

Pauli et al (1991) in their study also commented that in the absence of few rare contraindications, the most satisfactory surgical treatment of extrauterine pregnancy at present was laparoscopy. The authors found in their series of 223 patients desiring subsequent pregnancy that factors significantly affecting the fertility prognosis included the presence of adhesions on the tube, the condition of contralateral tube, and a history of salpingitis. Neither age, parity nor the characteristics of extrauterine pregnancy significantly affected the possibility of pregnancy in future.

In the era of laparoscopic carbon dioxide laser surgery, Langebrekke et al (1993) suggested in his study of 150 women with tubal pregnancy consecutively treated over a two years period by laparoscopic techniques. Sixty-six percent (38/58) of those women who desired pregnancy after conservative laparoscopic treatment achieved an intrauterine pregnancy. The corresponding rate for women who desired pregnancy after salpingectomy was 45% (18/40). The recurrent ectopic pregnancy rates in two groups were 7% (4/58) and 10% (4/40) respectively. This study confirms that tubal pregnancy can be appropriately managed by laparoscopic laser surgery with the advantages of minimal invasive techniques and also the laparoscopic management helps for better fertility outcome in future.

Oelsner et al (1994) studied that the reproductive performance following salpingectomy did not differ significantly whether by laparotomy or laparoscopy. The intrauterine pregnancy rate was 78 and 64% respectively and the repeat ectopic pregnancy rate was 12 and 6% respectively. Salpingectomy via laparoscopy can be performed safely with a low incidence of complications with subsequent reproductive performance comparable to laparotomy.

Akrong et al (1996) in his two years retrospective study reviewed the outcome of laparoscopic management versus laparotomy for the management of ectopic pregnancy. He found that there was no significant difference between the operating times and complications but the laparoscopy group had significantly fewer doses of opiate analgesia ($P < 0.05$), shorter length of stay ($P < 0.05$), and signifi-

cantly higher postectopic intrauterine pregnancy rates ($P < 0.05$) compared with the laparotomy group. Laparoscopic management of ectopic pregnancy is a viable alternative to conventional laparotomy in district general hospitals also.

Lundoff (1997) conducted a randomized, prospective clinical trial to compare the efficacy of laparoscopic treatment versus conventional conservative abdominal surgery for tubal pregnancy, and concluded that patients treated by laparoscopy had a shorter hospital stay and a shorter convalescence than patients from the laparotomy group.

Lo et al (1999) performed a prospective nonrandomized multicenter study to compare laparoscopic surgery and laparotomy in the immediate surgical outcome of tubal ectopic pregnancy (TEP), at nine teaching hospitals in Hong Kong. After exclusion of patients with shock, laparoscopic surgery offered a significantly shorter postoperative hospital stay (mean 2.7 days vs 5.3 days), a slightly lower perioperative complication rate (8.1% vs 13.9%), and more conservative surgery (90.1% of all salpingotomies) than laparotomy. A longer operating time was needed for laparoscopic surgery (1.2 hours vs 1.01 hours), which was not statistically significant.

Saleh et al (2003) in his study suggested that there were significant reductions of total blood loss, number of blood transfusion units, and duration of hospital stay in the laparoscopic group compared to the laparotomy group. The rates of subsequent intrauterine pregnancies were 74% (17/23) in the laparoscopy group and 61%, (19/31) in the laparotomy group, and the rates of subsequent ectopic pregnancies were 4% (1/23) in the laparoscopy group and 10% (3/31) in the laparotomy group concluding that laparoscopic treatment of ectopic pregnancy in hemodynamically stable patients offers major economic benefits superior to laparotomy in terms of less need for blood transfusion, shorter duration of hospital stay and convalescence, and future pregnancy outcome.

Tahseen et al (2003) concluded that laparoscopic surgery has advantages over open surgery and results in higher rates of subsequent intrauterine pregnancies and a lower rate of ectopic pregnancy. Authors also concluded the higher intrauterine pregnancy (IUP) rates after salpingotomy (2-23% higher IUP rates) than after salpingectomy.

Becker et al (2009) raised a concern as the most ectopic pregnancy cases now diagnosed and treated, early future reproductive outcome needs to be evaluated critically. Authors evaluated long-term reproductive outcome after

salpingotomy vs salpingectomy in patients with and without additional fertility reducing factors, and found that the laparoscopic salpingotomy is of particular benefit for patients with additional fertility reducing factors desirous of future pregnancy. Reproductive outcome is excellent in patients without such risk factors irrespective of the surgical approach.

Zhang et al (2010) favored the treatment of ectopic pregnancy with laparoscopic approach. In their study of 226 cases from January 2003 to December 2008, authors concluded that in order to preserve fertility, laparoscopic conservative surgery was a safe and feasible approach in treatment of tubal pregnancy. A word of caution added is that the preoperative serum hCG levels, size of tube gestational sac were significant factors influencing successful laparoscopic surgery.

Cochrane database review suggests different conclusions over different issues like intraoperative bleeding, need for intraoperative blood transfusion, hospital stay, cost, recurrence of the ectopic pregnancy and future pregnancy. Cochrane database (2007) reviewed the various treatment options and commented that the laparoscopic conservative surgery is significantly less successful than the open surgical approach in the elimination of tubal pregnancy due to higher persistent trophoblast rate of laparoscopic surgery. Long term follow-up shows similar tubal patency rates whereas the number of subsequent intrauterine pregnancies is comparable, and the number of repeat ectopic pregnancies lowers, although these differences are not statistically significant. The laparoscopic approach is less costly as a result of significantly less blood loss and analgesic requirement, and a shorter duration of operation time, hospital stay, and convalescence time.

Supporting the Cochrane database (2007), Desroque et al (2010) reviewed 24 papers of randomized control trial (RCT) or observational studies and concluded that there is no difference between laparotomy and laparoscopy as fertility was found.

CONCLUSION

Critical overview of literature of all possible approach demonstrates that the minimally access surgery is not only safe and effective but also economical than open laparotomy in the treatment of ectopic pregnancy and should consider as the gold standard in treating ectopic pregnancy. Not only in terms of short-term advantages of surgery, but it also had positive effects on the future pregnancy. Though certain studies and Cochrane database, and other recent studies

show no significant difference between the surgical and future pregnancy outcome, but it mentions the need for further properly organized, randomized controlled clinical trials. But from the past literature and ongoing research, a hopeful picture can be drawn about the laparoscopic management of ectopic pregnancy.

BIBLIOGRAPHY

1. Akbar N, Shami N, Anwar S, Asif S. Evaluation of predisposing factors of tubal pregnancy in multigravidas versus primigravidas. *J Surg PIMS* 2002;25:20-23.
2. Bangash N, Ahmed H. A study of 65 cases of ectopic pregnancy during one year period in military hospital. *Pak Armed Forces Med J* 2004;54:205-08.
3. Bangsgaard N, Lund CO, Otessen B, Nilas L. Improved fertility following conservative surgical treatment of ectopic pregnancy. *Br J Obstet Gynecol* 2003;110:765-70.
4. Becker S, Solomayer E, Hornung R, Kurek R, Banys M, Aydeniz B, Franz H, Wallwiener D, Fehm T. Optimal treatment for patients with ectopic pregnancies and a history of fertility-reducing factors. *Arch Gynecol Obstet* Nov 2009;10. [Epub ahead of print] [PubMed].
5. Ben Hmid R, Mahjoub S, Mourali M, El Houssaini S, Zeqhal D, Zouari F, et al. Management of ectopic pregnancy. *Tunis Med* 2006;84:238-41.
6. Bouyer J, Jobspira N, Pouly JL, Coste J, Germain E, Fernandez H. Fertility following radical, conservative surgical or medical treatment for tubal pregnancy: A population-based study. *BJOG* 2000;107(6):714-21.
7. Braun RD. Surgical management of ectopic pregnancy. Online 2005. Emedicine. [Cited 2005 Oct 27]. Available from: URL: <http://www.emedicine.com/med/topic3316.htm>-94k.
8. Bruhat MA, Manhes H, Mage G, et al. Treatment of ectopic pregnancy by means of laparoscopy. *Fertil Steril* 1980;33:411.
9. Brumsted J, Kessler C, Cison C, et al. A comparison of laparoscopy and laparotomy for the treatment of ectopic pregnancy. *Obstet Gynecol.* 1988;71:889.
10. Chung CS, Smith RG, Steinhoff PG, et al. Induced abortion and ectopic pregnancy in subsequent pregnancies. *Am J Epidemiol* 1982;115:879.
11. Clausen I. Conservative versus radical surgery for tubal pregnancy. *Acta Obstet Gynecol Scand* 1996;75:8-12. [PubMed]
12. DeCherney AH, Romero R, Naftolin F. Surgical management of unruptured ectopic pregnancy. *Fertil Steril* 1981;35:21.
13. DeCherney A, Agel W, et al. *Glob. libr. women's med.* (ISSN: 1756-2228) 2008; DOI 10.3843/GLOWM.10047, August 2008.
14. Desroque D, Capmas P, Legendre G, Bouyer J, Fernandez H. Fertility after ectopic pregnancy. *J Gynecol Obstet Biol Reprod (Paris)*. May 2010;15.
15. Grudzinskas JG. Miscarriage, ectopic pregnancy and trophoblastic disease. In: Edmonds DK. *Dewhurst's textbook of obstetrics and gynaecology for postgraduates.* (6th ed). Oxford: Blackwell Science 1999;61-75.
16. Hajenius PJ, Mol F, Mol BW, Bossuyt PM, Ankum WM, Veen. Interventions for tubal ectopic pregnancy. *Cochrane Database Syst Rev* 2007(1):CD000324. [PubMed]
17. Hankins GD, Clark SL, Cunningham FG, Gilstrap LC. Ectopic pregnancy. In: Dilmond E; Gilstrap. *Operative obstetrics.* New York: Appleton and Lange; 1995:437-56.
18. Hill GA, Herbert CM. Ectopic pregnancy. In: *Textbook of gynaecology.* Philadelphia: WB Saunders 1993;242-60.
19. Job spira N, Bouyer J, Pouly JL, Germain E, Coste J, Aublet Cuvelier B, Fernandez H. Fertility after ectopic pregnancy: First results of a population-based cohort study in France. *Hum Reprod* 1996;11:99-104.
20. Karsten U, Seifert B. Introduction and results in the endoscopic treatment of extrauterine pregnancy 1990;112(8):467-73.
21. Korhoren J, Stenman UH, Ylostalo P. Methotrexate with expectant management of ectopic pregnancy. *Obstet Gynecol* 1996;88:775-78.
22. Lehfeld H, Tietze C, Gorstein F. Ovarian pregnancy and the intrauterine device. *Am J Obstet Gynecol* 1970;108:1005.
23. Lehner R, Kucera E, Jirecek S, Egarter C, Husslein P. Ectopic pregnancy. *Arch Gynecol Obstet* 2000;263:87-92.
24. Lipscomb GH, Givens VM, Meyer NL, et al. Comparison of multidose and singledose methotrexate protocols for the treatment of ectopic pregnancy. *Am J Obstet Gynecol* 2005;192(6): 1844-47.
25. Lozean AM, Potter B. Diagnosis and management of ectopic pregnancy. *Am Fam Physician* 2005;72:1707-14.
26. Majumdar BH, Henderson PH, Semple L. Salpingitis isthmica nodosa: A highrisk factor for tubal pregnancy. *Obstet Gynecol* 1983;62:73.
27. Mol BWJ, Matthijse HC, Tinga DJ, Huynh T, Hajenius PJ, Ankum WM, Bossuyt PM, Veen van der F. Fertility after conservative and radical surgery for tubal pregnancy. *Hum Reprod* 1998;13:1804-09.
28. Mol F, Strandell A, Jurkovic D, Talcinkaya T, Verhoeve HR, Koks AM, Linden P, Graziosi G, Thurkow AL, Hoek A, Hangstrom L, Klinte I, Nilsson K, Mello N, Ankum W, Veen F, Mol B, Hajenius PJ. ESEP study: Salpingostomy versus salpingectomy for tubal ectopic pregnancy; The impact on future fertility: A randomized controlled trial. *BMC Women's Health* 2008, 8:11doi:10.1186/1472-6874-8-11.
29. Oelsner G, Goldenberg M, Admon D, Pansky M, Tur-Kaspa I, Rabinovitch O, Carp HJ, Mashlach S. Salpingectomy by operative laparoscopy and subsequent reproductive performance. *Human Reprod.* Jan. 1994;9(1):83-86.
30. Pouly JL, Mahnes H, Mage G, et al. Conservative laparoscopic treatment of 321 ectopic pregnancies. *Fertil Steril* 1986;46:1093.
31. Royal College of Obstetricians and Gynaecologists. The management of ectopic pregnancy. In *Guideline No. 21.* RCOG Press; 2004.
32. Seeber BE, Barnhart KT. Suspecting ectopic pregnancy. *Obstet Gynecol* 2006;107:399-413.
33. Shapiro HI, Adler DLH. Excision of an ectopic pregnancy through the laparoscope. *Am J Obstet Gynecol* 1973;117:290.
34. Silva P, Schaper A, Rooney B. Reproductive outcome after 143 laparoscopic procedures for ectopic pregnancy. *Fertil Steril* 1993;81:710-15.
35. Sowter MC, Farquhar CM, Petrie KJ, Gudex G. A randomized trial of comparing single dose systemic methotrexate and laparoscopic surgery for the treatment of unruptured tubal pregnancy. *Br J Obstet Gynecol* 2001;108:192-203.

36. Stromme WB, McKelvey JL, Adkins CD. Conservative surgery for ectopic pregnancy. *Obstet Gynecol* 1962;19:294-301. [Pubmed]
37. Symonds IM. Modern management in ectopic pregnancy, *Current obstetricians and gynecology* 1998;8:27-31.
38. Tahseen S, Wijldes M. A comparative case controlled study of laparoscopic versus laparotomic management for ectopic pregnancy: An evaluation of reproductive performance after radical versus conservative treatment of tubal ectopic pregnancy. *Am J Obstet Gynaecol* 2003;23:189-90.
39. Tait RL. Five cases of extrauterine pregnancy operated upon at the time of pregnancy. *Br Med J* 1:1884;1250.
40. The management of tubal pregnancy. *Royal college of obstetricians and gynecologists guidelines* 2004;21:1-10.
41. Vessey MP, Johnson B, Doll R, et al. Outcome of pregnancy in women using an intrauterine device. *Lancet* 1974;1:495.
42. Wasim T. Proportionate morbidity and risk factors of ectopic pregnancy. *Ann King Edward Med Coll* 2004;10: 298-300.
43. Westrom L, Bengtsson LPH, Mardh PA. Incidence trends, and risks of ectopic pregnancy in a population of women. *Br Med J (Clin Res)* 282;15:1981.
44. Wolf GC, Thompson NJ. Female sterilization and subsequent ectopic pregnancy. *Obstet Gynecol* 1980;55:17.
45. Yao M, Tulandi T. Current status of surgical and nonsurgical management of ectopic pregnancy. *Fertil Steril* 1997;67:421-33. [Pubmed]
46. Zhang J, Hao WM, Wei W, Zhang DW, Li YN. Outcome and relevant factors of tubal pregnancy treated with laparoscopic conservative surgery *Zhonghua Fu Chan Ke Za Zhi*: Feb. 2010;45(2):84-88.

Hysteroscopic Sterilization

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Abstract

Female sterilization is the most widely accepted contraception in the world today. From a practical perspective, gynecologists are at constant drive to provide effective, safe, least discomfort/pain and economical contraception to the couple. With the advent of hysteroscopic surgery innovation in the form of better optics, endoscopes, camera, equipment, and insufflation machines revolutionized the surgery. This review will discuss the evolution of different hysteroscopic sterilization methods, including the past, present and upcoming devices. However, concerns remain about the absolute irreversibility of the method of sterilization. Researchers have failed to find solution to meet all the criteria. But this route obviates surgical incision and requires local anesthesia or intravenous sedation. The safety, tolerability and efficacy of hysteroscopically placed device are discussed in depth. This article will certainly help the clinicians to keep abreast of latest advances in contraception and practice in broader perspective despite the availability of limited literature.

Keywords: Transcervical sterilization, Micro-insert device, Hysterosalpingogram (HSG).

INTRODUCTION

Blind attempts of electrocautery of uterotubal junction were reported as early as 1878. In 1916 Cooper and in 1927 Schroeder suggested direct visualization of tubal ostia and attempted hysteroscopic sterilization by diathermy. Some plugs were applied which expelled. All methods were withheld as private industry was not willing to spend money. Almost 30 years later re-exploration to occlude fallopian tube was undertaken with the advent of technology. Dr Rafael Valle et al introduced STOP intratubal device made up of stainless steel and coil amalgamate of steel and platinum. Upon deployment, it expands and anchors to fallopian tube. Inside the device, Dacron was used to permit tissue growth and occlude the tubes. The women indicated for hysterectomy at later date were picked for study design.

Historically, researchers have based their effects around one of the following strategies:

- Mechanical and occlusive devices or plugs
- Injection of tissue sclerosants or adhesives
- Diathermy.

PAST METHODS

Electrocautery

An electrode is passed into the intramural portion of the tube under hysteroscopic guidance, and coagulatory current is applied for several seconds. Authors reported patency rates as high as 20%. Poor effective rates, thermal injury, and uterine perforation made this technique unsafe in current use.

ND:YAG Laser

Laser is delivered through a long, flexible quartz fiber. Thermal injury to the depth of 5 mm is noted. The procedure was not cost-effective and trial was terminated due to high patency rate of 74%.

Chemical Method

Quinacrine is a drug with multitude of applications. Its main effects are antiprotozoal, antirheumatic, and sclerosing agent. This unique property of sclerosis was employed by Zipper et al to induce scar tissue at uterotubal junction to create block. In earlier studies (Chile), the quinacrine was delivered as slurry with dilution of 125 mg/ml and 250 mg/ml, three deaths were reported due to sudden absorption through endometrial capillaries. Later modified 7 pellets of 36 mg of quinacrine are placed into the uterus using a tube similar to Cu-T inserter in 2 to 3 doses one month apart in the proliferative phase of menstrual cycle. Quinacrine is a mutagen. It acts by chelation of DNA forming quinacrine DNA complex.

It is generally well tolerated and can be associated with cramping pain. Small number of women had salpingitis 3%, menstrual disorder 2.7% and dysmenorrhea 2%.

Pellets offered a cumulative pregnancy rate of 4.6%. Ten years of Vietnam study revealed a pregnancy rate of 12%. The most attractive part of quinacrine sterilization was cost effectiveness. No randomized controlled trials have been reported to date and there is controversy over its use.

CURRENT METHODS

Essure Micro-insert

It is the first transvaginal approach approved by FDA in 2002 for intertubal sterilization technique (Fig. 1). The Essure micro-insert is wound-down configuration in 4 cm long nickel-titanium(nitinol) alloy outer coil in which the polyethylene terephthate (pet fibers) is inserted to



Fig. 1: Expanded essure device. The essure micro-insert expands to a diameter of 1.5 to 2 mm depending on the diameter and shape of the surrounding fallopian tube

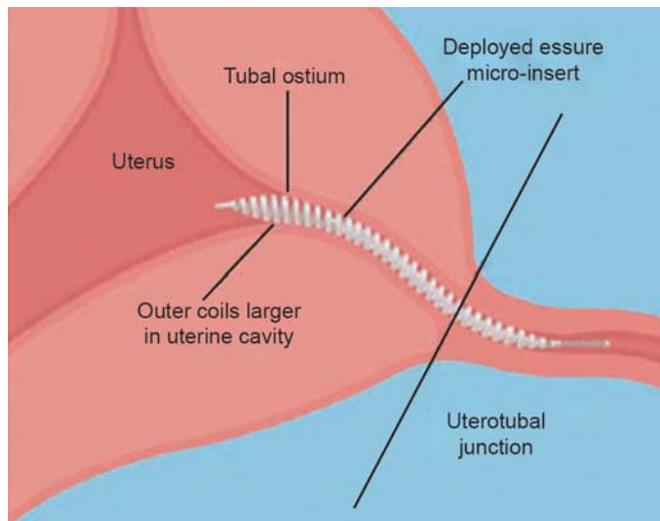


Fig. 2: Diagram of the UTJ. The micro-insert should span the UTJ, defined as the portion of fallopian tube just as it exits the uterus. In this location, the coils span the intramural and proximal isthmic portions of the fallopian tube. The device is placed far enough into the tube to prevent expulsion during uterine contractions during menses, but still has a portion trailing into the uterine cavity. The outer diameter of the coils that trail into the uterus is larger than that of the coils in the fallopian tube, which helps anchor the device. The UTJ is most consistently the narrowest portion of the fallopian tube, which further aids in anchoring the device

intramural part of fallopian tube under hysteroscope guidance (Fig. 2). It attracts macrophages, mononuclear cells, fibroblasts, foreign body giant cells, and plasma cells immediately (Figs 3A to C). The inflammatory response peaks between 2 and 3 weeks and lasts approximately 10 weeks. Induced fibrous reaction blocks the tube, which is irreversible. Hence, alternative contraception is advisable for three months. It is preferably advised in proliferative period or 6 weeks postnatal or post-termination allows enhanced visualization of tubal ostia and optimizes the success rate.

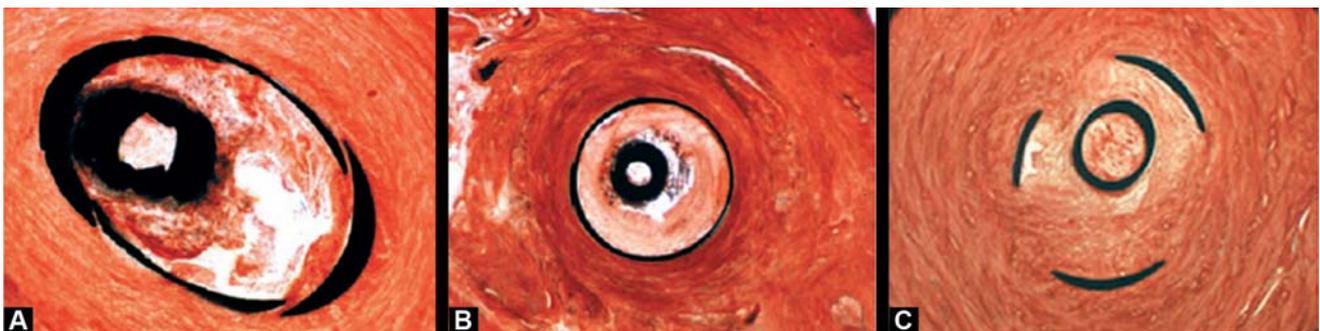
It is recommended to women who have completed their families and desire permanent sterilization. It is also excellent choice for women with high risk of general anesthesia, intraoperative complication, adhesions and bleeding. Women with an intracavity lesion, congenital anomaly, fibroids, infection, uterine synechiae, cervical cancer, cervical stenosis and scarring of uterus or cervix may not be eligible for essure as visualization of tubal ostia is compromised. Pregnancy test is essential on the day of surgery to exclude luteal phase of pregnancy if contraception not practised.

Patient Counseling

Patient's consent is taken which briefs the name of the surgery, procedure, benefits, risks of both sterilization and hysteroscopy, and alternative methods. The implications of anesthesia are also discussed and supported with information leaflet. Although the procedure is simple, nurse or assistant can reiterate in lay terms the procedure on the day of surgery. Patient is put to ease as much as possible. Patient is instructed to empty her bladder.

Procedure

The procedure is performed under intravenous conscious sedation (midazolam/fentanyl) or local paracervical block. The uterovaginal plexes are predominantly located lateral



Figs 3A to C: Histologic findings after essure placement. (A) At 1 week, fibrosis and acute inflammatory cells can be seen infiltrating the device.(B) Four weeks after placement, both acute and chronic inflammatory cells are present and fibrosis is beginning to occlude the lumen. (C) At 10 weeks, dense fibrosis is filling the tubal lumen

and posterior to the cervix. The cardinal ligament transit nerve at 3 and 9 o'clock position. Uterosacral at 5 and 7 o'clock position. Injection of 1% lignocaine 3 to 5 ml is recommended at 4 and 8 or 5 and 7 to maximize the anesthesia while paracervical block is performed. Each step is kept informed. A nonsteroidal anti-inflammatory suppository may help to alleviate her uterine cramps.

The OT is set with basic instruments which includes hysteroscope and diagnostic sheath, a sheath to permit passage of ancillary instruments, distension media, lighting system, and duck-billed speculum, a single-toothed tenaculum, dilators stand by and a paracervical kit (Fig. 4).

The procedure begins with the patient in the lithotomy stirrups. The vulva and perineal areas are sterilely prepped with the iodine based solution and then sterile drapes are placed over the legs and abdomen. A pelvic examination is performed to determine the size of uterus and its orientation. The cervix is identified. The hysteroscope is introduced and findings are explained to the women observing the view. A sterile speculum is placed on posterior vaginal wall.

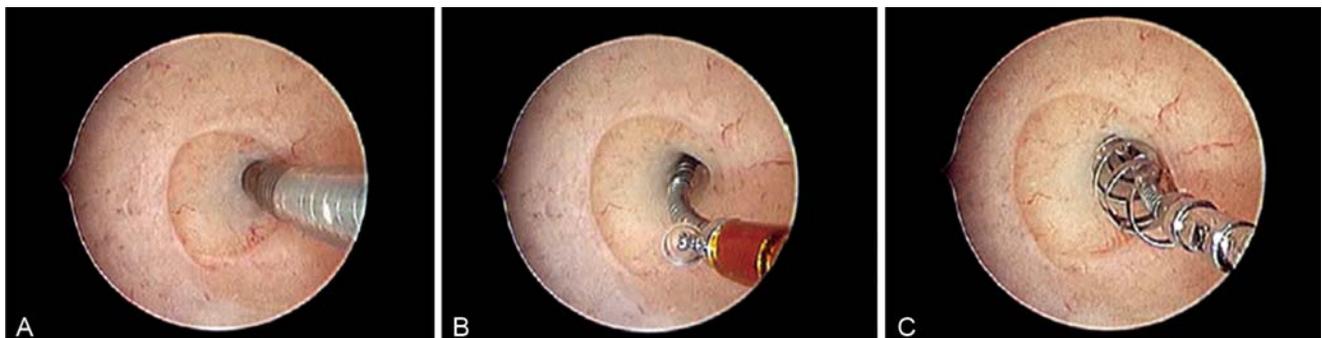
The micro-inserts are placed using essure delivery system through a 5 mm hysteroscope 12 to 30 degrees, which allows cannulation of fallopian tube, as it helps in forward view. With a continuous flow system, the hysteroscope is placed under direct visualization through the cervix prior to dilatation. Normal saline is used during placement of hysteroscope to aid visualization. An initial

attempt to pass the hysteroscope may be made without the use of tenaculum. If needed, cervical dilatation is performed. Normal saline is used at body temperature and introduced under gravity. Pressure bags may be used to maintain uterine distension. Panoramic view of uterine cavity is taken, ostia identified. Easier one is taken up first, which will help prevent the endometrium from becoming edematous and obscuring the view.

The essure delivery system is passed through introducer and down the working channel with tubal ostia in view. The system is advanced into the proximal fallopian tube with constant gentle forward pressure, which helps to prevent tubal spasm (Figs 5A to C). When the black mark is at ostia, the unit is deployed and handle of delivery device is stabilized against the hysteroscope. The technique involves the thumb on essure handle, which is rotated at one click/sec retracting the delivery catheter and exposing the wound-down. Approximately 1 cm of insert is visible in uterine cavity, i.e. small notch on wound-down insert and orange catheter is out and confirms proper placement. Then, button on the handle is depressed enabling the thumb to rotate. If arrest of rotation and no further withdrawal of orange catheter occurs, the procedure is complete and allows insert to expand approximately 10 cm. With a counter clockwise rotation, the delivery system is withdrawn from the catheter. After the procedure, 3 to 8 outer coils should be visible in uterine cavity. If 18 or more, consider removal of the device. The same procedure is repeated on contralateral side. The mean procedure time is 9 to 13 minutes. Proper placement of the device can be confirmed by X-ray at 11 o'clock and 1 o'clock position or ultrasound. Patency of the tube can be ascertained by HSG after three months. Postoperatively women are advised analgesics for pain and to abstain from sex for 10 days to avoid infection. The women are informed



Fig. 4: Essure micro-insert in wound-down configuration. The essure micro-insert, when attached to the delivery wire in a wound-down configuration, is 4 cm in length and 0.8 mm in diameter



Figs 5A to C: Steps for correct placement of the micro-insert. (A) When the black marker on the delivery catheter is at the ostia, the insert is in the ideal position spanning the intramural and proximal isthmic segments of the fallopian tube. (B) After retracting the delivery catheter and exposing the wound-down micro-insert, the orange attachment to the delivery catheter can be identified. To confirm proper placement, the small notch in the wound-down insert should be located just outside the tubal ostium before completing the deployment of the device. (C) Ideally, three to eight expanded outer coils should be trailing in the endometrial cavity. Here four coils are seen

of alternative contraception for 12 weeks. The women are discharged on the same day with follow-up date.

STUDY SUMMARY

Phase 1 trial revealed that 85% had successful placement, 98% had satisfactory rate and bilateral block demonstrated. In retrospective study from 2002 to 2008 in Netherlands, 10 unwanted pregnancies occurred which could be due to expulsion of device (2.9%), perforation (1%). Other reasons could be due to inadequate interpretation of HSG, noncompliance of physician or defaulted follow-up. After modification of device by innovating hydrophilic coating and improved flexibility, the success of cannulation was 98%. Phase 2 trial revealed 96% correct device placement. One patient expelled the device and in other device was placed in myoma. In phase 3 trial, 11 were declined due to uterine polyp, blocked ostia and cervical stenosis.

RESULTS

First study of safety was established in 2001. Over 50,000 procedures have been formed worldwide with 12,000 in Europe, where 600 surgeons were trained in the technique. Recently accepted FDA data indicates 99.7% effectiveness with usage over 5 years.

Adverse Effects

No method is 100% effective. There is a possibility of ectopic pregnancy. Postprocedural pain (1-3%) resolved in one to three days. Mild vaginal bleeding lasted upto one week. Perforation (1%) could be due to support catheter, which was later abandoned. A case of pyosalpinx noted could be attributed to migration of device. The risk of pregnancy can be reduced by strict follow-up. The theoretical risk of interference with IVF pregnancy. Progressive encapsulation is unlikely to interfere with embryo transfer. The risks of hysteroscopy should not be forgotten. The major drawback with the device is that first generation ablative techniques are not possible.

Hysteroscopy complications include cervical laceration with tenaculum forceps. Uterine perforation can be encountered with forceful dilatation, false passage; bleeding can occur if hysteroscope is advanced blindly or forcibly into the uterine cavity. Infection is rare if necessary precaution of disinfection is undertaken prior to surgery.

Complication of distention media is of concern in prolonged hystereoscopic surgeries. In sterilization surgery, fluids containing electrolytes when used are less likely to

cause serious problem. It is wise to keep intrauterine pressure below 100 mm Hg. Hypercarbia, acidosis and air embolism may be encountered if carbon dioxide is used in office hysteroscopy.

Local anesthesia occasionally may cause allergic reaction. The most common complications are due to intravasation.

DEVICE IN DEVELOPMENT

Adiana Complete System

It is a two stage procedure. In the first instance the intramural part is treated with radiofrequency energy (Fig. 6). The second step is the placement of porous silicone nonbiodegradable matrix, a size of grain is inserted into the tubal lumen. The implant provokes a fibrous reaction and occludes the tube over the period of week.

Procedure involves a flow hysteroscope, the 5F catheter is placed in 6F working channel. A black mark on catheter assures correct placement. Later, radiofrequency generator



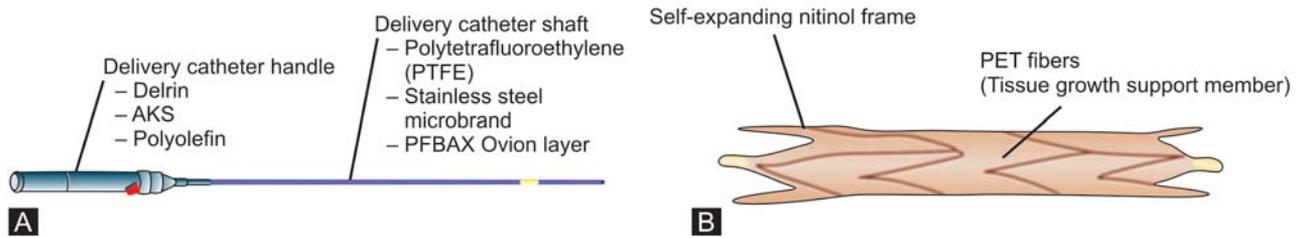
Fig. 6: The Adiana system

is activated at tubal ostia. The sensors give feedback when heated and later the matrix is released from the tip of the delivery system. Proximal 12 mm of tube is cannulated. The concept is to allow the growth of healthy vascularized tissue in the porous matrix. The mean procedure time is 12 minutes. There was no procedure related adverse event. Women are asked to continue contraception for 12 weeks. HSG at this point confirms success.

The EASE trial (evaluation of Adiana system) was completed in 2005. It was stated, 612 women were treated with an 95% bilateral insertion rate.

Ovion Eclipse

This system was designed to negate the shortcoming of Essure implant, such as endometrial ablation technique and potential need of IVF pregnancy (Figs 7A and B). To accommodate this criteria, the device was shortened by



Figs 7A and B: The Ovion System: (A) The Ovion system is 1 mm in outer diameter and can be placed through 3F working channels found in small rigid or flexible hysteroscopes. (B) The micro-insert is made up of a self-expanding nitinol frame embedded with PET fibers, which support tissue ingrowth

2 cm. It is permanent contraceptive device consisting of expandable metal tube containing an inner matrix that induces fibrosis and blockage of the intramural part of tube. FDA approval has not yet sought. The micro-insert is composed of self-expanding nitinol frame embedded with PET fibres. No portion of device trail to uterine cavity. Ovion system is 1 mm in outer diameter and can be placed through 3F working channel found in small rigid or flexible hysteroscopes. Both micro-inserts are loaded simultaneously so they could be deployed in succession. The ovion device can be loaded to flexible hysteroscope as office use. It is easier, faster and could have potential benefit of IVF or endometrial ablation.

Intratubal Ligation Device(USA)

The occlusion is achieved by ligation of intravaginal portion of tubal epithelium by an elastomeric band which leads to scar formation and creates permanent damage. This is under phase I trial.

SUMMARY

After 100 years of seeking safe and effective methods for female sterilization that avoid entry into the abdomen, transcervical sterilization is today's reality. Essure appears to be equal or superior to laparoscopic sterilization. It offers benefits of an office procedure under local anesthesia. It is cost-effective and better resource utilization. Hysteroscopic sterilization is alternative in women with severe cardiopulmonary disease, obesity or a history of prior abdominal or pelvic surgery where laparoscopy is contraindicated. Adequate audit and women counseling is essential. Future insight to develop reversible device is challenging.

Points to Remember

- Method of tubal occlusion using electrocautery or ND: YAG laser is abandoned.

- Transcervical methods. Essure is safe and effective. No major adverse events are reported. Strict inclusion criteria and follow-up is essential to optimize the outcome. Alternative contraception practice is mandatory for improved success rate. HSG is advocated after 12 weeks to assess the outcome.
- In the Adiana method, the procedure is safe and well tolerated. Cost data is not yet known.
- Quinacrine is studied in poorer nations where medical technology is less. It is a mutagen. It is implicated as a potential carcinogen although not established. It is cost effective.

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BIBLIOGRAPHY

1. Cooper JM, Carignan CS, Cher D, Kerin JF. Selective Tubal Occlusion Procedure 2000 Investigators Group. Microinsert nonincisional hysteroscopic sterilization. *Obstet Gynecol.* 2003;102(1):59-67.
2. Cooper JM. New approaches to hysteroscopic sterilization. *Contemp Ob Gyn* 2003;48:8-20.
3. Essure (package insert). San Carlos, CA: Conceptus Inc.; 2002.
4. Estridge TD, Feldman DS. Quantification of vascular ingrowth into Dacron velour. *J Biomater Appl* 1991;6(2):57-169.
5. Kerin JF, Carignan CS, Cher D. The safety and effectiveness of a new hysteroscopic method for permanent birth control: Results of the first Essure pbc clinical study. *Aust NZJ Obstet Gynaecol* 2001;41(4):364-70.
6. Kerin JF, Cooper JM, Price T, et al. Hysteroscopic sterilization using a microinsert device: Results of amulticentre phase II study. *Hum Reprod* 2003;18:1223-30.
7. Kerin JF, Munday DN, Ritossa MG, Pesce A, Rosen D. Essure hysteroscopic sterilization: Results based on utilizing a new coil catheter delivery system. *J Am Assoc Gynecol Laparosc* 2004;11(3):388-93.
8. MacKay AP, Kieke BA (Jr), Koonin LM, Beattie K. Tubal sterilization in the United States 1994-1996. *Fam Plann Perspect.* 2001;33(4):161-65.

9. New developments Advances in hysteroscopic sterilisation. The Obstetrician and Gynaecologist 10.1576/toag.8.2.103.27229 www.rcog.org.uk/togonline 2006;8:103-06.
10. Valle RF, Carignan CS, Wright TC. STOP Prehysterectomy Investigation Group. Tissue response to the STOP microcoil transcervical permanent contraceptive device: Results from a prehysterectomy study. Fertil Steril 2001;76(5):974-80.
11. Valle RF, van Herendael BJ. New indications for hysteroscopy: Sterilization. In: Van Herendael BJ, Valle R, Bettochi S (Eds). Ambulatory Hysteroscopy:Diagnosis and Treatment. Chipping Norton, Oxfordshire, UK: Bladon Medical Publishing; 2004: 143-51.
12. Veersema S, Vleugels MP, Moolenaar LM, Janssen CA, Brölmann HA. Unintended pregnancies after Essure sterilization in the Netherlands. Fertil Steril. Jan 2010;93(1):35-88. Epub 2008 Nov 21.
13. Westhoff C, Davis A. Tubal sterilization: Focus on the US experience. Fertil Steril. 2000;73(5):913-22.

Tissue Glue in Laparoscopic Inguinal Hernia Repair: A Retrospective Comparative Analysis

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Abstract

During the last two decades, there have been two revolutions in inguinal hernia repair surgery. First, the introduction of tension-free hernia repair by Liechtenstein in 1989 and then the application of laparoscopic surgery to the treatment of inguinal hernia in the early 1990s. In this context, the choice of mesh fixation methods being an integral part of this procedure remains a topic of arguments and discussions in laparoscopic inguinal hernia repair. There exist many methods of mesh fixation like polyglactin suture, titanium spiral tacks, nitinol anchors and fibrin glue.

Fixation usually uses staples that can lead to nerve injury and chronic postoperative pain. Laparoscopic repairs are associated with a risk of chronic pain of upto 22.5%. The use of fibrin glue may represent an alternative method of mesh fixation preventing the risk of nerve injury.

Keywords: Fibrin sealant, Tissue glue, Fibrin glue, Tisseel, Inguinal hernia, Laparoscopic herniorrhaphy, TAPP, TEP, Mesh fixation.

INTRODUCTION

Presently, the laparoscopic inguinal hernia repair is accomplished by two approaches: Transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) repair with mesh prosthesis. TAPP is preferred as it manages all types of hernia (direct, oblique, femoral, and obturator), whether unilateral or bilateral, primary or recurrent. Furthermore, because of its size the preperitoneal mesh prosthesis covers the entire musculopectineal foramen, where these hernias occur. Among various options available for mesh fixation, fibrin glue is being used increasingly as an alternative method for hernia surgery, significantly preventing the risk of nerve injury and helping to reduce the incidence of chronic pain. Reliable laparoscopic fixation of meshes prior to their fibrous incorporation minimizes recurrences following transabdominal preperitoneal hernia repair (TAPP) and totally extraperitoneal repair (TEP) repair of inguinal hernias. Various types of staples are available for reliable mesh fixation. However, their use has been associated with a certain amount of surgical trauma. Suture-tack- and staple-based fixation systems are associated with postoperative chronic inguinal pain. Reported complications include neuralgia or paresthesia because of nerve entrapments. A chronic form of pubalgia is caused by stapling of the prosthesis to Cooper's ligament. Bleeding or hematomas in Retzius' space (muscular, corona mortis) also may occur.

In 1997, Chevrel and Rath first proposed fibrin sealant as an alternate means of mesh fixation in hernia repair with the aim of reducing the rate of hernia recurrence. Canonico later reported the benefits of fibrin sealant in reducing bleeding complications following hernia repair in patients with impaired coagulation. Katkhouda employed a pig model using a total extraperitoneal (TEP) technique to evaluate the tensile strength of mesh fixation 12 days after the use of Tisseel[®], demonstrating equal strength to staples. The results of these studies have encouraged surgeons to use fibrin sealant in daily practice as an atraumatic alternative to mechanical mesh fixation. As an atraumatic alternative, the application of fibrin glue (Tissucol/Tisseel, Baxter Healthcare, Deerfield, IL, USA) is a viable and reliable option, which keeps mesh in place without the complications associated with stapling. In terms of tensile strength and mesh dislocation, fibrin glue is equivalent to stapling.

AIMS

The aim of this review article is to evaluate the feasibility and efficacy of use of fibrin glue/tissue glue (tisseel) in laparoscopic inguinal hernia repair, short- and long-term postoperative pain, surgical complications (bleeding, seroma, hematoma, wound infection, incisional hernia, testicular complications) and recurrence rates. This article also emphasizes on evaluation of the advantages and disadvantages of fibrin glue as compared to other methods

of mesh fixation to demonstrate whether fibrin-based mesh adhesion provides adequate biomechanical stability for repair of inguinal hernia by TAPP and TEP and to elucidate the extent to which tacks, anchor-based fixations can be replaced with fixation with fibrin glue/bioadhesives for laparoscopic inguinal hernia repair. The following parameters were also evaluated:

1. Patient selection
2. Operative technique
3. Operating time
4. Intra and postoperative complications
5. Postoperative pain
6. Hospital stay
7. Cost effectiveness.

MATERIALS AND METHODS

The literature utilized in this article were taken from search engine Google, SpringerLink library, HighWire press, Surgical endoscopy journal, World journal of surgery, Medscape. The following terms were used: Fibrin glue in laparoscopic hernia repair, TAPP, Fibrin sealant in hernia repair, role of fibrin glue in TAPP, TEP. The selected articles were screened for further references.

FIBRIN GLUE

Fibrin glue/sealant is a commercial tissue adhesive containing fibrinogen and thrombin. The commercial product is a two component system from human plasma that contains more than fibrinogen and thrombin. The first component contains

highly concentrated fibrinogen, factor XIII, fibronectin, and traces of other plasma proteins. The second component contains thrombin, calcium chloride, and antifibrinolytic agent such as aprotinin (Table 1). Mixing of two components leads to activation of fibrinogen and thrombin by calcium chloride, formation and cross-linking of fibrin leading to the formation of polymerized fibrin chains, duplicating the last step of the coagulation cascade. The fibrinogen component gives tensile strength, thrombin stimulates fibroblast proliferation and aprotinin, an antifibrinolytic agent enhances the life span of the sealant.

The required dose of fibrin sealant depends on the size of the surface to be covered, as shown in Table 2.

Fibrin sealant contains the following substances in four separate vials:

1. Sealer protein concentrate (Human), vapor-heated, freeze-dried
2. Fibrinolysis inhibitor solution (Bovine)
3. Thrombin (Human), vapor-heated, freeze-dried
4. Calcium chloride solution.

Freeze-dried sealer protein concentrate and thrombin are reconstituted in fibrinolysis inhibitor solution and calcium chloride solution respectively (Flow Chart 1). The resulting sealer protein solution and thrombin solution are then combined (by using the duploject system, or equivalent delivery device) to form the fibrin sealant:

Various methods can be used to apply the two components of the sealant, the duploject and application needle being the most convenient and popular in laparoscopic surgery.

Table 1: Composition of tissue glue

		Package sizes			
		0.5 ml	1.0 ml	2.0 ml	5.0 ml
Sealer protein concentrate	Fibrinogen (mg)	37.5-57.5	75-115	150-230	375-575
	Total protein (mg)	50-65	100-130	200-260	500-650
	Polysorbate 80 (mg)	0.1-0.2	0.2-0.4	0.4-0.8	1-2
	Sodium chloride (mg)	1-2	2-4	4-8	10-20
	Trisodium citrate (mg)	2-4	4-8	8-16	20-40
	Glycine (mg)	7.5-17.5	15-35	30-70	75-175
Fibrinolysis Inhibitor solution	Aprotinin (KIU)	1500	3000	6000	15000
	Volume (ml)	0.5	1.0	2.0	5.0
Thrombin	Thrombin (IU)	250	500	1000	2500
	Total protein (mg)	22.5-27.5	45-55	90-110	225-275
	Sodium chloride (mg)	4-6	8-12	16-24	40-60
	Glycine (mg)	1.2-1.8	2.4-3.6	4.8-7.2	12-18
Calcium chloride Solution	CaCl ₂ (µmol)	20	40	80	200
	Volume (ml)	0.5	1.0	2.0	5.0
	Total combined				
	Volume (ml)	1.0	2.0	4.0	10.0

Table 2: Amount of fibrin sealant required

Maximum size of the area to be sealed	Required package sizes of fibrin sealant
4 cm ²	0.5 ml
8 cm ²	1.0 ml
16 cm ²	2.0 ml
40 cm ²	5.0 ml

Commercially, fibrin sealant is available under the trade name of Tisseel, marketed by Baxter and is supplied in four different package sizes of 0.5, 1.0, 2.0 and 5.0 ml, containing the following components:

- Tisseel Kit 0.5 for 0.5 ml of reconstituted Tisseel solution and 0.5 ml thrombin solution.
- Tisseel Kit 1.0 for 1.0 ml of reconstituted Tisseel solution and 1.0 ml thrombin solution.
- Tisseel Kit 2.0 for 2.0 ml of reconstituted Tisseel solution and 2.0 ml thrombin solution.
- Tisseel Kit 5.0 for 5.0 ml of reconstituted Tisseel solution and 5.0 ml thrombin solution.

OPERATIVE TECHNIQUE TAPP WITH FIBRIN GLUE MESH FIXATION

Patient Positioning

The procedure is performed under general anesthesia. The position of the patient is supine with a slight trendelenburg tilt (15-20), legs together and arms alongside the body. The surgeon stands on the opposite side of the hernia and the assistant stands on the other side of the table. The scrub nurse and instrument table are beside the surgeon. The laparoscopy rack lies at the feet of the patient, in front of the surgical team.

Trocar Positioning

Pneumoperitoneum is achieved with a Veress needle inserted at the umbilical site. After an endoabdominal pressure of 12 to 14 mm Hg has been obtained, the first 10 mm trocar replaces the needle at the same site. A 30° scope is inserted. The other two trocars are inserted by transillumination under internal vision (with care taken to avoid the inferior epigastric

vessels) at the level of the transverse umbilical line just lateral to the rectus sheath. The 5 to 12 mm operative trocar is always placed on the right hand side for both unilateral and bilateral hernias, and a 5 mm trocar is placed on the opposite side. For bilateral hernias, the two operative trocars are placed about 1 cm below the transverse umbilical line. For a unilateral hernia, the trocar would be positioned 1 cm above the line, at the intersection with the midclavicular line to create the classic triangulation of base ball diamond concept aimed at the surgical field with the trocars. The assistant operates the scope from the opposite side of the table. Evaluation of inguinal regions allows all defects of the transversalis fascia to be detected. The main landmarks are the remnants of umbilical artery, the ligament of Cooper, epigastric vessels, and the anterosuperior iliac spine, all of which also allow definition of the hernia type.

Incision of the Peritoneum

If the hernia defect is on the right side, after the iliac spine is located by external pressure, the peritoneum is incised with the scissors at this point, and the incision is continued horizontally and medially. For a left-sided defect, the incision is performed from the lateral aspect of the umbilical artery and extended as far as the left iliac spine (Fig. 1). Peritoneal dissection follows the hernia orifice completely at about

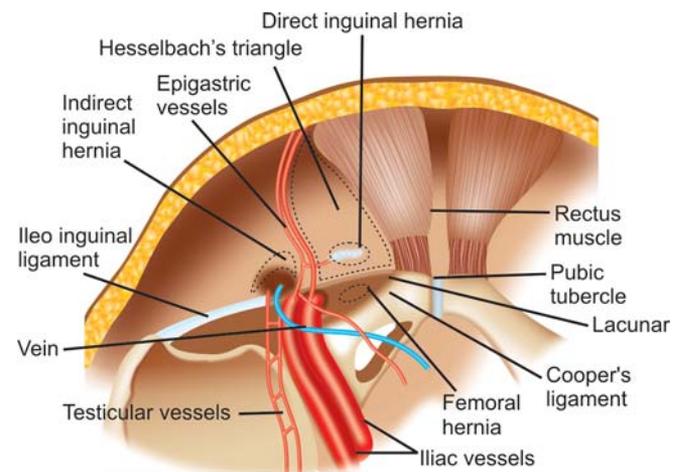
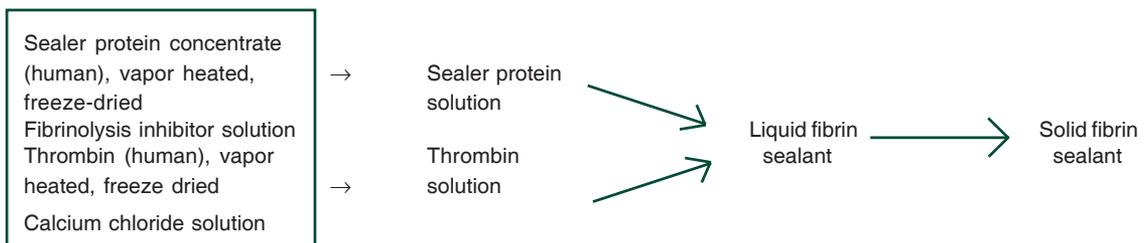


Fig. 1: Anatomy of left side inguinal hernia



Flow Chart 1: Action of sealant

0.5 to 1 cm from its upper margin, thus freeing the hernia sac from all visceral and parietal connections. Once the peritoneum is incised, it should be lifted bluntly with the scissors to allow seeping of the carbon dioxide (CO₂) to assist in peritoneal detachment. Forceps are used to lift the upper peritoneal margin, while scissors are used to complete peritoneal detachment and inferior epigastric vessel dissection.

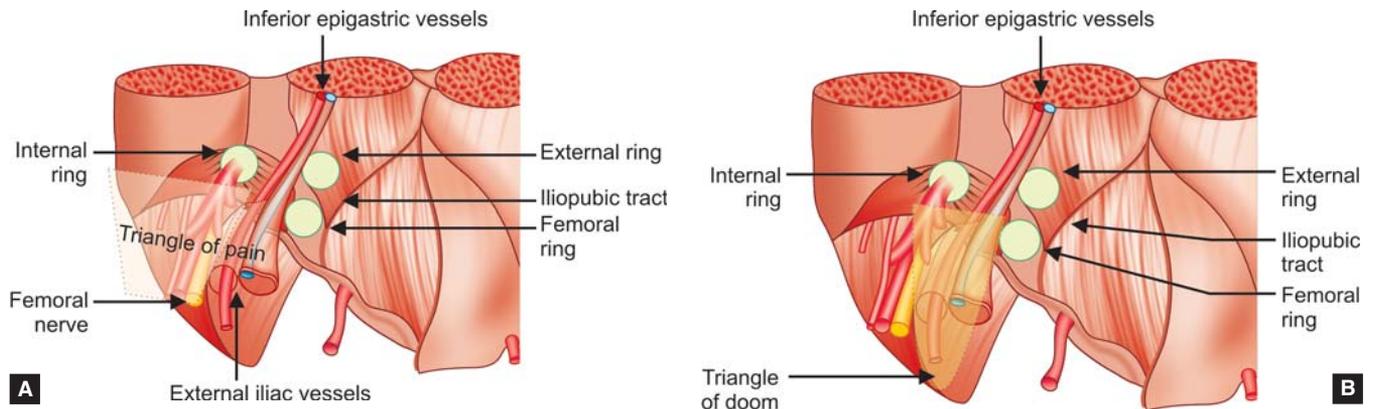
Parietalization

The pressure of CO₂ entering between the peritoneum and abdominal wall helps dissection and basically requires two instruments: Scissors and 5 mm tissue forceps. The inferior peritoneal margin is pulled towards the surgeon with tissue forceps and bluntly dissected from the spermatic cord, which is parietalized to obtain an inverted triangle with the vas deferens running medially and the genital vessels running laterally between the iliac vessels in the so-called “triangle of disaster.” Parietalization of the spermatic cord is an

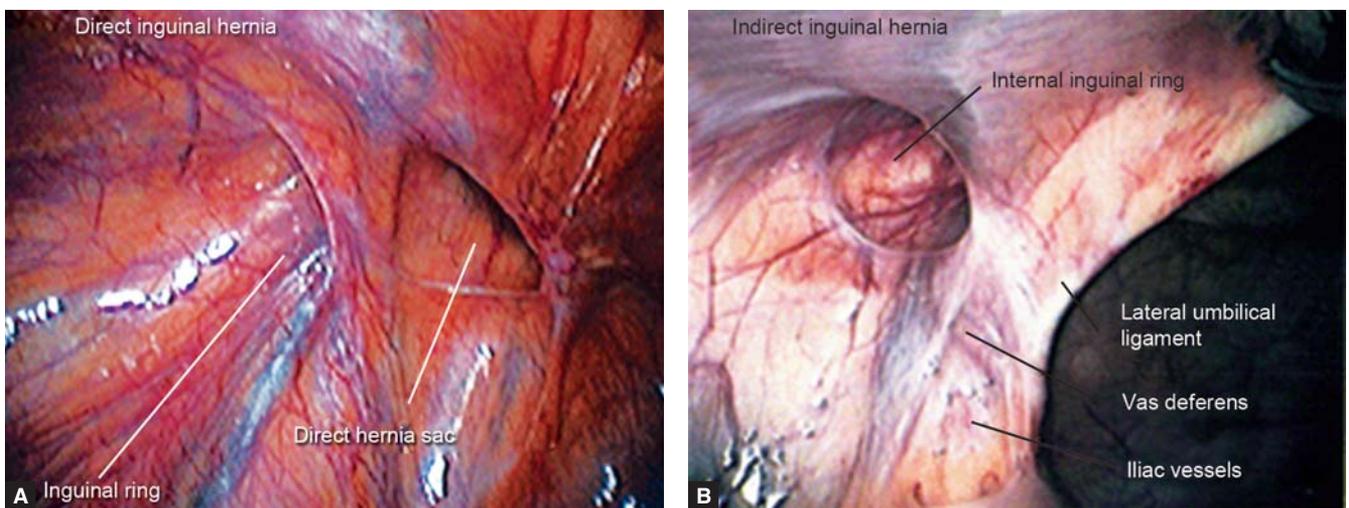
important step in the procedure because it allows the free cord to be placed against the posterior wall (Fig. 2). The prosthesis then lodges perfectly on the inguinofemoral wall, thus closing the entire pectineal foramen. Next, the ligament of Cooper is identified by its characteristic consistency and greyish-white color, and dissected (Fig. 3). The dissection of Cooper’s ligament is performed bluntly with both instruments, which are divaricated to free the ligament of prevesical fat from the pubic symphysis to the external iliac vein. Once the ligament of Cooper has been prepared, the dissection proceeds towards the upper peritoneal flap, which is bluntly detached using the scissors or traction with two forceps cranially to complete the preparation of inguinofemoral wall.

Prosthesis Positioning

Once there is sufficient space for placement of the mesh, the next step is the positioning of prosthesis. Closing of hernia defect is achieved by means of a nonadsorbable,



Figs 2A and B: Anatomy of hernia



Figs 3A and B: Uscay tissue glue in hernia surgery

wide-link mesh that enables the surgeon to recognize the structures on which it is lodged and fixed (Fig. 4). To avoid slippage and difficulty in positioning, the mesh should not be too soft. The mesh is introduced by grasping it on the medial and superior margin if the hernia is on the right, and by its superior and lateral margin if the hernia is on the left. Two forceps spread and positioned the mesh behind the peritoneal flaps against the posterior wall, so as to cover all hernia foramina, Cooper's ligament, the "triangle of pain", the "triangle of disaster," the epigastric vessels, and the spermatic cord elements. It is important for the mesh to overlap the hernia foramen by at least 2 cm, and for its medial margin to be alongside the pubic symphysis.

Fixation of the Prosthesis

The mesh is fixed with 1 ml of Tissucol for unilateral hernias and 2 ml for bilateral hernias. The prosthesis is fixed along its upper margin, from Cooper's ligament to the "triangle of disaster" and to the "triangle of pain," using a 3 mm catheter (Duplotip; Baxter healthcare), which fits the Tisseel syringe. The mesh also may be fixed wherever necessary

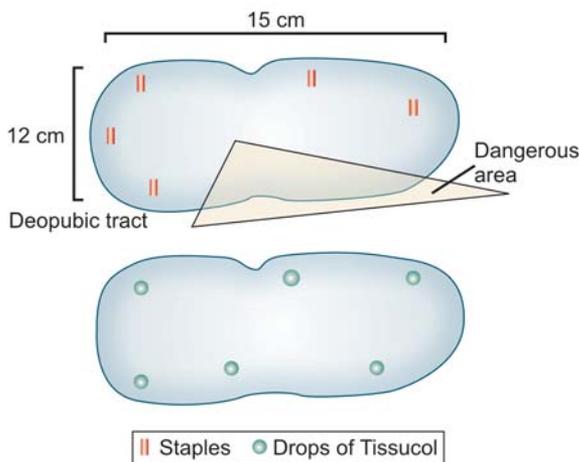
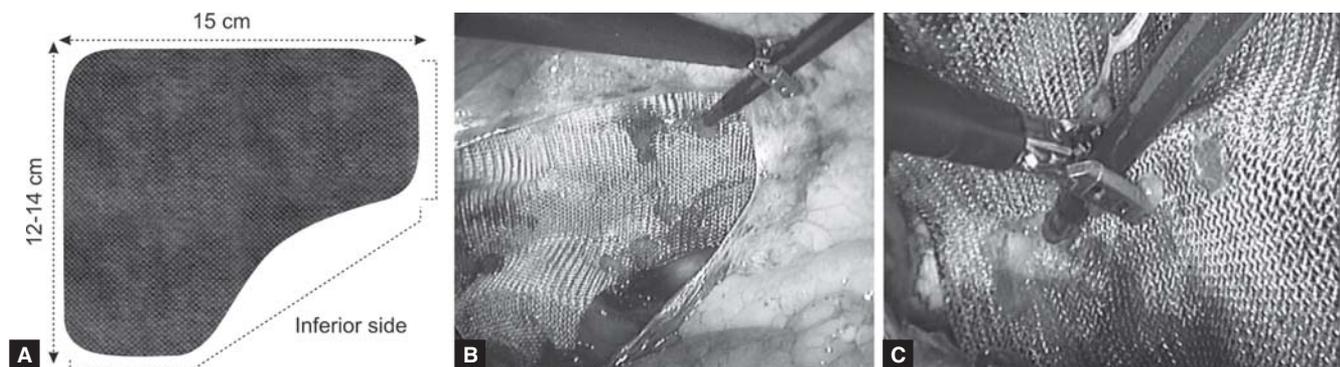


Fig. 4: Prosthesis



Figs 5A to C: Fixation of mesh

to increase its stability (Fig. 5). Tisseel may be applied in two different ways: By resting the tip of the duplotip catheter, where the mesh is to be fixed and by squeezing out a few drops of glue or the glue seeps across the mesh and fixes it. One can also separate the mesh slightly from the inguinal wall, spray the glue directly on it, and then place the mesh to the wall.

Peritoneal Suture

Closure of the peritoneal flap must be performed with extreme care to avoid leaving peritoneal breaches that could allow contact between the mesh and bowel loops.

Mesh prosthesis specifications and design lateral fixation near the triangle of pain Cooper's ligament fixation with Tisseel.

OPERATIVE TECHNIQUE TEP WITH FIBRIN GLUE MESH FIXATION

The two components of the fibrin sealant (Tisseel, Baxter Healthcare Corporation) were reconstituted. Patient is placed in the supine position and general endotracheal anesthesia was induced. A curvilinear incision is made near the umbilicus and carried down to the anterior rectus sheath, which is doubly grasped, elevated, and incised, entering the rectus sheath. The rectus muscles are retracted laterally, exposing the posterior rectus sheath. A peritoneal dissection balloon trocar is inserted and guided by manual and videoscopic guidance down to the level of the pubis where it was inflated and left as such for several minutes for tamponade effect. It is then deflated, removed and replaced with a structural balloon trocar. Pneumopreperitoneum was instituted under direct vision. Two 5 mm trocars are placed in the middle hypogastrium, one suprapubically and the second midway between pubis and umbilicus. Cooper's ligament is identified along with cord structures and inferior epigastric vessels. The cord structures are skeletonized, and the hernia sac is reduced off the internal ring down to

the level of peritoneum. A vertical line is drawn down the long axis of the mesh by using a surgical marker to assist mesh orientation during the procedure. The mesh (8 cm × 13 cm or 10 cm × 15 cm) is placed through the preperitoneum unfurled, and placed uncut over the myopectinate orifice after soaking the mesh in saline for 10 to 15 minutes. The two solutions of the fibrin sealant were drawn into separate syringes, which are then fitted into the laparoscopic applicator (Fig. 6). Once the mesh is deployed in the position desired, it is secured to the pubic bone (Cooper's ligament) in the midline, the lacunar ligament laterally, and superiorly into the transversalis fascia with the fibrin sealant, which is allowed to set for several minutes. The posterior aspect of the matrix repair is then held in place as the pneumopreperitoneum is released under direct vision, observing the peritoneum to obtain its desired position relative to the matrix repair (Fig. 7).

In a study by S Olmi et al^{1,10} on fibrin glue mesh fixation in TAPP in 230 patients with 320 hernias (unilateral and bilateral) the results had been encouraging. No perioperative complications were observed. After an average follow-up period of 26 months (range, 1-40 months), the only

postoperative complications observed were six seromas (1.8%) and one trocar-site hematoma (0.3%). The mean operating time was 30 minutes for unilateral hernias and 50 minutes for bilateral hernias, whether primary or recurrent. Patients usually were discharged the day after surgery and returned to work after five days. No patient experienced an inguinal hematoma, which sometimes occurs after stapling. After a mean follow-up period of 26 months (range, 1-40 months), none of the patients reported immediate or late paresthesia or neuralgia. Evaluation of pain levels by the use of a visual analog score indicated that these patients were free of pain by day 7 after surgery. The average operating time was 30 minutes for unilateral hernias (range, 15-45 minutes) and 50 minutes (range, 30-75 minutes) for bilateral hernias, both primary and recurrent.

According to a randomized trial reported in 93rd Annual Clinical Congress of the American College of Surgeons (ACS), fibrin glue was as effective as staples in preventing hernia recurrence. At the same time, fibrin glue produces less of the postoperative pain experienced with staples, which may cause nerve entrapment. This study enrolled 100 patients scheduled to undergo totally endoscopic

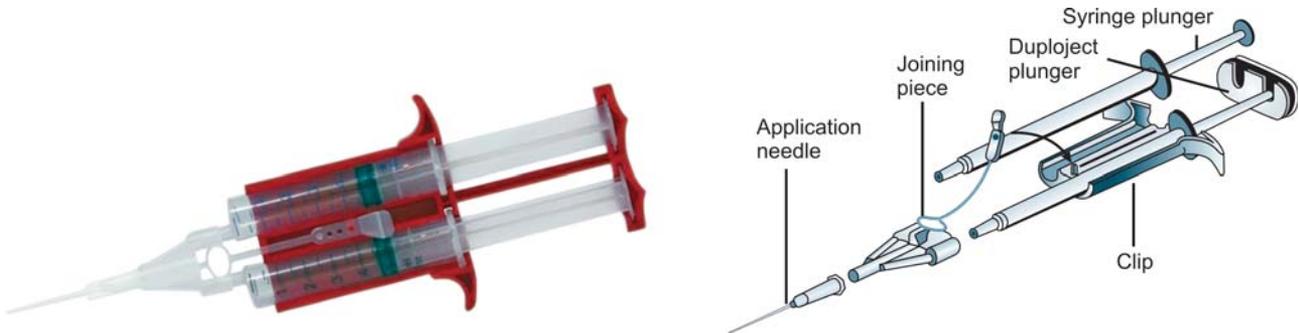
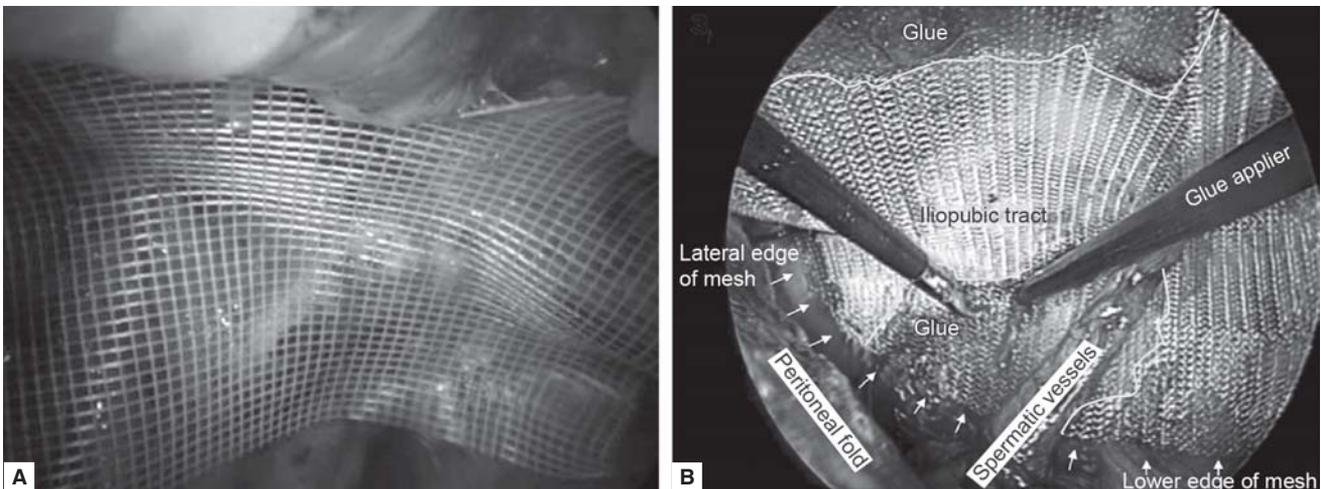


Fig. 6: Sealent syringe



Figs 7A and B: Prosthesis fixation with glue

preperitoneal inguinal hernia repair. Half of the subjects were randomly assigned to fibrin glue and half to staples for mesh fixation. All patients completed the protocol and were available for evaluation for one year after the procedure. Pain was reduced with the fibrin glue by several measures. On the first postoperative day, significantly fewer patients in the glue group reported mild pain (28% vs 46% of those receiving staples), and there was a nonsignificant trend toward more glue patients reporting no pain (68% for glue, 42% for staples). One week after the procedure, pain measures still showed a significant advantage for the glue. Using a 10-point visual analogue scale, patients who received glue reported pain in the 0 to 2 range, while those received staples reported pain in the range of 3 to 6. Patients in the glue group also consumed significantly less pain medication (oral diclofenac and paracetamol): A mean of 4.5 tablets per day vs 7.0 tablets per day for the staple group.

In a study by Stark et al¹⁴ the rate of nerve entrapment in laparoscopic patients was 4.2%. The genitofemoral nerve was affected with a high frequency (2%), and the ilioinguinal or lateral cutaneous nerve of the thigh was affected in 1.1% of the cases.

The morbidity in postoperative period in patients with staples and fibrin glue mesh fixation is a topic of interest. Federico Lovisetto et al¹⁸ carried out a randomized study in 197 patients with inguinal or femoral hernia. The primary outcomes were early postoperative and late neuralgia recorded using a visual analog scale (VAS). The effects of neuralgia on functional status were evaluated using the modified SF-36 questionnaire. Secondary outcomes included complications, such as nonspecific pain and recurrence. His study included 176 males (89.3%) and 21 females (10.7%) patients with a mean age of 53 years (range 18-79 years); 188 (95.4%) hernias were inguinal and nine (4.6%) were femoral. Patient characteristics were similar in the two groups. Follow-up visits were done in 1, 3, 6, and 12 months. No intraoperative complications were observed in either of the treatment groups. When compared, there was no significant difference in quality of life in the two study groups. The mean duration of intervention was 54 minutes (range 30-95 minutes) in the Tisseel/fibrin glue group vs 40 minutes (range 25-105 minutes) in the staples group. The mean postoperative hospitalization time in each group was one day. The mean recovery time to normal physical activity was 7.9 days (range 5-11 days) in the fibrin glue group vs 9.1 days (range 7-11 days) in the staples group. Early postoperative complications which included hematoma/seroma, orchitis, nonspecific pain occurred in 8% of patients in the fibrin group and in 12% of patients in

the staples group. The percentage of late postoperative complications was 3 and 7% of patients in the fibrin glue and staples groups respectively. There were no cases of hernia recurrences.

Over three years, Graziano Ceccarelli et al¹⁷ compared the characteristics of mesh fixation with titanium clips and fibrin glue (Tisseel) and evaluated if the use of fibrin sealant was as safe and effective as conventional stapling and if there were differences in postoperative pain, complications and recurrences. Comparison was made between two homogeneous groups of 68 patients (83 cases) treated with fibrin glue and 68 patients (87 cases), where the mesh was fixed with staples. TAPP technique was used. Operative times were longer in the group treated with fibrin glue with a mean of 35 minutes (range 22-65 mins) compared to the group treated with staples (25 minutes, range 14-50 mins). The time of hospital stay was the same (24 hours). Postoperative complications that were more frequent in the stapled group, included trocar site pain, hematomas, intraoperative bleedings and incisional hernias. No significant difference was observed concerning seromas, chronic pain and recurrence rate.

A study by Arthur P Fine et al involved 38 adult patients with 51 inguinal hernias. 38 patients with 45 primary and six recurrent inguinal hernias were treated with laparoscopic repair by the total extraperitoneal mesh placement (TEP) technique using mesh secured with fibrin sealant. All patients could care for themselves within a day of surgery. Immediately following surgery, patients on average took 7 days off from work. Short-term pain associated with the procedure generally subsided completely within three to four days. Follow-up examination two weeks after the surgery revealed no swelling or localized abdominal pain, and the patient was allowed full activity and returned to work. Postoperative complications were minor and generally expected as a consequence of surgery. Mild cord or canal swelling or both, following the procedure being the most common complaint. The degree of swelling was not judged as severe or necessitating intervention in any case. Mild to moderate orchitis was noted in three patients (7.9%) following surgery, as were two cases of hematoma (5.3%) and one suspected case of seroma (2.6%) that resolved without intervention. Two patients (5.3%) presented with mild fever and localized pain and swelling following surgery. Ciprofloxacin was given for suspected infection, and both patients eventually resolved without further intervention.

P Topart et al³ in his retrospective analysis of Tisseel vs tack staples as mesh fixation in totally extraperitoneal laparoscopic repair of groin hernias compared the result of

66 patients with fibrin glue mesh fixation in totally extraperitoneal (TEP) laparoscopic procedure with an earlier series of 102 patients operated on according to the same procedure in which mesh fixation used tack staples. For the fibrin glue group, the operative time was 54 ± 23 minutes and no difficulty was encountered during preparation or application of the fibrin sealant. There were no reoperations or postoperative deaths. The postoperative course was uneventful for 53 patients (80.3%). Eight patients (12%) had a seroma, which did not require any dedicated treatment in the majority of cases. Three patients (4.5%) had a hematoma: One patient had to remain on calciparin at the time of the operation, and two patients (3%) had a small bowel obstruction. No fever or inflammation was reported after surgery. Overall, patients were discharged 1.5 ± 1.7 days after the operation. In the tack staple group complications occurred in 26.4% of the patients. Ten patients (9.8%) had a seroma and eight (7.8%) had a hematoma. No major complications or deaths were reported. The length of stay was a mean of 2.3 days (1.9 days, when the additional procedures were excluded). During the follow-up, three patients (2.9%) developed a recurrence at a mean of 16.3 months after surgery. It was observed that 15 patients (14.7%) complained of pain in the groin area more than three months after surgery. There were slightly more seromas but less hematomas in the fibrin glue group compared to the tack staples group, but this was not statistically significant. However, the postoperative chronic pain rate was significantly reduced in the fibrin glue group.

In an animal study in which TEP groin hernia repairs were performed, Katkhouda et al demonstrated^{2,4} that graft motion and tensile strength were similar in the staples and fibrin glue groups. In addition, histological examinations revealed that the fibrin glue triggered a stronger fibrous reaction and inflammatory response with more fibroblastic mesh ingrowth. The procedures were performed laparoscopically in 49 sites. Eighteen grafts were fixed with fibrin glue and 16 with staples; 15 were not fixed. There was no significant difference in graft motion between the fibrin glue and stapled groups; there was no significant difference in median tensile strength between the fibrin glue and stapled groups. Fibrin glue triggered a significantly stronger fibrous reaction and inflammatory response than in the stapled and control groups. No infection related to method of fixation was observed in any group. The experiment did not involve serial examinations at later dates because fibroblastic ingrowth has already fixed the mesh in position by postoperative day 12, after which further mesh migration or folding is unlikely. It was found out that in addition to its adhesive property, fibrin glue acts as scaffolding for

fibroblastic ingrowth that is enhanced by the chemotactic action of its thrombin component.

Hung Lau et al studied in his randomized prospective study a total of 93 patients with 186 inguinal hernias, who underwent bilateral TEP and were randomized to have mesh fixation by either FS ($n = 46$) or mechanical stapling ($n = 47$). The FS group consumed significantly less analgesics compared with that of staple group. There was no significant difference in postoperative pain score at rest and on coughing from the day of operation to postoperative day 6 between the groups.

Stefano Olmi et al^{1,10} in his randomized prospective study termed "Quantification of pain in laparoscopic trans-abdominal preperitoneal (TAPP)" involving 600 patients, came to the conclusion that postoperative pain ranged from mild pain between 12 and 72 hours with Tisseel and it was higher in other methods of mesh fixation: Moderate pain with EMS (Ethicon Endo surgery, Inc.) to severe pain with Protak at 48 hours follow-up. Significant differences in length of stay occurred, no recurrence or conversion rates were observed among groups, and morbidity was generally lower with Tisseel. Patients using Tisseel also returned to work sooner than as in other mesh fixing devices. Prostheses were fixed with Protak (Tyco, Norwalk, Conn), Endoanchor (Ethicon Endosurgery, Inc., Cincinnati, Ohio), EMS (Ethicon Endosurgery, Inc.) and Tisseel (Baxter Healthcare, Milan, Italy).

RH Fortelny and R Schwab et al¹⁵ assessed the quality of life in a trial with mesh fixation with fibrin glue in TAPP. TAPP with fibrin mesh sealing was performed in 11 non-selected consecutive patients. A direct control group (e.g. TAPP with staples) was not considered as favorable change in the quality of life in patients with fibrin glue mesh fixation was the tested hypothesis and not the comparison of techniques. Quality of life and pain were assessed preoperatively and one year follow-up using the SF36 survey and the visual analogue score (VAS). Post one-year analysis of recurrences or complications was made. The analysis of the unmodified SF-36 revealed a highly significant improvement. The scale 'social functioning' (SOCIAL), which belongs to the mental-health-related scale, had also significantly improved. The VAS significantly reduced after one year.

In an observational prospective multicenter study involving 1,201 patients performed in France B Descottes et al¹⁶ assessed Tisseel[®] fibrin glue for atraumatic mesh fixation in inguinal hernia repair. Out of 1,201 patients, 526 procedures were performed using open techniques and 675 using laparoscopic repairs. Local complications occurred in 4.7% of patients: 3.0% hematoma, 1.4% seroma, 0.3%

recurrence. The mean visual analogue scale (VAS)-rated pain scores were 3.2 preoperatively, 2.3 immediately after surgery and 1.8 at one month. Surgeons rated the product as very easy to use.

DISCUSSIONS

During the past few years, attention has focused on the pain that may arise after groin hernia surgery. Chronic pain after hernia surgery is a complex and controversial problem that affects not only open but also laparoscopic procedures. Three pain syndromes have been identified: Somatic, neuropathic, and visceral pain. Besides nerve damage during dissection, thermal injury due to electrocautery, and inflammatory and/or mechanical reaction to the mesh, stapling of the mesh is the most frequent evoked mechanism. According to various literature sources, there is a great variation in the rate of postoperative chronic pain, ranging from 0.1 to 0.4% and 22.5% in laparoscopic repairs for which staples are used to attach the mesh. Among the explanations for such a wide discrepancy are the range of pain evaluation methods used, which include clinical examination of the patients, phone calls, and mailed questionnaires and tools to score the severity of the pain. For laparoscopic hernia repair, the possibility of nerve injury (pain or paresthesia) caused by entrapment from incorrect placement of staples (above all lateral cutaneous femoral nerve, but ilioinguinal, and genitofemoral are also at risk) and epigastric vessels lesion by clips application may be avoided using fibrin glue either in the TAPP technique or in the TEP. It seems that not only entrapment but also postoperative fibrous scar around the staples can lead to nerve injury. In conventional TAPP, the prosthesis is anchored using metal clips. This is a critical step that requires the utmost attention to avoid damaging the surrounding nerves and blood vessels. Lesions arising due to such intraoperative damage can lead to complications, including hemorrhage, or painful neuralgia during follow-up. The nerves in the inguinal area that are most frequently involved in postoperative pain following TAPP hernia repair include the genitofemoral, lateral cutaneous femoral, and ilioinguinal and iliohypogastric nerves. Lesions of the lateral cutaneous femoral nerve are the most frequent postoperative neurologic complications associated with laparoscopy. Such lesions are the result of damage or entrapment of the nerve during lateral fixation of the mesh to the deep inguinal ring with pain in the lateral region of thigh. TAPP hernia repair with Tisseel resulted in a low rate of postoperative pain and rapid resumption of normal activities. Postoperative complications affected only 2.2% of the hernias and were readily treated without the need to extend the hospital stay. Importantly,

no recurrences have been observed. These statistics are in favor of fibrin glue mesh fixation, along with other studies, which report postoperative complication rates of 4.6% for hematomas, 2% for neuralgias, and 0.4% for chronic pain. Reported persistent neuralgia with inguinal pain attributable to stapling vary in the literature from 0.5 to 14%.

To date, the series reporting the lowest postoperative chronic pain rates have not used any means of mesh. Tamme et al¹⁹ observed 2.55 and 0% chronic pain problems respectively, after TEP repair with a recurrence rate of less than 0.6%. However, the largest of these two series did not specify the length of follow-up and the other one was a rather small series (n = 89). Although, two randomized studies with a short follow-up of nonfixed mesh in laparoscopic repairs (one in TEP and the other in TAPP) did show promising results in terms of recurrence justification for routine nonstapling of the mesh in TEP is not yet substantiated.

Studies points to the fact that mesh stapling does play a key role in generating postoperative pain after laparoscopic hernia repair. Mesh fixation with fibrin glue is preferable as it meets the requirements for both efficiency and security of fixation.

The recurrence rate in the fibrin glue was found to be slightly lower than in the tack staples group but did not differ significantly, and the case of recurrence reported in the fibrin glue group is probably related to an inadequate mesh size in a large direct hernia. Overall, the recurrence rate in the fibrin glue group remains within the range most report approve. Inadequate lateral fixation is the main cause of recurrence after both TAPP (36%) and TEP (22%). The reason for this is that most of the nerves run laterally, where no staples can be applied. Gluing a large mesh on the triangles of disaster and pain is likely to stop the prosthesis from lifting and dislocating, thereby avoiding inferomedial and inferolateral recurrence. It is not known if the enhanced inflammatory response induced by fibrin glue may explain the slightly higher rate of seromas in the fibrin glue mesh fixation. There exists no significant difference in the development of postoperative hematomas, even though the rate is slightly lower in fibrin glue mesh fixation, as compared to the tack staplers but the data available are inconclusive to give the credit to the effect of fibrin glue on local hemostasis. Although, no comparison is available between the tack staples group and the fibrin glue group in terms of operation duration, the use of fibrin glue and its application device did not seem to change the mean operative time, which is comparable to that of other series using tackers. This can be attributed primarily to the peritoneum closure using a running laparoscopic suture and the preparation of fibrin glue and its applicator during the hernia

sac dissection. From a mechanical standpoint, fixation of the mesh was equivalent to that obtained with clips but prevented complications related to the application of staples (bleeding and hematomas in Retzius' space, neuralgia and chronic pain).

The difference in terms of operating costs between the two fixation techniques/methods does tilt in favor of fibrin glue. Two milliliters of Tisseel is available for 149 USD, whereas the single use tacker stapler is 287 USD, 300 euros for Endoanchor (Ethicon Endosurgery) and 250 Euros for Protak (Tyco, Norwalk, CT, USA). On long-term prospective, considerable cost savings can be done if postoperative complications (neuralgias, seromas, and hematomas) are reduced and hospital recovery periods are shortened.

CONCLUSIONS

The use of fibrin glue has a distinct advantage in laparoscopic treatment of inguinal hernias compared with other conventional methods of mesh fixation. The use of fibrin sealant reduces the risk of post- and intraoperative complications, such as bleeding, seroma, chronic pain, has a lower incidence of postoperative neuralgia and provides an early faster return to social life. The recurrence rates are similar, but the operative time is slightly longer if the preparation time of the fibrin sealant is taken into consideration. Otherwise, the operative time is shorter in fibrin mesh fixation as compared to staples/tacks. Fibrin glue appears to be an effective alternative to staples, tacks and anchors for mesh fixation. Mesh fixation with fibrin glue is preferable as it meets the requirements for both efficiency and security of fixation.

REFERENCES

1. Olmi S, Erba L, Bertolini A, Scaini A, Croce E. Fibrin glue for mesh fixation in laparoscopic transabdominal preperitoneal (TAPP) hernia repair: Indications, technique, and outcomes. *Surg Endosc* (2006) 20:1846-50. DOI: 10.1007/s00464-005-0502-1.
2. Katkhouda N. A new technique for laparoscopic hernia repair using fibrin sealant. *Surg Technol Int* 2004;12:120-26.
3. Topart P, Vandenbroucke F, Lozac'h P. Tisseel vs tack staples as mesh fixation in totally extraperitoneal laparoscopic repair of groin hernias: A retrospective analysis. *Surg Endosc* (2005) 19:724-727. DOI: 10.1007/s00464-004-8812-2.
4. Katkhouda N, Mavor E, Friedlander MH, Mason RJ, Kiyabu M, Grant SW, Achanta K, Kirkman EL, Narayanan K, Essani R. Use of fibrin sealant for prosthetic mesh fixation in laparoscopic extraperitoneal inguinal hernia repair. *Ann Surg* 2001;233:18-25.
5. Ferzli GS, Frezza EE, Pecoraro AM (Jr), Ahern KD. Prospective randomized study of stapled versus unstapled mesh in a laparoscopic preperitoneal inguinal hernia repair. *J Am Coll Surg* 1999;188:461-65.
6. Novik B, Hagedorn S, Skullman J, Dalenback S. Fibrin glue for securing the mesh in laparoscopic totally extraperitoneal inguinal hernia repair. A study with a 40-month prospective follow-up period.
7. Schmidt SC, Langrehr JM. Autologous fibrin sealant (Vivostat®) for mesh fixation in laparoscopic transabdominal preperitoneal hernia repair. *Endoscopy* 2006;38(8):841-44. DOI: 10.1055/s-2006-944609.
8. Schulze S, Kristiansen VB, Fischer Hansen B, Rosenberg J. Biological tissue adhesive for mesh-application: An experimental study. *Surg Endosc* 2005;19:342-44. DOI: 10.1007/s00464-004-9054-z.
9. Graziano Ceccarelli A, Luciano Casciola A, Massimo Codacci Pisanelli A. Comparing fibrin sealant with staples for mesh fixation in laparoscopic transabdominal hernia repair: A case control-study. *Surg Endosc* 2008;22:668-73. DOI 10.1007/s00464-007-9458-58.
10. Olmi Stefano, Scaini Alberto, Erba Luigi, Bertolini Aimone, Croce Enrico. Laparoscopic repair of inguinal hernias using an intraperitoneal onlay mesh technique and a Parietex composite mesh fixed with fibrin glue (Tissucol). Personal technique and preliminary results. *Surg Endosc* 2007;21:1961-64. DOI: 10.1007/s00464-007-9355-0.
11. C Schug-Pass A, H, Lippert A, F, Köckerling. Fixation of mesh to the peritoneum using a fibrin glue: Investigations with a biomechanical model and an experimental laparoscopic porcine model. *Surg Endosc* 2009;23:2809-15. DOI 10.1007/s00464-009-0509-0.
12. Schulze S, Kristiansen VB, Fischer Hansen B, Rosenberg J. Biological tissue adhesive for mesh-application in pigs: An experimental study. *Surg Endosc* 2005;19:342-44. DOI: 10.1007/s00464-004-9054-z.
13. R Schwab A, O, Schumacher A, K, Junge A, M, Binneboesel A, U, Klinge A, HP, Becker A, V Schumpelick. Biomechanical analyses of mesh fixation in TAPP and TEP hernia. Repair *Surg Endosc* 2008;22:731-38. DOI 10.1007/s00464-007-9476-5.
14. Stark E, Oestreich K, Wendl K, Rumstadt B, Hagemüller E. Nerve irritation after laparoscopic hernia repair. *Surg Endosc* 1999;13:878-81.
15. Fortelny RH, Schwab R, Glaser KS, Puchner KU, May C, König F, Redl H, Petter-Puchner AH. The assessment of quality of life in a trial on lightweight mesh fixation with fibrin sealant in transabdominal preperitoneal hernia. DOI: 10.1007/s10029-008-0365-1499-505.
16. Descottes B, Bagot M d'Arc. Fibrin sealant in inguinal hernioplasty: An observational multicentre study in 1,201 patients. *Hernia*. October 2009;13(5):505-10.
17. Ceccarelli Graziano, Casciola Luciano, Codacci Massimo Pisanelli, Bartoli Alberto, Di zitti Lelio, Spaziani Alessandro, Biancafarina Alessia, Stefanoni Massimo, Patrìti Alberto. Comparing fibrin sealant with staples for mesh fixation in laparoscopic transabdominal hernia repair: A case control-study. DOI: 10.1007/s00464-007-9458-7 668-73.
18. Lovisetto, Federico MD, Longoni, Mauro MD. Fibrin glue mesh fixation in hernia repair. *Annals of surgery*. November 2007;246(5):908-09. DOI: 10.1097/SLA.0b013e318158a42.
19. Tamme C, Scheidbach H, Hampe C, Schneider C, Köckerling F. Totally extraperitoneal endoscopic inguinal hernia repair (TEP). DOI 10.1007/s00464-002-8905-8. 190-95.