World Journal of Laparoscopic Surgery

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

WJOLS

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

Access Online Resources

For more details, visit
www.wjols.com

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

JAYPEE Jaypee Journals

Editorial

The concept of surgery is evolving and so we are constantly challenged to enhance our patient outcomes by improving or improvising our surgical skill. Surgery has traditionally been a specialty within the profession of medicine that has revolved around invasive procedures to deal with various diseases. Initially, trauma induced by the therapeutic procedure was necessary and reasonable to provide benefit to the patient. But now, with the innovation of advanced technology, combined with optical engineering and improved video displays, surgeons can operate within body cavities for therapeutic intervention with no larger incisions previously necessary to allow a surgeon's hands use of the required organs.

Noninvasive surgical techniques typically rely on small incisions encircling the surgical field in order to insert small scopes and instruments. Laparoscopic surgery is responsible for a change in the path of access and it has significantly and irrevocably changed the surgical procedure on most disease processes. As the benefits of minimal access surgery approach were numerous for that patient, early technology limited the application with a procedures. Specifically, surgeons using standard minimally invasive techniques lost the need for an all natural three-dimensional image, depth perception and articulated movements.

Magnified view of tissue was often difficult and instruments were rigid without joints. Robotic surgery has provided the technology to deal with these limitations and permit the use of minimally invasive surgery to some broader spectrum of patients as well as their diseases. Surgical robots relieve a few of these limitations by giving fine motor control, magnified three-dimensional imaging and articulated instruments.

This issue of World Journal of Laparoscopic Surgery (WALS) is perfectly timed as the field of robotics has evolved past its infancy and it has proven itself to become a useful and lasting innovation. We have now decided to regularly publish the article associated with robotic surgery. As use of robotics in surgical treatment is now broad-based across multiple surgical specialties and can undoubtedly expand within the next decades as new technical innovation and methods increase the applicability of their use. I believe that reader will enjoy our journey toward these new innovations in minimal access surgery.

World Association of Laparoscopic Surgeons endeavors to disseminate education, training and research of minimal access surgery. The WALS took initiative to advertise further innovations within the laparoscopic surgery. In keeping with its objectives, the WALS is holding the next Laparoscopic Congress on 14th and 15th February, 2012 at World Laparoscopy Hospital, Cyber City, Gurgaon, Haryana, India.

The Congress will give a platform for the practitioners of laparoscopic surgery to address key issues, devolves on strengths and weakness, identify technological gaps, opportunities and challenges and create a road map to consider minimal access surgery to the rightful place. Hence, the theme: 'Recent Advances in Robotic and Laparoscopic Surgery.'

I am inviting all of you to attend this scientific conference and wishing you a very happy New Year!

RK Mishra
Editor-in-Chief

10.5005/jp-journals-10007-1129
ORIGINAL RESEARCH

Scarless Cholecystectomy with Standard Laparoscopic Instruments in Selected Patients

[1]Ali Aminian, [2]RK Mishra, [1]Rasoul Mirsharifi

[1]Department of General Surgery, Imam-Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran
[2]Chairman and Director, World Laparoscopic Hospital Pvt Ltd, DLF Cyber City, Gurgaon, Haryana, India

ABSTRACT

Laparoscopic cholecystectomy is a gold standard for treatment of gallstone-related diseases. We have now modified this technique and introduced scarless cholecystectomy with standard laparoscopic instruments. Patients with normal body mass index and with no previous history of acute cholecystitis are suitable candidates for scarless cholecystectomy. Operation is performed through two 10 mm ports placed just above and below the umbilicus. Surgical exposure is created by applying two traction sutures, one placed in fundus and another in infundibulum of gallbladder. The ends of these sutures are pulled out the abdomen by means of percutaneously inserted suture passer. Applying different traction to these stitches, enable appropriate exposure of the Calot's triangle and gallbladder bed for dissection. We have concluded that scarless cholecystectomy is technically feasible and safe. Further validation of this approach, however, awaits randomized clinical trials and accurate comparison with outcomes of more conventional approaches.

Keywords: Laparoscopic cholecystectomy, Minimally invasive, Scarless cholecystectomy, Two-port laparoscopic cholecystectomy, Pain, Gallbladder.

INTRODUCTION

Laparoscopic cholecystectomy (LC) is a gold standard for treatment of gallstone-related diseases. This procedure is usually performed with four-or three-ports of entry into the abdomen around the world. Recent developments in LC have been directed toward reducing the size or number of ports to achieve the goal of minimal invasive surgery. Less abdominal wall trauma and subsequent postoperative pain and early recovery are major goals in order to achieve better patient care and cost-effectiveness. Several studies demonstrated that less postoperative pain was associated with reduction in either size or number of ports. Poon et al published the result of first randomized clinical trial comparing two-port versus four-port LC in 120 patients. They concluded that two-port LC resulted in fewer surgical scars, less individual port-site pain and similar clinical outcomes compared with four-port LC.[1] Additionally, cosmetic issue is important for patients. In recent surveys, it has been shown that patients would largely favor NOTES (natural orifice translumenal endoscopic surgery) cholecystectomy compared with standard LC, unless the risks of NOTES cholecystectomy drastically exceeded those of conventional LC. This shows the importance of cosmesis and should warrant surgeons to look for less invasive surgical procedures.[2,3]

The first brief report about single incision LC was published in 1997, when Navarra et al described a series of 30 cases performed with two 10 mm ports placed via a single umbilical incision. The gallbladder was retracted using three traction sutures through the abdominal wall. Even cholangiography was performed in some cases.[4,5] Piskun et al used the same concept of multiple trocars deployed through a single umbilical incision in 1999, but used two 5 mm ports. These authors also used traction sutures to retract the gallbladder.[6] Bresadola et al compared similar technique with standard LC and showed lower pain scores in the single-port group.[7] Recently, Cuesta et al describe a procedure that uses two transumbilical 5 mm ports and a 1 mm Kirschner wire instead of sutures for gallbladder traction.[8] Poon et al and Bucher et al published the result of single transumbilical access LC using modified laparoscope with extra working channel.[1,3] Romanelli et al reported a single-port cholecystectomy using the TriPort and AirSeal port.[4,9]

Most of these single access procedures need special devices and instruments. Several types of access devices, such as TriPort (Advanced Surgical Concepts, Wicklow, Ireland), AirSeal (SurgiQuest, Orange, CT, USA), SILS port (Covidien, Inc, Norwalk, CT, USA), different type of articulating instruments and modified telescope with operating channels have been innovated for this purpose.[4] Two other advances in recent years in the field of less invasive cholecystectomy are NOTES cholecystectomy and needlescopic cholecystectomy. However, the two important drawbacks with application of these instruments and innovations are the cost and need for learning of technically demanding procedures.[1,3]

Herein, we report our experience of scarless LC using a simple technique with standard laparoscopic instruments. This represent a safety concern, as use of standard laparoscopic instruments enables to conform to surgical principles of standard cholecystectomy, which have been used for years. Surgeons are familiar with application of standard instruments. The use

This article was presented at International College of Surgeons (ICS) 2009 Beijing Conference, China.

of newly developed instruments and techniques may expose patients to additional risk.[1,3]

OPERATIVE TECHNIQUE

After initial experience in pig model, this procedure was performed in human. Patients with normal body mass index and with no previous history of acute cholecystitis are suitable candidates for elective scarless LC. Preoperative preparations are similar to standard LC.

This procedure is performed by using a surgical principal similar to standard LC, except that it is conducted through two periumbilical ports. Surgeon stands at the left side of operating table and holds the laparoscope with left hand and instruments with right hand, similar to diagnostic laparoscopy (Fig. 1). The patient is placed in the reverse Trendelenburg position and rotated to the left. Insertion of orogastric tube may be necessary, as indicated in standard LC.

After incising of skin overinfraumbilical ridge, insertion of Veress needle and creation of pneumoperitoneum, first 10 mm port is introduced. If the gallbladder is seemed suitable for this procedure during the first inspection, then the second 10 mm trocar is inserted in supraumbilical ridge. Before introducing the second port, it is necessary to remove 30º laparoscope from abdomen and lift up the abdominal wall to facilitate entering of the second port. If surgeon encounters with gallbladder inflammation, adhesion, inappropriate working space, unclear anatomy especially around the cystic pedicle, or no progress over a set period of time whenever during the procedure, then addition of other ports and conversion to standard LC is considered.

Surgical exposure is created by applying two traction sutures (Silk 3/0 with cutting modified ski needle) in gallbladder. The first needle is introduced through supraumbilical port and passed through the fundus of gallbladder taking a good bite (Fig. 2A). The needle is cut and removed. Suture passer is introduced percutaneously below the costal cartilage. The two ends of suture are pulled out by the help of suture passer (Fig. 2B). By pulling on this suture, the gallbladder and liver are pulled up toward costal margin, exposing the inferior portions of gallbladder (Fig. 2C). This suture mimics the action of the fundal grasper that is normally used to perform this function. The second stitch is placed over infundibulum (Fig. 2D). This thread is also pulled out through the right side of abdomen by means of suture passer (Fig. 2E). Applying different traction to these stitches enables appropriate exposure of the Calot's triangle and gallbladder bed for dissection (Fig. 2F).

Dissection of cystic pedicle is performed with aid of curved or right-angle dissectors (Figs 3A and B). After identification of important anatomical structures, three Hem-o-lok clips (Weck Closure Systems, Research Triangle Park, NC, USA) are placed to the cystic artery and duct; two on the proximal part and one on the distal part which would be removed (Figs 3C to F). Then dissection of gallbladder from its bed is started by the help of hook. It may be necessary to change the place of second traction suture from right side of abdomen to epigastric area in order to get better visualization of gallbladder bed (Figs 4A to D). At the end of dissection, irrigation and suction and control of hemostasis are performed (Fig. 5A). Grasping forceps is introduced through supraumbilical port and the gallbladder is removed under direct vision (Figs 5B to D). The periumbilical fascia and skin are closed. Postoperative care is similar to standard LC.

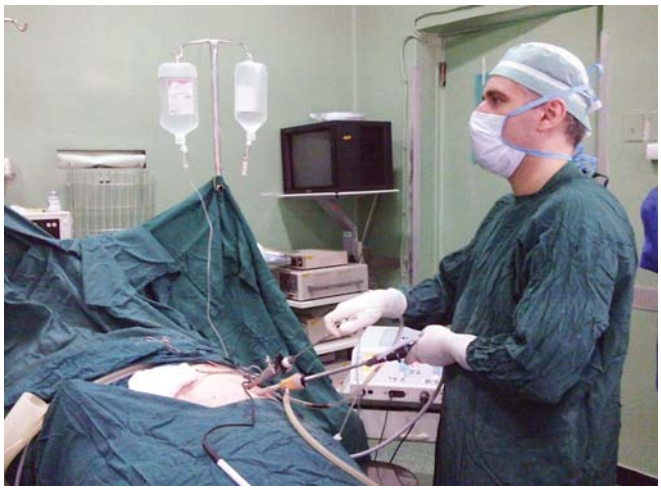
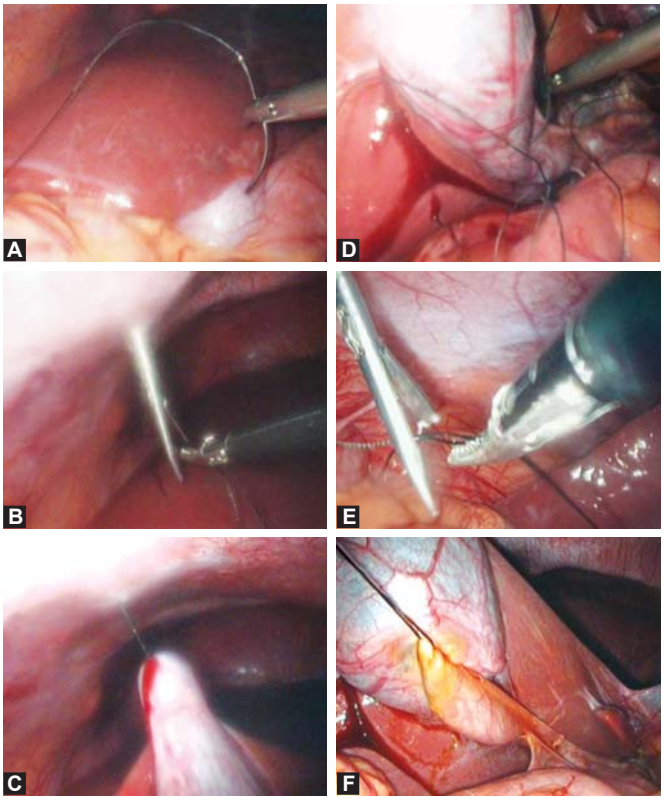
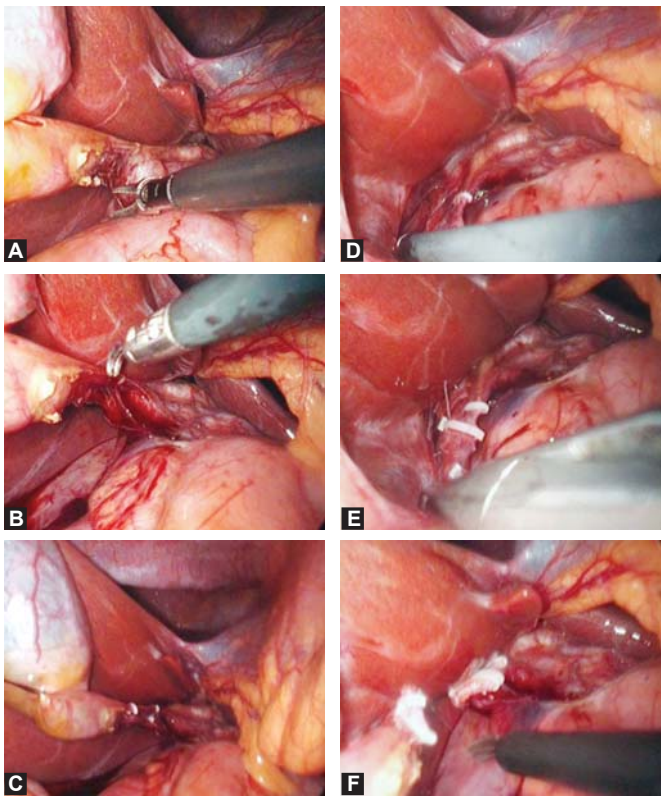


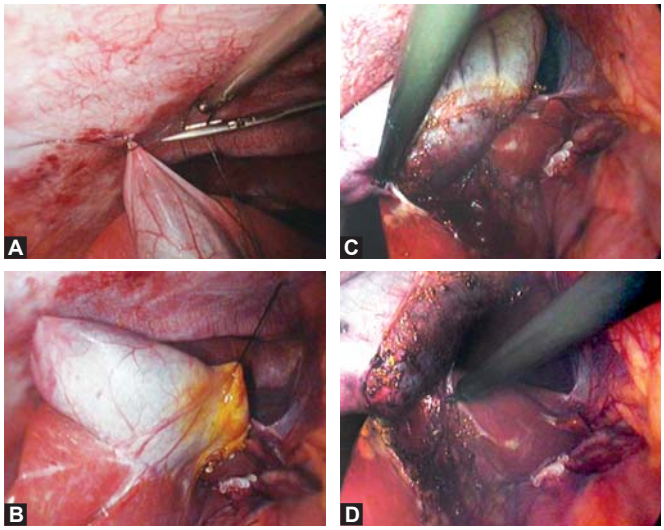
Fig. 1: Surgeon stands at the left side of patient and holds the laparoscope with left and instruments with right hand



Figs 2A to F: Traction sutures: (A) First stitch in fundus of gallbladder, (B) holding the threads with suture passer, (C) pulling up the gallbladder, (D) second stitch in infundibulum, (E) holding the threads with suture passer, (F) exposure of Calot's triangle



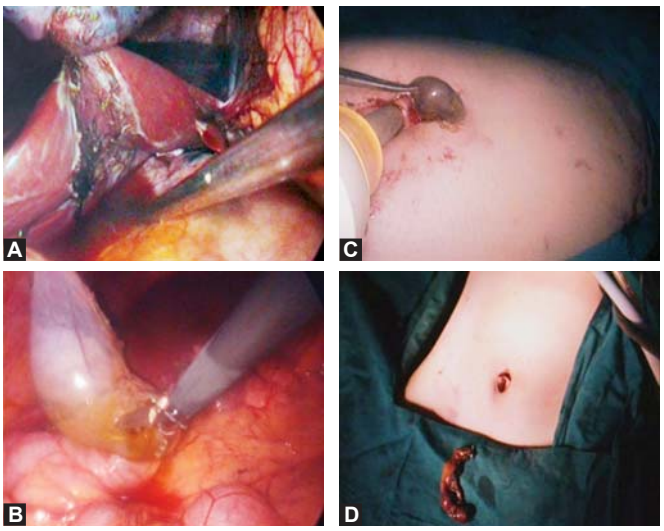
Figs 3A to F: (A and B) Dissection of cystic pedicle, (C) clipping of anteriorly located cystic artery, (D) ensuring the anatomy of cystic duct, (E) application of Hem-o-lok clips overcystic duct, (F) cutting of cystic duct



Figs 4A to D: (A and B) Changing the position of second traction stitch to epigastric area in order to facilitate the dissection (C and D). Dissection of gallbladder from its bed

CONCLUSION

As mentioned above, descriptive studies and at least one randomized clinical trial showed that patients experience less postoperative pain and discomfort and faster recovery by these less invasive techniques.[1-9] Our modification of scarless cholecystectomy performed with standard instruments is technically feasible and safe. It also provides good cosmetic result. Further validation of these approaches, however, awaits randomized clinical trials and accurate comparison with outcomes of the more conventional approaches.



Figs 5A to D: (A) Irrigation and suction and control of hemostasis, (B and C) gallbladder extraction through supraumbilical port, (D) result of scarless cholecystectomy

ACKNOWLEDGMENTS

The author thank the staff of operating room (number one) of Imam Khomeini Hospital, Tehran, Iran for their cooperation.

REFERENCES

1. Poon CM, Chan KW, Lee DW, Chan KC, Ko CW, Cheung HY, et al. Two-port versus four-port laparoscopic cholecystectomy. Surg Endosc 2003;17:1624-27.
2. Varadarajulu S, Tamhane A, Drelichman ER. Patient perception of natural orifice transluminal endoscopic surgery as a technique for cholecystectomy. Gastrointest Endosc 2008;67:854-60.
3. Bucher P, Pugin F, Buchs N, Ostermann S, Charara F, Morel P. Single port access laparoscopic cholecystectomy (with video). World J Surg 2009;33:1015-19.
4. Romanelli JR, Earle DB. Single-port laparoscopic surgery: An overview. Surg Endosc 2009;23:1419-27.
5. Navarra G, Pozza E, Occhionorelli S, Carcoforo P, Donini I. One-wound laparoscopic cholecystectomy. Br J Surg 1997;84:695.
6. Piskun G, Rajpal S. Transumbilical laparoscopic cholecystectomy utilizes no incisions outside the umbilicus. J Laparoendosc Adv Surg Tech A 1999;9:361-64.
7. Bresadola F, Pasqualucci A, Donini A, Chiarandini P, Anania G, Terrosu G, et al. Elective transumbilical compared with standard laparoscopic cholecystectomy. Eur J Surg 1999;165:29-34.
8. Cuesta MA, Berends F, Veenhof AA. The invisible cholecystectomy: A transumbilical laparoscopic operation without a scar. Surg Endosc 2008;22:1211-13.
9. Romanelli JR, Mark L, Omotosho PA. Single port laparoscopic cholecystectomy with the TriPort system: A case report. Surg Innov 2008;15:223-28.

10.5005/jp-journals-10007-1130
REVIEW ARTICLE

The Camera-holding Robotic Device in Laparoscopy Surgery

[1]Muhammad Nurhadi Rahman, [2]RK Mishra

[1]Urogynecology Division, Department of Obstetrics and Gynecology, Sardjito Hospital, Faculty of Medicine Gadjah Mada University, Yogyakarta, Indonesia

[2]Chairman and Director, World Laparoscopic Hospital Pvt Ltd, DLF Cyber City, Gurgaon, Haryana, India

ABSTRACT

Background: The inconvenience of laparoscopic operations lies mainly in the difficulties in mutual understanding between the surgeon and the camera assistant who maneuvers the laparoscope according to the surgeon's instructions. Another problem arises when the operation has to be performed for many hours. In this case, the camera image tends to become unsteady due to fatigue of the camera assistant. The self camera-control by the surgeon gives more stability of the laparoscopic image. A robotic camera assistant, directly under surgeon's control, can help the surgeon control the view better. This review is limited only in the robotic camera holder to replace the assistant camera holder in laparoscopy surgery.

Materials and methods: Several types of the camera-holding robotic devices, such as the AESOP, EndoAssist, PMAT and PARAMIS were reviewed respectively.

Discussion: Most of the camera-holding robotic devices have the advantages, such as elimination of the fatigue of the assistant who holds the camera, elimination of fine motor tremor and small inaccurate movements, delivery of a steady and tremor-free image, nondependency on camera operator, reduced cost of surgery and reduced number of highly skilled staff. Some of them have additional advantages and disadvantages depend on their uniqueness.

Conclusion: There is no fundamental difference between the operation performed with and without the devices, but the machines do contribute to certain aspects of the operations and may help to overcome some of the difficulties encountered in these complex laparoscopy procedures. Unavailability and variability in quality of human camera-holders should not be an obstacle to performing satisfactory laparoscopic surgery. Therefore, some form of standardization of assistance is required and laparoscope-holding systems are a first step in this direction.

Keywords: Camera-holding robotic device, Robotic camera assistant, Camera holder, Laparoscopy surgery, AESOP, EndoAssist, PMAT, PARAMIS.

BACKGROUND

Robotic surgical devices have developed beyond the investigational stage and are now routinely used in minimally invasive general surgery, pediatric surgery, gynecology, urology, cardiothoracic surgery and otorhinolaryngology. Robotic devices continue to evolve and as they become less expensive and more widely disseminated.[1] But not every country, especially, the developing countries ready for this. In the developing countries, the conventional laparoscopy surgery is just about to grow.

The term 'robot' was coined by the Czech playright Karel Capek in 1921 at Rossom's Universal Robots. The word 'robot' is from the 'Czech' word robota which means forced labor. The era of robots in surgery began in 1994 when the first AESOP (voice, controlled camera-holder) prototype robot was used clinically in 1993 and then marketed as the first surgical robot ever in 1994 by the US FDA. Since then, many robot prototypes like the EndoAssist (Armstrong Healthcare Ltd, High Wycombe, Buck, UK), FIPS endoarm (Karlsruhe Research Center, Karlsruhe, Germany) have been developed to add to the functions of the robot and try and increase its utility. Integrated surgical systems (now Intuitive Surgery, Inc.) redesigned the SRI Green Telepresence Surgery System and created the daVinci Surgical System® classified as a master-slave surgical system. It uses true 3D visualization and EndoWrist®. It was approved by FDA in July 2000 for general laparoscopic surgery, in November 2002 for mitral valve repair surgery. The da Vinci robot is currently being used in various fields, such as urology, general surgery, gynecology, cardiothoracic, pediatric and ENT surgery. It provides several advantages to conventional laparoscopy, such as 3D vision, motion scaling, intuitive movements, visual immersion and tremor filtration. The advent of robotics has increased the use of minimally invasive surgery among laparoscopically naïve surgeons and expanded the repertoire of experienced surgeons to include more advanced and complex reconstructions.[2]

Manipulation of instruments is what makes the difference between laparoscope holders and fully operational robots, such as the da Vinci®. These robots allow the surgeon to perform meticulous dissections and microsutures in restricted and difficult-to-reach areas. However, their exorbitant price, their volume, their technological complexity and long setup time mean they have not yet entirely won over the surgical community and their cost-effectiveness still needs to be evaluated. It should be made perfectly clear that the rationale for fully operational robots and laparoscope holders is different; robots are not meant

to address economic concerns or lack of assistance in the operating room (OR); therefore, they are probably not for every general hospital.[3]

During minimal access surgery, an assistant is controlling the laparoscope and surgeon should be free to manipulate instruments. Although the advantages of laparoscopic surgery are well-documented, one disadvantage is that, for optimum performance, an experienced camera driver is required who can provide the necessary views for the operating surgeon. There are many drawbacks in human camera operator, especially, if they are not trained.[4] The inconvenience of laparoscopic operations lies mainly in the difficulties in mutual understanding between the surgeon and the camera assistant who maneuvers the laparoscope according to the surgeon's instructions. Another problem arises when the operation has to be performed for many hours. In this case, the camera image tends to become unsteady due to fatigue of the camera assistant. The self camera-control by the surgeon gives more stability of the laparoscopic image. A robotic camera assistant, directly under surgeon's control, can help the surgeon control the view better.[5] This review is limited only in the robotic camera-holder to replace the assistant camera-holder in laparoscopy surgery. In this review, 'Camera-holding robotic device' term is used. Camera-holding robotic device is a robotic device that replaces the human assistant and ensures steady visualization of the operative field and a view which can be controlled by the surgeon (Fig. 1).[6]

MATERIALS AND METHODS

Several types of the camera-hoding robotic devices were reviewed. The first of camera-holding robotic device is AESOP. AESOP is an acronym for automated endoscopic system for optimal positioning. This computerized robotic assistant for laparoscopic surgery was created by Yulun Wang, PhD, and a team of robotic expert. They had a research grant from the National Air and Space Administration and initially were charged with the development of a robotic arm for use in the US space program. This arm was later modified to hold a laparoscope and to replace the human laparoscopic camera holder. AESOP 1000, the first generation AESOP, was based on this development. The surgeon controlled AESOP with either a footswitch or hand control. AESOP 2000 was marketed in 1996 (Fig. 2) with improvements in design and function, including voice control. Voice activation allowed the surgeon to control the laparoscope with simple spoken commands. AESOP 3000 system became available in 1998. It had additional joint, functioning as a second 'elbow', on the robotic arm, and made it possible to apply the robot in a broader range of procedures. The fourth generation system, the AESOP HR (Hermes Ready), enables the surgeon to control AESOP as well as other peripheral devices, such as the operating table and room lights by voice command. By the end of the year 2002, over 8000 AESOP units had been sold and used in over 175,000 procedures in over 600 hospitals around the world.[7]

The other device is EndoAssist (Fig. 3). EndoAssist is programmed to detect and follow the movements of the surgeon's head. The surgeon wears a lightweight headband fitted with an infrared emitter. The head position of the surgeon is detected by a receiver unit and converted into motion of the robot, so to move the view left, the surgeon simply glances to the left of the monitor and the camera pans round. To move the view up, the surgeon looks to the top of the monitor and the camera follows. Movement only occurs if the surgeon is simultaneously pressing a footswitch, thus allowing unrestricted head movements at all other times.[6]

Another camera-holder device was invented by Prof Mishra, India, in collaboration with Mexican engineers. 'PMAT', the name of his invention, is mechatronic assistant wih three degrees of freedom, which is made of aluminium and weighs 2.5 kg (Fig. 4), including laparoscope and camera. This system consists of a harness that is placed over the surgeon's shoulders. The active degree of freedom is moved in both ways using two switches. To make mixed movements, the surgeon moves his/her body through visual perception. This invention was helping the laparoscopic instrument companies to make ideal camera holder.[4]

PARAMIS (parallel robot for minimally invasive surgery) was invented in Romania, which is used for laparoscope camera positioning. The system has been built in such a way that it has the possibility to transform it in a multiarm robot controlled from the console. The control input allows the user to give command in a large area for the positioning of the laparoscope using different interfaces: Joystick, microphone, keyboard, mouse and haptic device.[8]

DISCUSSION

Based on robotic system's classification, such devices function as endoscopic holders that can be directed by commands from the surgeon are classified under 'Intern replacement' surgical

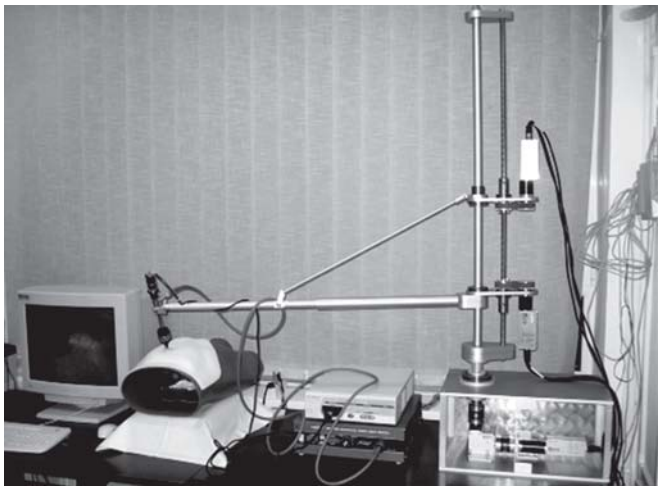


Fig. 1: Laparoscopic primitive camera-holder

robots. These robots are an intermediate class between the 'precise path systems' surgical robots and the 'master-slave' device. They substitute the surgical assistant to perform tasks that require dexterity without tiring.[9]

Most of the camera-holding robotic devices have the advantages, such as elimination of the fatigue of the assistant who holds the camera, elimination of fine motor tremor and small inaccurate movements, delivery of a steady and tremor-free image, nondependency on camera operator, reduced cost of surgery and reduced number of highly skilled staff.[4]

Some of them have additional advantages and disadvantages depend on their uniqueness. There are mechanical, nonrobotic table-mounted clamps, but these require manual adjustment. Another robotic device is the AESOP which is table-mounted and, therefore, has the advantage of moving with the table, if the table position is changed. The EndoAssist, being floor-mounted, has to be brought to the operating table once the optimal position has been decided and has to be reset if the table position is changed. The AESOP device is voice-activated and needs to be set to recognize each individual operator, whereas the EndoAssist is activated by the infrared head device and the surgeon's head movements and this is transferable between individuals according to who wears the head controller.[6] Two robotic laparoscopic camera-holders, EndoAssist and AESOP 3000 are compared from a system design viewpoint measuring the time taken to perform certain tasks by the operator. The results showed the EndoAssist robot to be significantly quicker for most of the tasks studied. This was attributed to increased accuracy of movement in EndoAssist in comparison to the voice recognition errors evident while operating AESOP.[10]

On the other device, the surgeons were slightly felt fatigue with use of the PMAT for laparoscopic procedures which took more time and prompting for motion adjustment was required repeatedly for the cases studied.[4] PARAMIS robot has some

Fig. 2: AESOP

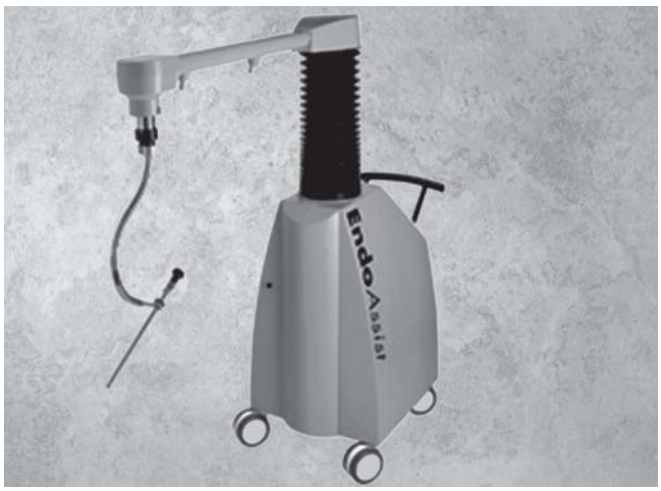


Fig. 3: EndoAssist

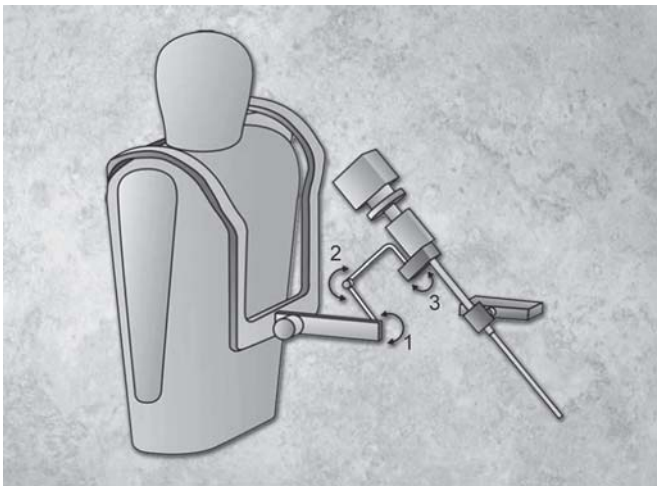


Fig. 4: PMAT

advantages that could be emphasized: Rapid returning in key-positions, open architecture allowing a simple and fast introduction of new commands or modification of the existing ones, direct control over a smooth, precise, stable view of the internal surgical field for the surgeon, no fatigue, save three anatomical positions and return to them by a single voice command.[8]

CONCLUSION

There is no fundamental difference between the operation performed with and without the devices, but the machines do contribute to certain aspects of the operations and may help to overcome some of the difficulties encountered in these complex laparoscopy procedures.

Unavailability and variability in quality of human camera holders should not be an obstacle to performing satisfactory laparoscopic surgery. Therefore, some form of standardization of assistance is required and laparoscope-holding systems are a first step in this direction.

REFERENCES

1. Herron MD, et al. A consensus document on robotic surgery 2007, cited from http://www.sages.org/publication/id/ROBOT/

2. Palep JH. Robotic assisted minimally invasive surgery. J Minim Access Surg Jan 2009;5(1):1-7.
3. Polet R, Donnez J. Using a laparoscope manipulator (LAPMAN) in laparoscopic gynecological surgery, 1998, cited from http://www.surgicaltechnology.com/17-187-GY-Abstract.html
4. Mishra RK, et al. Comparison of PMAT camera holder with human camera control. World Journal of Laparoscopy Surgery May-Aug 2008;1(2):1-5.
5. Shirwalkar V, et al. Robotic camera assistant for laparoscopic surgery, cited from http://www.scribd.com/doc/45776626/Robotic-Camera-Assistant.
6. Gilbert JM. The EndoAssist robotic camera holder as an aid to the introduction of laparoscopic colorectal surgery. Ann R Coll Surg Engl July 2009;91(5):389-93.
7. Ballantyne GH, et al. Primer of robotic and telerobotic surgery. Lippincott Williams and Wilkins 2004;35.
8. Pisla D, et al. PARAMIS parallel robot for laparoscopic surgery. Chirurgia Sep 2010;105(5):677-83.
9. Otero JL, et al. History, evolution and application of robotic surgery in urology. Arch Es Urol 2007;60(4):335-41.
10. Nebot PB, et al. Comparison of task performance of the camera-holder robots EndoAssist and AESOP Oct 2003;13(5):334-38.

10.5005/jp-journals-10007-1131
REVIEW ARTICLE

Role and Advantages of Laparoscopic Surgery in Liver Cirrhosis

Rajiv Gupta

Director, Chief Consultant and Surgeon, Department of General and Laparoscopic Surgery, Rajiv Surgical Clinic and Hospital Dehradun, Uttarakhand, India

ABSTRACT

Liver cirrhosis has always been associated with operative morbidity and mortality because of associated coagulopathies, nutritional disorders and portal hypertension. Laparoscopic surgery has changed the thinking and now liver cirrhosis is not a contraindication for mild to moderate liver cirrhosis patients.[1] This article's review studies done by operating laparoscopically on patients with liver cirrhosis and the methods with which the complications are avoided by laparoscopy during various surgeries and also in the diagnosis and management of cirrhosis of liver.

Keywords: Laparoscopy, Cirrhosis, Portal hypertension, Laparoscopic surgery in cirrhosis, Cirrhosis and laparoscopy, Surgical procedures in cirrhosis.

BACKGROUND

Surgical diseases appear more frequently in patients who present with cirrhosis. Cholecystitis and cholelithiasis is a common problem in patients with cirrhosis and open surgery is definitely riddled with dangers due to changes in homeostasis in the patients which leads to greater morbidity and mortality.

In the past, cirrhosis of liver was considered an absolute contraindication to laparoscopic surgery.[17] Even the open surgical procedures were fraught with life-threatening complications because of associated coagulation disorders, nutritional deficiencies and sometimes portal hypertension which itself was complicating the outcome of surgery. As the experience of the surgeons grew, even in the laparoscopic surgery, cirrhosis is not considered an absolute contraindication for laparoscopic procedures,[2] but it is taken with an extra ounce of care. Lots of surgeons have described procedures previously unthought-of laparoscopically but now can be done very safely by just taking a few precautions and following the rules of good laparoscopic techniques. This article reviews some of the effects of cirrhosis on the outcomes of minimal access surgery in recent times.

Laparoscopic cholecystectomy is definitely a better option because of the focal vision and to some extent the magnification offered by the telescope which enable to see the vessels clearly and also because of the availability of better instruments for example harmonic scalpel. The proven benefits of laparoscopy seem to be especially applicable to patients with chronic disease like cirrhosis of liver.[22]

BASICS OF CIRRHOSIS OF LIVER

Cirrhosis of liver is a chronic and progressive disease most commonly associated with chronic alcoholism which leads to deformity of the normal liver parenchyma into fibrous nodules which in turn reduce the liver function to such an extent that the normal functioning of liver is not possible leading to great morbidity and finally mortality.[5,6] The physiological changes lead to change in the coagulation profiles, nutritional deficiencies, fluid retention, greater susceptibility to infections which in turn increase the peri-and postoperative morbidity due to change in tissue texture and great fluid retention. The diagnostic armamentarium is sometimes not able to correctly classify the stage of cirrhosis. But the latest articles show that cirrhosis is no longer a contraindication, but in fact is recommended as a safe procedure and provides some advantages for some surgeries when cirrhosis is associated. Child–Pugh classification of cirrhosis is still the gold standard for assessing the severity of the cirrhosis in patients.[7]

METHODS OF REVIEW

A literature search was performed using the following search engines: Hinari, Google, HighWire Press, PubMed and the online Springerlink MetaPress Library available at the Laparoscopy Hospital, New Delhi, India, where this study was carried out. The following terms were used for the search: 'Laparoscopy in liver cirrhosis', 'Liver cirrhosis, diagnosis', 'Laparoscopic surgery in cirrhosis'. 'Surgery and cirrhosis' and 'Surgical procedures in cirrhosis'.

A review of articles has proven that patient number size varies from 50 to 1000 in which it is proven that laparoscopic surgery is more useful and less harmful than open surgery because of the associated disease.

AIM

During this review, the aim was to find out if the laparoscopic surgery was dangerous or safe for patients with cirrhosis of liver. Most of the earlier studies have concluded that open

surgery is definitely not safe in patients with cirrhosis as it is associated with a high rate of morbidity and mortality due to associated malnutrition, coagulopathies and ascites. But a review of articles proved that laparoscopy is safer than open surgery in mild to moderate cases of cirrhosis.

This study reviewed:

- The risk of laparoscopy and laparoscopic surgery in cirrhotic patients,
- Previous role and current trends in the use of laparoscopy in the diagnosis of liver cirrhosis, and
- Safety and efficacy of laparoscopy in the treatment of various surgical conditions in cirrhotic patients.

SAFETY CONSIDERATIONS IN CIRRHOTIC PATIENTS UNDERGOING LAPAROSCOPIC PROCEDURES

Factor 1: The Surgeon

A tremendous amount of patience is necessary during the procedure because conversion does not help to control the coagulopathy which is the main danger in cirrhosis (Schiff et al 2005).[8] During their study, they converted 3 out of 24 laparoscopic procedures in cirrhotics, two were due to surgeon's inexperience. Hence, the experience of surgeon plays a key role in performing a safe surgery in patients with cirrhosis of liver.

Factor 2: Anesthetic Techniques

As such, an adequate circulation and volume maintenance is the key to a successful anesthesia in all cases. It does not change in cirrhotics as hepatosplanchnic perfusion may be impaired in cirrhotic cases. But certain drugs like isoflurance increase hepatic regional blood flow, halothane is noted of increase hepatic arterial resistance. Fentanyl, vencuronium and pancuronium do not significantly affect hepatic blood flow and may be preferable in cirrhotic patients.[9]

Factor 3: Preoperative Preparation

In elective surgery, a good preoperative preparation is surgery half done. No words can describe the importance of recognition of coagulopathies by proper investigations and correcting them prophylactic Vit-K administration and/or transfusion with fresh frozen plasma, lowering of portal hypertension with medications, maintain adequate fluid and electrolyte balance and control of infection if present. Garrison et al (1984)[10] had identified absolute serum albumin concentration, presence of infection or contamination and number of seconds partial thromboplastin time is deviated from its control value as the three main preoperative variables that predict surgical outcome in cirrhotic patients.[10]

Factor 4: Good Operative Technique

Some authors have advocated a number of operative techniques to help minimize the morbidity associated with surgery in cirrhotic patients undergoing laparoscopic procedures.

The major risk in cirrhotic is transmission of hepatitis B and/or C virus in cirrhotic from the patient to the operating team. Hence, a safe disposal of sharps and gentle and meticulous transfers of instruments are key to the safety.

As said earlier, patience during operation makes it safe and meticulous hemostasis will prevent the unavoidable blood loss in patients with cirrhosis.

An open technique (Hassan's trocar) for access to prevent inadvertent puncture of an umbilical varix or placement of trocar away from umbilicus in whom the umbilical varices are evident, is another precaution that can be taken.[11]

Modification of surgery in the form of subtotal cholecystectomy, use of ultrasonic energy like harmonic scalpel, glue, oxidized cellulose are other means to prevent more bleeding.[11]

ROLE OF LAPAROSCOPY IN DIAGNOSIS OF LIVER CIRRHOSIS

Historically, histopathology of the biopsied liver specimen has been the gold standard of the diagnosis of cirrhosis of liver. The danger associated with the invasive procedures made surgeons cautious in performing those procedures. Hence, other biochemical and indirect tests were performed to give evidence as to the status of liver. Ultrasound provided a good noninvasive means but its ability to diagnose early cirrhosis is debated. It can very well provide clue to the damaged liver in the form of architectural damage and portal engorgement in advanced stage of disease, but its ability to diagnose cirrhosis in early stage is debatable. Moreover, it gives false-positive results of metastatic disease in some cases of macronodular cirrhosis.

Laparoscopy has an advantage over other diagnostic means especially in liver cirrhosis. It gives a visual impression of the severity of the case and also macroscopic evidence of the destruction of liver. Direct visualization of both lobes of liver gives a comprehensive view of the amount of liver diseased by cirrhosis. A biopsy performed laparoscopically has the advantage of taking the specimen under direct vision and not blindly as taken by needle biopsy which may not hit the target and falsely give a negative report though there may be cirrhosis.[19]

Laparoscopy also allows application of direct pressure or a heater probe to attain hemostasis in the event of bleeding from a biopsy site and may hence be carried out safely despite hematological abnormalities (e.g. PTR > 1.3; platelet < 80,000/mm^3) which routinely contraindicate blind percutaneous biopsy.

The use of diagnostic laparoscopy has, therefore, expanded in liver cirrhosis so much that Vargas et al (1995) recommended that diagnostic laparoscopy should be incorporated into the training programs for gastroenterologists in America.[4] Haydon and Hayes (1997) also advocated that physicians in the United Kingdom should be the ones performing diagnostic laparoscopy.

LAPAROSCOPY AS TREATMENT MODALITY IN PATIENTS WITH ASSOCIATED CIRRHOSIS

Laparoscopic Cholecystectomy in Cirrhotic Patients

The incidence of gallstones is reported to be twice in patients with cirrhosis than in general population.[13-15] Most stones are small pigment stones which are friable and are also associated with more complications.[16] Laparoscopic cholecystectomy is hence the most widely performed surgery on patients with cirrhosis.

Open cholecystectomy is associated with high rates of morbidity (5-30%) and mortality (7-25%) in cases with cirrhosis. Hence, laparoscopic surgery was studied as an alternative and better procedure for cirrhotic patient as it is associated with less bleeding because better visualization with magnification, shorter duration of hospital stay. There are certain difficulties like, some adhesions around gallbladder and hilum of liver, thick margin of liver which makes traction on liver difficult and increased vascularity of gallbladder bed. But the use of additional port and extracting the gallbladder fundus first, or a partial cholecystectomy makes life easier for the surgeon and also for the patient. Laparoscopic cholecystectomy is more useful for mild and moderate degree of cirrhosis, but is Child–Pugh's class C, it still remains relatively contraindicated. The experience of Yeh et al (2002) with LC in 226 cirrhotic patients represents the largest series published so far. However, no patient with Child-Pugh's class C was operated upon. Curro et al (2005) compared four Child-Pugh's class C patients who had LC with 38 Child-Pugh's A and B patients in the same center and found a morbidity rate of 75% in the Child-Pugh's C patients compared with 26% in the A and B group. The authors further advised that surgery in Child-Pugh's C patients should be avoided except in acute emergencies where conservative procedures, such as gallbladder aspiration and partial cholecystectomies may be considered. Even in such instances, percutaneous drainage of the gallbladder and other conservative procedures may suffice.[18]

Laparoscopic Hernia Repair in Cirrhosis

The main concern during hernia repair is the approach. In cirrhosis, the abdominal wall may be riddled with multiple engorged vein due to associated portal hypertension. Performing an open repair of hernia is riddled with bleeding due to these veins and bleeding disorders.

Laparoscopically, all these distended veins are avoided and the abdominal wall is left untouched. The whole surgery is behind the abdominal wall and just involves insertion of a mesh between the peritoneum and the abdominal wall. Hence, avoiding all the potentially distended veins and bleeding.[20]

In a report of 14 cirrhotic patients who underwent laparoscopic incisional and umbilical hernia repair, Giulio et al (2006) observed that though open repair in cirrhotic patients has significant recurrence rates and frequent wound infections, laparoscopic repair yields less morbidity and fewer recurrences. The study further highlighted that the preservation of the anterior abdominal wall in laparoscopic repair avoids the interruption of collateral veins which are not infrequently distended in cirrhotic patients.

There is a tendency to develop umbilical hernias in cirrhosis due to increased porta systemic communication and opening of obliterated umbilical veins to accommodate the pressure. Laparoscopic umbilical hernia repair in cirrhotic patients appears to offer advantages over the open methods.[20] Ascites may add to this effect of producing umbilical hernia due to increased intra-abdominal pressure.

Successful laparoscopic repair of recurrent incarcerated umbilical hernia in a cirrhotic patient with refractory ascites has also been reported.[4] In the report, the authors used dual mesh prosthesis and advocated meticulous sterile fashion of mesh insertion and fixation. This is important since ascitic fluid infection, which may occur after surgery may affect the hernia mesh repair. The possibility of mesh migration due to the ascitic fluid can be reduced by placing the mesh in a preperitoneal space.[12]

Ascites itself may be treated laparoscopically more effectively by placing the peritoneovenous shunt.[21] Surgical treatment of ascites is reserved for severe ascites, others can be treated medically. In cases of ascites with renal failure, insertion of peritoneal dialysis catheters under vision.[22]

Other Laparoscopic Procedures in Cirrhotic Patients

Cobb et al (2004)[2] reported 52 laparoscopic procedures performed on 50 cirrhotic patients. These procedures, including cholecystectomies, splenectomies, colectomies, diagnostic laparoscopies, ventral hernia repairs, nissen fundoplication, Heller's myotomy, gastric bypass and radical nephrectomy had a morbidity rate of 16% but no mortality. Tsugawa et al (2001)[3] had earlier compared open and laparoscopic appendicectomies among patients with liver cirrhosis.[3] They reported fewer rates of wound infection and wound bleeding in the laparoscopic group. Many other laparoscopic procedures including laparoscopic liver resections for hepatocellular carcinomas[21,22] and laparoscopic ultrasound with radiofrequency ablation are now routinely done in cirrhotic patients in some centers.

CONCLUSION

Cirrhosis of liver because of its associated comorbidity, is not a contraindication of any simple or advance procedure by laparoscopy. Although technically challenging because portal hypertension, varices and thrombocytopenia frequently coexist, basic and advanced laparoscopic procedures are safe for patients with mild to moderate cirrhosis of the liver. However, its safety in advanced disease like Child-Pugh's class C is not yet proven, we advocate caution in such cases and further

studies need to be done to find out other ways to make laparoscopic surgery safer even in these cases.

ACKNOWLEDGMENTS

The author wishes to acknowledge the entire staff of World Laparoscopy Hospital who has been very cooperative and supportive during the entire course of DMAS. Their unflinching assistance and patience helped us to learn the skill and perfect it in record time. Also acknowledgments are due to the whole administrative and supportive staff of the hospital who from time to time assisted during periods of difficulty, if there were any.

Last but not the least, a very big thanks to Prof RK Mishra, who has been an excellent orator and teacher. His way of explaining things make it crystal clear so that there are no doubts in the minds of the learner. His patience is admirable, his knowledge of the subject is commendable and his skill is worth achieving.

REFERENCES

1. Adisa AO, Mishra RK. Changing role of laparoscopy in the management of patients with cirrhosis. J Min Access Surg (serial online) 2008 (cited 2011 Aug 19); 4:63-70. Available from: http://www.journalofmas.com/text.asp?2008/4/3/63/43089
2. Cobb WS, Heniford BT, Burns JM, Carbonell AM, Matthews BD, Kercher KW. Cirrhosis is not a contraindication to laparoscopic surgery. Surgical Endoscopy 2005;19(3): 418-23.
3. Tsugawa K, Koyanagi N, Hashizume M, Tomikawa M, Ayukawa K, Akahoshi K, et al. A comparison of open and laparoscopic appendectomy for patients with liver cirrhosis. Surg Laparosc Endosc Percut Tech 2001;11:189-94.
4. Flores Cortes M, Obispo Entrenas A, Docobo Durantez F, Romero Vargas E, Legupin Tubio D, Valera Garcia Z. Laparoscopic treatment of cholelithiasis in cirrhotic patients. Rev Esp Enform Dig Sep 2005;97(9):648-53.
5. Williams EJ, Iredale JP. Liver cirrhosis. Postgrad Med J 1998;74:193-202.
6. Gines P, Cardenas A, Arroyo V, Rodes J. Management of cirrhosis and ascites. N Engl J Med 2004;350:1646-54.
7. Child CG, Turcotte JF. The liver and portal hypertension. Philadelphia: WB Saunders 1964.
8. McDermott WV Jr. The double portacaval shunt in the treatment of chronic ascites. Surg Gynaecol Obstet 1960;110: 457-69.
9. Gelman S, Dillard E, Bradley EL. Hepatic circulation during surgical stress and anesthesia with halothane, isoflurane, or fentanyl. Anesth Analg 1987;66:936-43.
10. Garrison RN, Cryer HM, Howard DA, Polk HC Jr. Clarification of the risk factors for abdominal operations in patients with hepatic cirrhosis. Ann Surg 1984;199:648-55.
11. Friel CM, Stack J, Forse RA, Babineau TJ. Laparoscopic cholecystectomy in patients with hepatic cirrhosis: A five-year experience. J Gastrointest Surg 1999;3:286-91.
12. Mahal AS, Knauer C, Gregory PB. Bleeding after liver biopsy. West J Med 1981;134:11-14.
13. Nicholas P, Rinaudo P, Conn HO. Increased incidence of cholelithiasis in Laennec's cirrhosis: A post-mortem evaluation of pathogenesis. Gastrenterology 1972;63:112-21.
14. Bouchier IA. Postmortem study of the frequency of gallstones in patients with cirrhosis of the liver. Gut 1969;10:705-10.
15. Maggi A, Solenghi D, Panzeri A, Borroni G, Cazzaniga M, Sangiovanni A, et al. Prevalence and incidence of cholelithiasis in patients with liver cirrhosis. Ital J Gastroenterol Hepatol 1997;29:330-35.
16. Schwesinger WH, Kurtin WE, Levine BA, Page CP. Cirrhosis and alcoholism as pathogenetic factors in pigment gallstone disease. Ann Surg 1985;210:319-22.
17. Cuschieri A, Dubios F, Mouiel J, Mouret P, Becker H, Buess G, et al. The European experience with laparoscopic cholecystectomy. Am J Surg 1991;161:385-87.
18. Curro G, Baccarani U, Adani G, Cucinotta E. Laparoscopic cholecystectomy in patients with mild cirrhosis and symptomatic cholelithiasis. Transplant Proc 2007;39:1471-73.
19. Jeffers LJ, Findor A, Thung SN. Minimizing sampling error with laparoscopic guided liver biopsy of the right and left lobes. Gastrointest Endosc 1991;37:A266.
20. McAlister V. Management of umbilical hernia in patients with advanced liver disease. Liver Transpl 2003;9:623-25.
21. Renzo C, Dorico R, Massimiliano B, Silvia C, Maria Antonella R, Claudio Z. Role of different techniques for the placement of Denver Peritoneovenous Shunt (PVS) in malignant ascites. Surg Laparosc Endosc Percutan Tech 2004;14:222-25.
22. Lessin MS, Luks FI. Primary laparoscopic placement of peritoneal dialysis catheter in children and young adults. Surg Endosc 1999;13:1165-67.

10.5005/jp-journals-10007-1132
REVIEW ARTICLE

Current Laparoscopic Management of Symptomatic Meckel's Diverticulum

Morvendhran Moodley
Specialist Surgeon, RK Khan Hospital, Durban, South Africa

ABSTRACT

Laparoscopic management is currently becoming an acceptable technique in the management of complicated Meckel's diverticulum. The study reviews the current techniques described in numerous series since over the past 10 years. Three laparoscopic techniques are described namely; LAMD (Laparoscopic-assisted Meckel's diverticulectomy—3 port technique with exteriorization of the diverticulum via the umbilical port and extracorporeal diverticulectomy), VATMD (Video-assisted Meckel's diverticulectomy—single umbilical port using operating laparoscope) and LMD(Laparoscopic Meckel's diverticulectomy—3 port technique with intracorporeal diverticulectomy). Small study sizes make in-depth statistical analysis impossible. Patient outcome with each technique however, seems similar, suggesting that the ultimate choice of procedure should be left to surgeon and institutional preference. The high incidence of heterotropic gastric mucosa (HGM) in complicated Meckel's diverticulum is confirmed and calculated to be an average of 78.2%.

Keywords: Meckel's diverticulum, Laparoscopic management, Complication.

INTRODUCTION

Meckel's diverticulum is a rare congenital abnormality of the midgut widely accepted to occur in approximately 2% of the general population. The embryological and anatomic description of this anomaly was first published by Johann Friedrich Meckel in 1809 and as such it now carries his name. Meckel's diverticulum is a true diverticulum, containing all layers of the intestinal wall, and represents a failure of complete obliteration of the embryonic omphalomesenteric duct, and is usually present on the antimesenteric border of the distal ileum within approximately 100 cm of the ileocecal valve. It is also a common site for heterotopic mucosa, most frequently gastric although heterotopic, colonic and pancreatic tissues are not infrequently reported within the diverticulum.

The majority of cases are asymptomatic and may often be discovered incidentally. Even in symptomatic patients, preoperative diagnosis is often difficult. Clinically, there is as yet no consensus as to the precise management of asymptomatic diverticula, since the risk of postoperative complications may still be as high as 8%. Surgical excision, however, would still seem appropriate in those cases where patient profile and diverticulum morphology may increase the likelihood of complications later on in life.[1]

Morphological variations include:

- Short diverticulum with a wide base
- Long diverticulum with a narrow base
- Short diverticulum with adherent fibrous band to the umbilicus
- Patent vitellointestinal duct
- Periumbilical sinus.

Clinical presentation in symptomatic patients:

- Anemia/Lower GI bleeding
- Diverticulitis presenting as an acute abdomen
- Intestinal obstruction
- Nonspecific abdominal pain.

Intestinal obstruction may occur as a result of:

- Volvulus of the small bowel around the fibrous band of the diverticulum
- Luminal fibrosis and stenosis secondary to recurrent or chronic diverticulitis, or
- Intussusception.

Conventional surgical management has been laparotomy and any of:

- Simple diverticulectomy
- Diverticulectomy with wedge excision of adjacent ileum
- Segmental ileal resection and anastomosis.

There are two commonly performed laparoscopic procedures for Meckel's diverticulum. The 'conventional' procedure is a 3 port laparoscopy, identification of the diverticulum and either intracorporeal diverticulectomy using endoscopic linear stapler-cutting device or exteriorization of the diverticulum through the enlarged umbilical port site and subsequent extracorporeal excision of the diverticulum and repair of the enteric defect as appropriate. A more novel approach involves a single port technique using an operating laparoscope through the umbilicus—subsequent grasping and exteriorization of the diverticulum through the umbilical incision and diverticulectomy.

AIM

Aim of this review is to determine whether laparoscopy offers a safe and feasible alternative to conventional surgery, particularly in the pediatric population.

METHODS

A PubMed search was conducted using the keywords: Laparoscopy; Meckel's diverticulum; children; laparoscopic

management. Search revealed 20 articles, of which those published after the year 2000 were reviewed, and the search further expanded to include related citations. Articles describing laparoscopic management of Meckel's diverticulum were then selected for analysis. A description of the various procedures, as provided by the various authors is included. Attention is paid to key variables namely, mean operative time, intraoperative complications, duration of postoperative hospitalization and results tabulated to allow for easy comparison.

RESULTS

The largest published series since 2000, was that by Sai Prasad et al.[2] This was a review of 36 patients (27 males and 9 females) who underwent laparoscopic-assisted transumbilical Meckel's diverticulectomy (LATUM) between October 2002 and April 2006.

The procedure described in this series was a two or three port technique using first a 10 mm umbilical port for the laparoscope inserted by the Hassan technique and combined with two 5 mm operating ports inserted in the left iliac fossa and suprapubically. The second operating port being omitted for cases of bleeding MD.

After systematic laparoscopic examination of the intra-abdominal contents, Meckel's diverticular complications when present were managed laparoscopically, following which the freed MD was delivered through an extension of the linea alba, while maintaining the skin incision within the umbilical cicatrix, to allow extracorporeal diverticulectomy and hand-sewn intestinal anastomosis. The authors describe their procedure as LATUM. In this study, one patient with a torted MD underwent intracorporeal diverticulectomy after endoloop ligation of the base.

Clinical presentation of patients in this study population was as follows:

- Sixteen (44.4%) patients presented with lower gastrointestinal bleeding (14 with painless bleed and 2 with perforated peptic ulcer in the ileum adjacent to the MD).
- Six (16.7%) patients presented with intestinal obstruction (four due to a mesodiverticular band and one each due to intussusception and floppy giant cystic dilatation of MD causing intestinal compression)
- Four (11.1%) patients presented with features masquerading as appendicitis (one with Meckel's diverticulitis and perforation, one with perforated peptic ulcer adjacent to MD and two with a torted and gangrenous MD)
- Ten (27.8%) patients, incidental MD with a narrow, base were noted at laparoscopic exploration for suspected appendicitis.

All patients underwent successful LATUM along with appendicectomy.

LATUM along with appendicectomy was successfully performed in all patients.

Mean operative duration was 125.9 ± 48.4 minutes, ranging from 72 to 266 minutes. No intraoperative complications were reported, neither was there any need for conversion to open surgery in any of the procedures. The hospital stay ranged from 3 to 9 days (mean 5.3 ± 1.2). There were three (8.3%) cases of postoperative adhesive intestinal obstruction; two underwent successful laparoscopic adhesiolysis and one necessitated conversion to suprapubic laparotomy to release the pelvic adhesions. Over the 16 months median follow-up period, no other complications were reported.

Ranitidine augmented 99mTc scintigraphy was performed in 14 out of the 16 patients presenting with lower GI bleeding and was suggestive of gastric heterotopia in 12 patients (85.7%). Histopathological analysis found 15 out of the 16 patients (93.7%) to have gastric with or without pancreatic heterotopia. Overall, this study found ectopic gastric, pancreatic or duodenal epithelium in 25 patients (69.4% of the study population). Five (50%) of the incidentally detected MD showed gastric heterotopia.

Shalaby et al[3] reviewed the clinical data of 33 children who were admitted with rectal bleeding and/or recurrent abdominal pain with no identifiable cause, over a period of 8 years, at their institution. This study group consisted of 23 male patients and 10 females with a mean age of 5.12 years (range, 3-12 years). In 21 cases, Meckel's diverticulum was an incidental finding on laparoscopic appendectomy and symptomatic in 12 cases. Preoperative workup for patients with rectal bleeding included upper gastrointestinal endoscopy; colonoscopy and technetium Tc 99m-labeled pertechnetate scan in the addition to the routine investigations performed for all other patients.

Pneumoperitoneum was created by open Hasson's technique using a 12 mm port to a pressure of 12 mm Hg. Through this port, a 10 mm telescope was used for initial visualization of the whole abdomen and two 3 mm accessory ports were inserted on both sides of the lateral borders of the rectus muscle below the level of the umbilicus. Following complete laparoscopic visualization of the abdomen, the ileocecal segment was identified and the terminal ileum was examined stepwise from ileocecal junction proximally using atraumatic graspers.

Laparoscopy was able to make a correct diagnosis in all 12 symptomatic patients. These included MD (n = 8), intussusception secondary to M (n = 1), duplication of distal ileum (n = 1) and no pathology was identified on detailed laparoscopic examination.

If a Meckel's diverticulum was identified, a 3.3 mm telescope was placed through the left accessory port leaving the umbilical port free for either application of a endostapler-cutter and specimen extraction (LMD-Laparoscopic Meckel's Diverticulectomy) or for exteriorization of the diverticulum to facilitate laparoscopy-assisted Meckel's diverticulectomy (LAMD).

The choice of whether LAMD or LMD was based on the appearance of the MD.

LAMD was performed for bleeding and for those patients with short incidental MDs, with height-to-width ratio (HD ratio) less than 1.6, so as to ensure complete removal of ectopic mucosa that may line the proximal end of MD and adjacent ileal mucosa. The intestinal segment bearing MD was delivered through the umbilical port site to the abdominal surface. Small bowel resection and anastomosis were then accomplished extracorporeally either by manual suturing or by an endostapler-cutting device.

LMD was performed for long MDs, either symptomatic or incidental with HD ratio greater than 1.6. The tip of the MD was held and pulled toward the anterior abdominal wall and an endolinear-stapler-cutter device was applied obliquely to its base to remove all the diverticular tissue without threatening the ileal lumen.

In those cases where no lesions were found on diagnostic laparoscopy, laparoscopic appendectomy (LA) alone was carried out.

In all, LMD and LAMD were done for 18 and 12 MDs, respectively.

The mean operative time was as follows:

- 45 minutes for LA and LMD was 45 minutes
- 55 minutes for LA and LAMD was 55 minutes
- The mean operative time for LA and laparoscopic release of intussusception was 30 and 35 minutes respectively.

Long MD with HD ratio greater than 1.6 was found in 18 cases. Short MD with HD ratio less than 1.6 was found in 12 cases. The histopathologic studies confirmed heterotopic gastric mucosa (HGM) in 13 cases (43.3%). HGM was present in the distal end of six long cases and in seven short MDs; it was found in the proximal end.

No intraoperative or postoperative complications occurred.

Mean hospital stay in this study group was 1.66 ± 0.8 days (range, 1-5 days). No postoperative complications were reported. All patients were reported to be asymptomatic after 1 year of follow-up.

Clark et al[4] conducted a retrospective chart review of patients who underwent laparoscopic excision of MD from 2000 to 2005 at their center. Nine patients were identified. They describe a 3 port, laparoscopy-assisted procedure (LAP) and a single port video-assisted transumbilical procedure (VAT).

VAT Technique

A 10 mm trocar is placed through a vertical, transumbilical incision and a pneumoperitoneum is established. A 10 mm, zero degree, operative laparoscope with a 400 mm atraumatic grasper is used to run the bowel and to locate the MD. The MD is pulled through the umbilical incision and resected extracorporeally. The umbilical incision is slightly enlarged to accommodate the bowel.

LAP Technique

A 10 mm trocar is placed through a vertical, transumbilical incision and a pneumoperitoneum is established. Two working 5 mm trocars are inserted in the lower quadrants. The MD is pulled through the umbilical incision and resected extracorporeally. The umbilical incision is slightly enlarged to accommodate the bowel.

Four patients underwent the three-trocar technique (LAP, n = 4). The remaining five underwent the video-assisted transumbilical single-trocar technique (VAT, n = 5) procedure. In this study, the choice of the technique of resection was left to the discretion of the surgeon. Indications for surgery included gastrointestinal bleeding (VAT, n = 3; LAP, n = 2), malrotation (LAP, n = 2), intussusception (VAT, n = 1) and abdominal pain (VAT, n = 1). All patients were male, and age ranged from 7 months to 17 years for the VAT group and 8 months to 15 years for the LAP group.

The average length of surgery for the LAP *vs* VAT was 128 minutes (94-170 minutes) and 81.4 minutes (42-96 minutes) respectively. Of the five patients undergoing LAP, two Ladd's procedures and three appendectomies were included during the same anesthesia. Only a single appendectomy procedure was performed during a VAT. The average time until full feeds with the LAP and VAT was 4.3 days (2-8 days) and 2.0 days (1-3 days) respectively. The overall length of stay with LAP *vs* VAT was 4.3 days (2-8 days) and 3.7 days (2-5 days). Only one case using the LAP method required conversion to an open laparotomy because of unclear anatomy. The only complication reported was a single patient who developed postoperatively ileus in the LAP group.

Chan et al[5] report their 10-year experience with laparoscopic management of complicated Meckel's diverticulum cases presenting in childhood from 1998 to 2007. Their study group contained 20 children (17 males and 3 females), with a mean age of 5 years, ranging from 7 months to 13 years.

Diagnostic laparoscopy was performed on all patients and proceeded successfully to laparoscopically-assisted transumbilical Meckel's diverticulectomy in 18 patients. Two patients required conversion to open surgery due to nature of the pathology. The mean operative time was 115 minutes with a range from 50 to 190 minutes. All the children had an uneventful recovery, except one, who experienced a postoperative wound infection. Ectopic gastric mucosa was found in 14 cases. Mean hospital stay reported was 6.9 days (range of 5-9 days).

Cobellis et al[6] describe their experience with nine patients with a median age of 6.1 years (range, 6 months to 13.6 years) who underwent single trocar transumbilical laparoscopic-assisted procedures for Meckel's diverticulum between January 2001 and December 2004. They used an intraumbilical Hassan 10 mm trocar inserted in an open fashion after which a 10 mm operative laparoscope was introduced. Using an atraumatic instrument, the terminal ileum was grasped exteriorized through the umbilicus allowing ileal exploration and treatment to be performed extracorporeally.

Meckel's diverticulum was identified in eight patients and ileal duplication in one patient. Resection/anastomosis was

performed in seven patients and excision of diverticulum performed in two. The mean operative time was 70 minutes (range, 40-100 minutes). There were no operative complications. The histology of the resected MDs showed ectopic gastric mucosa in all eight patients, associated with focal ulceration in two. The authors reported no operative complications. Median hospital stay was four days (range, 3-7 days). At a median follow-up of 24 months (range, 3-51 months), all patients were asymptomatic.

The series by Palanivelu et al[7] 2008 included 12 patients with symptomatic Meckel's diverticulum treated from 1994 to 2006. All the patients presented with features of either appendicitis or peritonitis, some with a vague abdominal mass. Clinical diagnosis of Meckel's diverticulum was made in only four patients. Diagnostic laparoscopy confirmed Meckel's diverticulitis in all patients. The open Hasson technique was used to establish pneumoperitoneum. A 10 mm trocar was inserted into the umbilicus followed by two working ports, a 5 mm suprapubic port and another 5 mm port in the right lower quadrant; both introduced under vision. A 10 mm (300) laparoscope was introduced into the 10 mm port for diagnostic laparoscopy. Laparoscopic stapler resection of the lesions was performed for all patients using an endostapler-cutter which was introduced into a 12 mm trocar, replacing the 10 mm umbilical trocar. Tangential excision was performed in 10 patients and wedge excision in two patients in whom the base of the diverticulum was thought to be inflamed. Routine appendicectomy was performed for all patients.

No cases of staple line leaks were reported in this study. One patient had infection of the umbilical wound, which was treated with the appropriate antibiotics. One patient had postoperative pneumonitis, treated with intravenous antibiotics for 5 days. Histopathology of the diverticulum showed heterotopic gastric mucosa in 11 (73%) patients, pancreatic tissue in one (27%) patient, evidence of acute inflammation in nine patients and perforation in three patients. The day of discharge was in the range of the fourth to the seventh postoperative day. Eight patients were followed up for 24 months and four patients reported for follow-up after 45 months. All were found to be symptom free.

DISCUSSION

Meckel's diverticulum, even today still presents as a diagnostic and therapeutic challenge. As already stated, the majority of people with Meckel's diverticulum are asymptomatic. Cullen et al[8] found the lifetime risk of complications in people with Meckel's diverticulum to be 6.4%. The potential for complications though may be greater in people who are less than 50 years of age; male; have diverticuli greater than 2 cm in length; and in diverticuli that contain heterotropic mucosa.[1]

Cullen et al[8] also showed that surgery for complicated Meckel's diverticulum is associated with significant operative mortality and morbidity, 2 and 12% respectively. Long-term postoperative complications are likely to occur in approximately 7% of patients.[8] Significantly, this study also showed that even incidental diverticulectomies carried an operative surgical mortality and morbidity risk of 1 and 2% respectively as well as a risk of long-term complications in 2% of patients.

Complicated Meckel's diverticulum is thus by no means an innocuous diagnosis and highlights the need for both a reliable diagnostic and therapeutic tool to optimize management in these patients. Advances in minimal access surgery, we may now provide us with such a tool. The low incidence of symptomatic Meckel's diverticulum in the general population implies that high-powered randomized controlled trials comparing various modes of laparoscopic and even open surgical procedures are unlikely to occur. As such institutional experience becomes increasingly significant in determining optimal management of this condition.

As laparoscopic appendicectomy and diagnostic laparoscopy increasingly gain popularity, it is more likely that the diagnosis of complicated Meckel's diverticulum will be made with the use of a laparoscope, particularly in patients presenting with an acute abdomen. At this point, the surgeon has three therapeutic options, namely proceed with LMD which implies intracorporeal diverticulectomy; LAMD; or if the pathology warrants conversion to open surgery. Conversion to open surgery is likely to be required in patients with gangrenous bowel, irreducible intussusception or alternate diagnosis.

Diverticulum morphology may also influence surgical management. Mukai et al[9] suggest that the external appearance of the diverticulum indicates the distribution of the HGM and as such would influence the choice of laparoscopic procedure. According to their results, long diverticula (more than 1.6 HD ratio) have HGM only in the distal area, while short diverticula (less than 1.6 HD ratio) have HGM in almost all areas. In long diverticula, simple transverse resection with a stapling device would be acceptable provided immediate frozen section analysis is present to ensure that the stump does not contain HGM. For short diverticula, wedge resection or ileal resection with end-to-end anastomosis after exteriorization would be more appropriate. Adequate resection of heterotropic mucosa is mandatory, not only because residual mucosa may result in persistence of symptoms following surgery, but also because of its possible neoplastic potential.[10]

The incidence of heterotropic mucosa in the analysis of the studies included in this review is calculated to be 78.2%. As such LAMD with exteriorization of the diverticulum, wedge resection and ileal repair would be the preferred procedure, given that it allows for tactile examination of the diverticulum, wedge excision, without significant differences in outcome and has the added cost-saving benefit of avoiding use of an endostapler-cutter device (Table 1).

A second distinct group of patients are those in whom the diagnosis of Meckel's diverticulum is suspected preoperatively. These patients are more likely to have presented with lower

Table 1: Comparison of outcomes

Study	*N*	*LAMD*	*VATMD*	*LMD*	*RA*	*Mean operative time (min)*			*Mean hospital stay (days)*			*Postoperative complications*	*Ectopic gastric mucosa*	
						LAMD	*VATMD*	*LMD*	*LAMD*	*VATMD*	*LMD*			
Sai Prasad et al, 2006	36	36	–	–	No	125.9 ± 48.4	–	–	5.3 ± 1.2	–	–	8.3%	93.7%	(50% in incidental MD)
Shalaby et al 2005	33	18	–	12	Yes	55	–	45	1.66 ± 0.8 (for all patients)			0%	44%	
Clark et al 2008	9	4	5	–	No	128	81.4	–	4.3	3.7	–	11%	n/r	
Chan et al 2008	20	18	–	–	No	115	–	–	6.8	–	–	5.5%	92%	
Cobellis et al 2007	9	–	9	–	No	–	70	–	–	4	–	0%	88.9%	
Palanivelu et al 2008	12	–	–	12	Yes	–	–	62-110 mins	–	–	4-7 days	16%	73%	
Total	119	76	14	24										
Average						106	75.7	n/a	4.5	3.85	n/a	6.8%	78.3%	

MD: Meckel's diverticulectomy; LAMD: Laparoscopically-assisted transumbilical Meckel's diverticulectomy (3 port technique); VATMD: Video-assisted transumbilical Meckel's diverticulectomy (single port technique); LMD: Laparoscopic Meckel's diverticulectomy (3 port intracorporeal diverticulectomy); RA: Routine appendicectomy

gastrointestinal bleeding with or without anemia and would have had endoscopic or radiological imaging of the GIT and possibly 99Tc pertechnetate scintigraphy (Meckel scan). The sensitivity of the Meckel scan, however, may only be in the region of 60 to 66%[11,12] and carries a relatively high false-negative rate.[12] In cases, where investigations and clinical suspicion favor the diagnosis of Meckel's diverticulum which seem most appropriate to proceed with the novel single-port video-assisted transumbilical procedure proposed by both Clark[4] and Cobellis.[6]

CONCLUSION AND RECOMMENDATION

This study illustrates the fact that the laparoscopic era brings with it novel approaches to old pathologies. Large-scale trials comparing specific therapeutic strategies are unlikely to occur. From the available evidence, however, we can conclude that all current laparoscopic techniques in the management of Meckel's diverticulum are both safe and effective with no significant difference in outcome between them. In the appropriate clinical setting, I would however suggest that preference be given to either LAMD or VATMD rather than 'conventional' LMD using an intracorporeal stapler-cutter.

REFERENCES

1. Mackey WC, Dineen P. A fifty-year experience with Meckel's diverticulum. Surg Gynecolo Obstet Jan 1983;156(1):56-64.
2. Sai Prasad TR, et al. Meckel's diverticular complications in children: Is laparoscopy the order of the day? Pediatr Surg Int 2007;23:141-47.
3. Shalaby RY, et al. Laparoscopic management of Meckel's diverticulum in children. Journal of Pediatric Surgery 2005;40: 562-67.
4. Clark JM, et al. Video-assisted transumbilical Meckel's diverticulectomy in children. The American Surgeon. April 2008;74(4):327-29.
5. Chan KW, et al. Laparoscopic management of complicated Meckel's diverticulum in children: A 10-year review. Surg Endosc 2008;22:1509-12.
6. Cobellis G, et al. One-trocar transumbilical laparoscopic-assisted management of Meckel's diverticulum in children. Journal of Laparoendoscopic and Adv Surg Tech 2007;17:238-41.
7. Palanivelu C, et al. Laparoscopic management of symptomatic Meckel's diverticula: A simple tangential stapler excision. JSLS 2008;12:66-70.
8. Cullen JJ, et al. Surgical management of Meckel's diverticulum: An epidemiologic, population-based study. Ann Surg 1994;220: 564-69.
9. Mukai M, et al. Does the external appearance of a Meckel's diverticulum assist in choice of laparoscopic procedure? Pediatr Surg Int 2002;18:231-33.
10. Bona D, et al. Laparoscopic resection for incidentally detected Meckel diverticulum. World J Gastroenterol Aug 2008;14(31): 4961-63.
11. Menezes M, et al. Symptomatic Meckel's diverticulum in children: A 16-year review. Pediatr Surg Int 2008;24:575-77.
12. Swaniker F, et al. The utility of technetium 99 m pertechnetate scintigraphy in the evaluation of patients with Meckel's diverticulum. J Pediatr Surg May 1999;34(5):760-64.

10.5005/jp-journals-10007-1133
REVIEW ARTICLE

Laparoscopic *vs* Open Pyeloplasty

Ahmed Nihad Abtar
Specialist in Urology, Director, Rania General Hospital, Rania, Sulaimaniyah, Iraq

ABSTRACT

This review article compares open *versus* laparoscopic management of pelviureteric junction obstruction (PUJO). Untreated PUJO will cause hydronephrosis and gradual renal impairment. Using PubMed, Google, Journal of Minimal Access Surgery (JMAS), Medscape, European Urology Journal and SpringerLink internet search engines, I reviewed several articles that have tried to find out which way is better. Most of the articles I reviewed showed that laparoscopic pyeloplasty (LP) is as good as open pyeloplasty (OP) and has additional advantages. The parameters that were evaluated included operative time, the use of pain killers (analgesic), period of hospitalization and complications.

Conclusion: Most of the studies agreed on that LP had less morbidity and less hospital stay than OP, but the main disadvantage was the longer operative time.

Keywords: Laparoscopic pyeloplasty, Management of PUJ obstruction, Laparoscopic PUJ surgery.

INTRODUCTION

Many procedures have been described for the management of Pelviureteric Junction Obstruction (PUJO) including open, laparoscopic and endourological approaches. The first reconstructive procedure was performed by Trendelenburg in 1886 and in 1891, Kuster performed the first successful dismembered pyeloplasty.[1] The first laparoscopic pyeloplasty (LP) was described by Schuessler et al[2] in 1993. Many procedures exist for correction of PUJ obstruction, but surgical management of PUJ obstruction has recently been improved by the introduction of minimally invasive surgical techniques as alternative to standard open surgery in an effort to reduce the morbidity of the treatment. Initially, minimally invasive approaches included antegrade and retrograde endoscopic endopyelotomy, but there is increasing evidence that laparoscopic dismembered pyeloplasty is becoming the preferred option for treatment of PUJO and it can be performed by transperitoneal, retroperitoneal or hand-assisted techniques, having a success rate of more than 95%.[3,4] These outcomes are better than other minimally invasive approaches to PUJO, including retrograde and antegrade endopyelotomy or balloon dilation.[5] Patients suffering from PUJO present with a wide range of symptoms. Only a small percentage present with pain severe enough to necessitate insertion of ureteric stent until the definitive surgery is prepared.[6]

MATERIALS AND METHODS

A search for literatures and articles was performed using Google search engine, SpringerLink, eMedicine, WebMD and PubMed. The following search terms were used: Laparoscopic *versus* open pyeloplasty, pyeloplast repair, advanced management of PUJ obstruction, robotic pyeloplasty. Multiple articles were found. Selection criteria included those articles comparing open *versus* laparoscopic (or robotic) techniques, actual application of the methods.

DISCUSSION

LP has developed worldwide as the first minimally invasive option to match the success rates of open pyeloplasty while achieving the added goals of low morbidity, short hospital stay and convalescence. The success rate of Piyush Singhania et al[7] was 86.66% with a median follow-up period of 10.6 months which compares favorably with other series. The operative time decreased with increasing surgeon's experience and standardization of the operative steps. LP allows the surgeon to perform the operative steps similar to those in open pyeloplasties, such as dissection, transection and suturing. However, it is a difficult procedure that requires careful ureteral dissection and considerable proficiency in the intracorporeal suturing.[8] Standardization of a surgeon's steps and introduction of additional techniques specific for laparoscopic surgery can help to overcome the difficulties and enhance the performance. Toward this end, we placed a transcutaneous suture in the medial edge of the redundant renal pelvis just below the renal vein. We found this step very useful in the transection and suturing as it tends to open up the pelvis and acts as a stay suture holding the anterior and the posterior walls of the pelvis apart. We also tried taking a stay suture on the ureter in our initial cases, but it caused entanglement of the sutures and so to avoid confusion this step was omitted in the subsequent cases. Crossing vessels were observed in 7 out of 15 (46.7%) patients. The contribution of crossing vessels to the functional obstruction of the PUJ is an area of controversy. There is a higher incidence of crossing vessels as detected by color Doppler ultrasonography, in relation to kidneys with known PUJO (79%) than in kidneys with no PUJO (35%).[9] Crossing vessels are common in adult kidneys (50 to 80%) with PUJO

than in pediatric kidneys with PUJO (30%) and absent in prenatally detected PUJO.[10] Thus, there may be a time-dependent relation between the development of adult PUJO and the presence of crossing vessel. The identification of crossing vessels tends to be higher in laparoscopic than in open surgery.[11] The explanation for this difference may lie in the minimal mobilization of the kidney needed during the laparoscopic procedure to access the PUJ, in contrast to the open pyeloplasty in which the entire kidney needs to be mobilized and rotated medially to expose the pelviureteric segment.[11] Van Cangh et al showed the negative association between the presence of crossing vessel and the success rate of endopyelotomy.[12] Crossing vessels are an important consideration in managing PUJO even though the relative contribution of crossing vessels to the pathophysiology of the individual PUJO will probably always be difficult to quantify as there are subtle differences in vessel size, distance from and relation to the PUJ, degree of hydronephrosis, level of kidney function and the presence of periureteric and perivascular bands and adhesions. Incidence of crossing vessels reported in retroperitoneal series is lower than those reported in most transperitoneal studies. And a retroperitoneal surgeon is less likely to transpose the anterior crossing vessel arguing that the ureter is lying naturally and anatomically as the most posterior structure in the retroperitoneum as evidenced in the series of Eden CG et al. Still, there is no apparent difference in the success rate of transperitoneal or retroperitoneal LP. Precise plastic repair of the PUJ is most important for the success rate of pyeloplasty with the crossing vessel either transposed or translocated cephalad from the PUJ area, as per the individual case.[13] The necessity for reduction of the renal pelvis might be controversial. We do not reduce the pelvis when it is small and has active peristalsis. However, in a large pelvis with poor movement, we actively consider reduction, particularly when the reduction is necessary to give the PUJ, a funnel-like shape. All patients in our series had primary PUJ obstruction. LP has been used even in patients in whom previous endoscopic and/or open pyeloplasty had failed. Sundaram CP et al[14] reported an overall success rate of 94% in a series of 36 patients with secondary PUJO. Siqueria et al[15] also reported success in eight out of nine patients. Jarrett[16] reported 17 laparoscopic pyeloplasties with secondary PUJO with a success rate of 88%. Notable point recorded in these studies was the longer mean operative time. Soulie et al[17] and Lachkar et al[18] report that any previous retroperitoneoscopic procedure makes a new retroperitoneoscopic pyeloplasty unlikely. So, a transperitoneal approach is preferred for such cases over the retroperitoneal approach. We used transperitoneal approach in all our patients. This approach offers more working space and a better field of view which is important for a reconstructive surgery. However, several disadvantages have been reported for this approach. For access to the retroperitoneum, the colon has to be mobilized and separated from the Gerota's fascia. In addition, the renal pelvis is not completely exposed as the renal artery and vein cross ventrally. In Rasweiler's experience,[19] this approach is also more invasive as reflected by the higher postoperative morbidity rates relative to the retroperitoneoscopic nephrectomy. However, we did not experience any technical difficulty or increased morbidity in the postoperative period in our series of transperitoneal pyeloplasty. Fourteen out of 15 patients did not suffer from ileus or distention of abdomen and we started oral sips from the evening of the surgery which was tolerated well by all patients. One out of 15 patients developed urinary peritonitis due to leak from the anterior suture line of the ureteropelvic anastomosis and required open exploration. Others have reported shorter operative times[17] but higher complication rates[20] for the retroperitoneoscopic approach. The success rates seem to be better with transperitoneal pyeloplasty (97 to 99%) than with the retroperitoneoscopic approach (87 to 98%).[8] Long-term outcomes need to be assessed because in rare cases PUJ obstruction can recur a year or more postoperatively. Several investigators recommend assessment of outcome by at least 1-year follow-up with diuretic renal scan or IVP.[8] Jarrett et al[16] reported the results of 100 laparoscopic pyeloplasties with a mean clinical and radiographic follow-up of 2.7 and 2.2 years respectively. The overall success rate was 96% and no late failure (after 1 year) was observed. We intend to follow all our patients for a period of 1 year after surgery with IVP and DTPA renal scan. At the present time, eight patients are under follow-up and seven patients have completed the 1 year follow-up and there was only one failure.

CONCLUSION

LP is a safe and effective minimally invasive treatment option that duplicates the principles and techniques of definitive open surgical repair. The success rates associated with LP are comparable to those of the gold standard, open pyeloplasty. LP is associated with significant reductions in overall morbidity, including less discomfort, shorter hospital stay, lower complication rate, and shorter time to convalescence and is cosmetically superior to the open pyeloplasty. Varied surgical anatomy associated with PUJ like the crossing vessels and high insertion of the ureter in the pelvis can be successfully repaired with LP which have been shown to compromise the results of other endourological procedures. The disadvantage includes the longer operative duration as compared to open pyeloplasty, steep learning curve and requires technical expertise. With the steady increase in worldwide laparoscopic experience and education, LP is indeed emerging as the new gold standard of care for symptomatic PUJ obstruction.

REFERENCES

1. Thomas HS, Stevan B Streem, Stephen Y Nakada. Campbell-walsh urology (9th ed). Management of upper urinary tract Obstruction 2007.

2. Schuessler WW, Grune MT, Tecuanhuey LV, Preminger GM. Laparoscopic dismembered pyeloplasty. J Urol 1993;150: 1795-99.
3. Sung GT, Gill IS, Hsu TH. Robotic-assisted laparoscopic pyeloplasty: A pilot study. Urology 1999;53:1099-1103.
4. Moon DA, El-Shazly MA, Chang CM, Gianduzzo TR, Eden CG. Laparoscopic pyeloplasty: Evolution of a new gold standard. Urology 2006;67(5):932-36.
5. Wolf J Stuart, Jr Stoller Marshall L. Smith's urology (17th ed). Laparoscopic Surgery 2008;149-50.
6. Calvert RC, Morsy MM, Zelhof B, Rhodes M, Burgess NA. Comparison of laparoscopic and open pyeloplasty in 100 patients with pelviureteric junction obstruction. Surg Endosc 2008;22: 411-14.
7. Singhania Piyush, Andankar Mukund G, Pathak Hemant R. Laparoscopic dismembered pyeloplasty: Our experience in 15 cases. World Journal of Laparoscopic Surgery, May-Aug 2009;2(2):6-11.
8. Masatsugu Iwamura, et al. Laparoscopic pyeloplasty for ureteropelvic junction obstruction: Outcome of initial 12 procedures. International Journal of Urology 2004;11: 449-55.
9. Janeteschek G, Frauscher F, Frauscher F. Laparoscopic pyeloplasty. Urol Clin North Am 2000;27:695-704.
10. Ross JH, Kay R, Knipper NS, Streem SB. The absence of crossing vessels in association with ureteropelvic junction obstruction detected by prenatal ultrasonography. J Urol 1998;160:973-75.
11. Eden CG, Cahill D, Allen JD. Laparoscopic dismembered pyeloplasty: 50 consecutive cases. BJU Int 2001;88:526-31.
12. Van Cangh PJ, Wilmart JF, Opsomer RJ, Abi-Aad A, Wese FX, et al. Long-term results and late recurrence after endoureteropyelotomy: A critical analysis of prognostic factors. J Urol 1994;151: 934-37.
13. Gill Inderbir S, Hrouda David, Adeyoju Adebanji B. Laparoscopic pyeloplasty: The first decade. BJU International 2004;94: 264- 67.
14. Sundaram CP, Grubb RL, Rehman JA, Yan YA, Chen CA, et al. Laparoscopic pyeloplasty for secondary ureteropelvic junction obstruction. J Urol 2003;169:2037-40.
15. Siqueira TM Jr, Nadu A, Kuo RL, Paterson RF, Lingeman JE, et al. Laparoscopic treatment for ureteropelvic junction obstruction. Urology 2002:60;973-78.
16. Jarrett TW, Chan DY, Charambura TC, Fugita O, Kavoussi LR. Laparoscopic pyeloplasty: The first 100 cases. J Urol 2002;167: 1253-56.
17. Soulie M, Salomen L, Patard JJ, Mouly PA, Manunta AN, et al. Extraperitoneal laparoscopic pyeloplasty: A multicenter study of 55 procedures. J Urol 2001;166:48-50.
18. Lachkar A, Sibert L, Rozet F, et al. Contribution of lumboscopy to the treatment of ureteropelvic junction syndromes, based on a series of 25 cases. Progr Urol 2000;10:524-28.
19. Rassweiler J, Frede T, Henkel TO, et al. Nephrectomy: Comparative study between the transperitoneal and retroperitoneal laparoscopic versus the open approach. Eur Urol 1998;33:489-96.
20. Slama MR, Salomon L, Hoznek A, et al. Extraperitoneal laparoscopic repair of ureteropelvic junction obstruction: Initial experience in 15 cases. Urology 2000;56:45-48.

10.5005/jp-journals-10007-1134
REVIEW ARTICLE

Advances in Minimal Access Surgery in the Surgical Staging of Carcinoma Endometrium

Jayasree Santhosh
Specialist, Department of Obstetrics and Gynecology, Royal Hospital, Muscat, Oman

ABSTRACT

The concept of minimal access surgery for gynecologic malignancies has gone from a perceived near impossibility to a fully recognized option for many patients over the past 10 years. This article reviews the different minimal access techniques used for surgical staging of carcinoma endometrium, their outcome, feasibility and safety in comparison to conventional staging laparotomy. After review of literature, it is concluded that laparoscopic and robotic-assisted procedures are acceptable and safer alternatives to traditional laparotomy in the staging of carcinoma endometrium, especially in obese women. Long-term outcome reports for robotic surgery is awaited.

Keywords: Carcinoma endometrium, Laparoscopy, Robotic surgery, Surgical staging.

INTRODUCTION

Endometrial carcinoma is one of the most common gynecological malignancies in women. It is expected to become more common as the prevalence of obesity, one of the major risk factors of endometrial carcinoma increases worldwide.[1]

Surgical management is the mainstay of initial treatment for most patients and is usually curative.

Comprehensive surgical staging includes total hysterectomy, bilateral salpingo-oophorectomy, pelvic and para aortic lymphadenectomy and pelvic cytology. This has been shown to define the biology of disease and guides the use of postoperative adjuvant therapy.[2]

Regarding the therapeutic role of lymphadenectomy in women with disease that clinically seems to be confined to the uterus, there has been much debate. Although lymphadenectomy forms part of the International Federation of Gynecology and Obstetrics (FIGO) surgical staging system,[3] evidence from a large randomized controlled trial. A study in the treatment of endometrial cancer (ASTEC) showed that this approach does not provide therapeutic benefit.[4] Inspite of debates, surgical treatment and staging are performed according to the FIGO[5] staging system and American Joint Committee on Cancer.[6]

Comprehensive surgical staging is technically difficult in obese patients with comorbidities which is the usual clinical picture in endometrial cancer. Limiting surgical morbidity while maintaining staging adequacy is a primary concern in patients with uterine malignancy. Hence, research directed to improve surgical techniques to appropriately manage these patients is important.[7]

Surgical staging of carcinoma endometrium was primarily by laparotomy. Childers and Surwit first proposed laparoscopy as an option for apparently early stage endometrial cancer (1993). Since April 2005, the role of robotic-assisted surgery in gynecologic oncology was identified. Several studies are published comparing the surgical, pathologic and quality of life and survival outcomes for conventional laparotomy and the two minimally invasive treatment modalities for endometrial cancer—laparoscopy and robotics. This article compares the different modalities of surgical staging in carcinoma endometrium, the advances in minimal access surgery in this context, its relevance and safety.

OBJECTIVES

The objective of this article is to review the advances in minimal access surgery in the surgical staging of carcinoma endometrium and to compare the outcome of the different modalities of surgical treatment in patients with carcinoma endometrium.

MATERIALS AND METHODS

Articles published regarding the methods of surgical staging in carcinoma endometrium for a period of 10 years from January 2001 to date were reviewed. The extensive electronic search included Medline, PubMed, Cochrane library, HighWire press, SAGES website, Google search engine, Yahoo search engine and SpringerLink Journal Electronic Library.

REVIEW OF LITERATURE

Regardless of preoperative grade, our management goal in endometrial cancer is comprehensive staging, to include pelvic washings, hysterectomy, bilateral salpingo-oophorectomy and pelvic-aortic lymphadenectomy. The boundaries of the pelvic and para-aortic lymph node dissection include up to the duodenum on the right side and to the inferior mesenteric artery on the left.[8]

Historically, comprehensive surgical staging in endometrial cancer has been accomplished via open laparotomy.[9] The decade of the 1990s brought the use of minimally invasive surgery to replicate the traditional goals of comprehensive surgical staging of endometrial cancer. Dargent and Querleu et al in France and

Childers et al and Spirtos et al in the United States demonstrated the adequacy and safety in small single-institution studies.[10-13] There are isolated reports of surgical staging with micro-laparoscopy also.

Inspite of its advantages, the limitations of laparoscopy which includes counterintuitive motion, nonwristed instrumentation and heavy reliance on skilled surgical assistance contributed to a difficult and long learning curve. Comprehensive laparoscopic surgical staging is more difficult in the morbidly obese and with other patient factors, such as associated comorbidities, adhesive disease, large uteri, fatty mesentery. Since, the da Vinci surgical system was approved for gynecology in April 2005, the role of robotic-assisted surgery in gynecologic oncology continues to evolve.

The main concerns with the advent of minimal access surgery in surgical staging were adequacy of lymphadenectomy, intraoperative and postoperative complications, long-term survival, quality of life, feasibility in elderly and obese, learning curve and cost involved.

Adequacy of Surgical Staging and Operative Complications

A large randomized control trial comparing laparotomy and laparoscopy in surgical staging of carcinoma endometrium was done by gynecologic oncology study group (LAP 2 study). A total of 1,682 laparoscopy patients and 909 laparotomy patients were included in the analysis of short-term surgical outcomes. Laparoscopy was completed without conversion in 1,248 patients (74.2%). Conversion from laparoscopy to laparotomy was secondary to poor visibility in 246 patients (14.6%), metastatic cancer in 69 patients (4.1%), bleeding in 49 patients (2.9%) and other causes in 70 patients (4.2%). Laparoscopy had fewer, moderate to severe postoperative adverse events than laparotomy (14 *vs* 21% respectively; $p < 0.0001$) but similar rates of intraoperative complications, despite having a significantly longer operative time (median, 204 *vs* 130 minutes, respectively; $p < 0.001$). Hospitalization of more than 2 days was significantly lower in laparoscopy *versus* laparotomy patients (52 *vs* 94% respectively; $p < 0.0001$). Pelvic and para-aortic nodes were not removed in 8% of laparoscopy patients and 4% of laparotomy patients ($p < 0.0001$). No difference in overall detection of advanced stage (stage IIIA, IIIC or IVB) was seen (17% of laparoscopy patients *vs* 17% of laparotomy patients; $p < 0.841$).[14]

Holub Z et al report a prospective multicentric study in three oncolaparoscopic centers. A total of 221 patients who had laparoscopic surgery were compared with 45 patients who had laparotomy. Difference in surgical complications was insignificant. Blood loss was comparable. Mean hospital stay was significantly less for the laparoscopy group ($p < 0.0001$). Operating time was significantly more for the laparoscopy group. Recurrence and disease-free survival was comparable.[15]

A randomized control study from Turkey—out of 52 patients, 26 underwent laparotomy and the remaining 26 underwent laparoscopic staging surgery. No significant difference existed between the demographic characteristics of the two groups. The mean number of harvested lymph nodes was 18.2 in the laparoscopic group and 21.1 in the laparotomy group ($p > 0.05$). Pelvic lymph node metastases were detected in 7.7% of the patients in the laparoscopy group and 15.4% in the laparotomy group and the difference was not significant. Operative morbidity was higher in the laparotomy group mainly because of postoperative wound infection and the patients in the laparotomy group had a longer hospital stay. They concluded that the lymph node detection rates do not differ.[16]

A retrospective cohort study compares the adverse event rates between laparoscopic *versus* open surgery. A total of 107, who underwent surgical staging for endometrial cancer were compared to 269 age and body mass index matched women. Laparotomies had higher rates of cellulitis (16 *vs* 7%; $p = 0.018$) and open wound infection (9 *vs* 2%; $p = 0.02$). Laparoscopy group had significantly higher sensory peripheral nerve deficit (5 *vs* 0%; $p = 0.008$) and lymphedema (7 *vs* 1%; $p = 0.003$).[17]

After analyzing four randomized control trials, Suzanna Granado et al from Spain have concluded that the short-term results of laparoscopic surgery are better than laparotomy and long-term results are comparable.[18]

Robotic surgical staging of carcinoma endometrium was started from 2003 onward. Several studies are published to date assessing the surgical adequacy and complications of robotic-assisted staging as well as it is compared with laparoscopic staging and conventional laparotomy. Lowe et al have published a multi-institutional data of all patients who underwent robotic staging for endometrial carcinoma. A total of 405 patients who underwent surgery in the period from April 2003 to January 2009 were included. Mean BMI was 32.4. A total of 55% had prior abdominal surgery. Mean operating time was 170.5 minutes. Mean estimated blood loss was 87.5 ml. Mean lymph node count was 15.5. Mean hospital stay was 1.8 days. Conversion to laparotomy was done in 6.7% of patients. Postoperative complications were reported in 14.6%.[19]

A prospective analysis of 80 patients who underwent robotic staging is reported from European Institute of Oncology, Milan, Italy. They concluded that for endometrial cancer, open surgical procedures decreased from 78 to 35% and their preliminary data confirm that surgical robotic staging for early-stage endometrial cancer is feasible and safe. Age, obesity and previous surgery do not seem to be contraindications.[20]

Dan SA et al have reported a prospective case-control study comparing robotic surgery with laparotomy. A total of 118 patients underwent robotic staging and were compared with 131 patients who had laparotomy and staging. Lymph node yield was comparable ($p = 0.11$). Blood loss was significantly more in the laparotomy group (66.6 and 197.6 ml, $p < 0.001$). Length of hospital stay was significantly longer in the

laparotomy group. Operating time was significantly more for the robotic group. (283 minutes *vs* 139 minites, $p < 0.001$).[21]

Akhila Subrahmanian et al have also compared robotic surgery and laparotomy in a retrospective cohort study and has concluded that robotic management of obese women with endometrial cancer yields acceptable staging results and improved surgical outcomes. Although operating time is longer, hospital time is shorter. Robotic surgery may be an ideal approach for these patients.[22]

From University of Pennsylvania, Joel cardinas et al have conducted a retrospective chart review of cases of women undergoing minimally invasive total hysterectomy and pelvic and para-aortic lymphadenectomy by a robotic-assisted approach or traditional laparoscopic approach. A total of 275 cases were identified—102 patients with robotic-assisted staging and 173 patients with traditional laparoscopic staging. There was no significant difference in the rate of major complications between groups ($p = 0.13$). The mean operative time was longer in cases of robotic-assisted staging (237 minutes *vs* 178 minutes, $p < 0.0001$); however, blood loss was significantly lower (109 *vs* 187 ml, $p < 0.0001$). The mean number of lymph nodes retrieved were similar between groups ($p = 0.32$). There were no significant differences in the time to discharge, re-admission or reoperation rates between the two groups.[23]

Seamon et al have done a prospective cohort study of surgically staged carcinoma endometrium. A total of 105 patients underwent robotic staging from 2006 to 2008. Patients (n = 76), who underwent laparoscopic staging by the same surgeon from 1998 to 2005, were taken as the other cohort. Mean BMI was 34 in the robotic group, whereas mean BMI was 29 in the laparoscopy group. The estimated blood loss, transfusion rate, laparotomy conversion rate and length of stay were lower in the robotic cohort. The odds ratio for conversion to laparotomy based on BMI for robotics to laparoscopy is 0.2% (95% CI 0.08-0.56, $p = 0.002$). Mean skin to skin time was 242 minutes in robotic cohort, whereas it is 287 minutes in laparoscopic cohort, ($p < 0.001$). They concluded that robotic hysterectomy and lymphadenectomy can be achieved in heavier patients successfully.[24]

John FA Boggess et al have done a comparative study of three surgical methods for hysterectomy with staging for endometrial cancer: Robotic assistance, laparoscopy, laparotomy.

A total of 322 women underwent endometrial cancer staging: 138 by laparotomy (TAH); 81 by laparoscopy (TLH) and 103 by robotic technique (TRH).

The TRH cohort had a higher body mass index than the TLH cohort ($p = 0.0008$). Lymph node yield was highest for TRH ($p < 0.0001$); hospital stay ($p < 0.0001$) and estimated blood loss ($p < 0.0001$) were lowest for this cohort. Operative time was longest for TLH (213.4 minutes) followed by TRH (191.2 minutes) and TAH (146.5 minutes; $p < 0.0001$. Postoperative complication rates were lower for TRH, compared with TAH (5.9 *vs* 29.7%; $p < 0.0001$). Conversion rates for the robotic and laparoscopic groups were similar.

They concluded that TRH with staging is feasible and preferable over TAH and may be preferable over TLH in women with endometrial cancer. Further study is necessary to determine long-term oncologic outcomes.[25]

Long-term Oncologic Outcome

One of the most important concerns when any new modality of treatment is introduced in oncology is its long-term outcome. There are now several reassuring reports on the long-term outcome of minimal access surgery in the staging of carcinoma endometrium especially laparoscopic approach as it is now more than a decade older than robotics.

Nezhat et al have done a retrospective cohort study to assess the effect of laparoscopic surgery on the survival of women in early stage endometrial carcinoma from Jan 1993 to June 2003. A total of 67 women were treated by laparoscopy and 127 by laparotomy. Two and 5-year recurrence-free survival were 93 and 91.7% respectively. Overall 5-year survival rate was 100 and 97% respectively. They concluded that laparoscopic surgery resulted in similar survival rates as laparotomy.[26]

Another long-term data on this issue is published in 2009. Randomized control trial comparing laparoscopy (n = 40) and laparotomy (n = 38) with a follow-up period of 78 months. The cumulative recurrence rates were 8/40 and 7/38 respectively ($p = 0.860$). Death reported were 7/40 and 6/38 ($p = 0.839$), overall survival and disease-free survival were comparable ($p = 0.535$ and $p = 0.515$ respectively).[27]

Ghezzi et al report another comparative study supporting the same observations. A total of 117 patients of laparoscopy cohort were compared with 122 patients of laparotomy cohort with a median follow-up period of 52 months and 80 months respectively. Three-year recurrence-free survival and overall survival were comparable. Multivariate analysis showed that advanced surgical stage, unfavorable histology and patient age > 65 years significantly affect survival, regardless of the surgical approach used.[28]

Due to the recent incorporation of robotics in staging long-term survival data are not available. Prospective randomized trials are awaited.

Quality of Life

The first 802 eligible patients (laparoscopy, n = 535, laparotomy, n = 267) participated in the QoL study in a gynecologic oncology group (GOG) randomized trial of laparoscopy *versus* laparotomy (GOG 2222). Patients completed QoL assessments at baseline; at 1, 3 and 6 weeks; and at 6 months postsurgery. Laparoscopy patients reported significantly higher functional assessment of cancer therapy-general (FACT-G) scores ($p < 0.001$), better physical functioning ($p < 0.006$), better body image (BI; $p < 0.001$), less pain ($p < 0.001$) and its interference with QoL ($p < 0.001$), and an earlier resumption of normal activities

($p < 0.003$) and return to work ($p < 0.04$) over the 6-week postsurgery period, as compared with laparotomy patients. However, the differences in BI and return to work between groups were modest, and the adjusted FACT-G scores did not meet the minimally important difference (MID) between the two surgical arms over 6 weeks. By 6 months, except for better BI in laparoscopy patients ($p < 0.001$), the difference in QoL between the two surgical techniques was not statistically significant.[29]

A two-stage randomized controlled trial, comparing total laparoscopic hysterectomy (TLH) with total abdominal hysterectomy (TAH) for stage I endometrial cancer (LACE), began in 2005. The primary objective of stage 1 was to assess whether TLH results in equivalent or improved quality of life (QoL) up to 6 months after surgery compared with TAH. A total of 361 patients were enrolled from 19 centers. QoL improvements from baseline during early and later phases of recovery and the adverse event profile, favor TLH compared with TAH for treatment of stage I endometrial cancer.[30]

Feasibility in Elderly and Obese

Melissa KF et al have done a retrospective analysis on 60 patients aged above 65 years and 69 patients less than 65 years who underwent surgical staging of carcinoma endometrium by laparoscopic and robotic hysterectomy. They concluded that minimal access surgery is feasible and safe in elderly women.[31]

Sribner et al have reported that age is not a contraindication for laparoscopic surgery. Transvaginal hysterectomy remains a proven option for women with serious comorbidities.[32]

A review article published from North Carolina School of Medicine, Obesity–Physiologic Changes and Challenges in Laparoscopy concludes that with thorough preparation and careful preoperative evaluation, laparoscopy can be performed safely and is the preferred surgical method in obese patients.[33]

Gamal H et al compared laparoscopy and laparotomy in a cohort of obese women with carcinoma endometrium. Prospective study over 2 years applying laparoscopic surgery to all women with clinical stage I endometrial cancer and body mass indices (BMIs) between 28.0 and 60.0 who can tolerate such surgery. Controls were women with clinical stage I endometrial cancer and similar BMIs who underwent laparotomy in the previous 2 years. Both groups were compared in their characteristics, surgical outcome, cost and hospital stay and interviewed regarding time to recovery, recall of postoperative pain control, and overall satisfaction with their management. Forty out of 42 obese women had laparoscopic surgery. The procedure was converted to laparotomy in 3 (7.5%) patients. Laparoscopic surgery was thus successful in 88.1% of all obese women. There was no significant difference between women who underwent laparoscopy and those who underwent laparotomy in patient characteristics, proportion of women who underwent lymphadenectomy, complications, total cost, patients' recall of postoperative pain and patients' satisfaction with management. Women who underwent laparoscopy had a significantly longer operative time, more pelvic lymph nodes removed, a smaller drop in postoperative hematocrit, less pain medication, and a shorter hospital stay (194.8 *vs* 137.7 minutes, $p < 0.001$; 11.3 *vs* 5.3, $p < 0.001$; 3.9 *vs* 5.4, $p = 0.029$; 32.3 *vs* 124.1 mg, $p < 0.001$; and 2.5 *vs* 5.6 days, $p < 0.001$ respectively). There was a trend toward earlier resumption of full activity and return to work among women who underwent laparoscopy (23.2 *vs* 45.0 days, $p = 0.073$, and 35.3 *vs* 67.0 days, $p = 0.055$ respectively).

They concluded that most obese women with early stage endometrial cancer can be safely managed through laparoscopy with excellent surgical outcome, shorter hospitalization and less postoperative pain than those managed through laparotomy.[34]

Seamon et al have done a case-control study comparing robotic surgery and laparotomy in obese women. A total of 109 patients underwent surgery with the intent of robotic staging and were matched to 191 laparotomy patients. The mean BMI was 40 for each group. The robotic conversion rate was 15.6% [95% confidence interval (CI) 9.5-24.2%]. Ninety-two completed robotic patients were compared with 162 matched laparotomy patients. The two groups were comparable regarding total lymph node count (25 ± 13 compared with 24 ± 12, $p = 0.45$) and the percentage of patients undergoing adequate lymphadenectomy (85% compared with 91%, $p = 0.16$) and adequate pelvic (90% compared with 95%, $p = 0.16$) and aortic lymphadenectomy (76% compared with 79%, $p = 0.70$) for robotic and laparotomy patients respectively, but there was limited power to detect this difference. The blood transfusion rate [2% compared with 9%, odds ratio (OR) 0.22, 95% CI 0.05-0.97, $p = 0.046$], the number of nights in the hospital (1 compared with 3, $p < 0.001$), complications (11% compared with 27%, OR 0.29, 95% CI 0.13-0.65, $p = 0.003$), and wound problems (2% compared with 17%, OR 0.10, 95% CI 0.02-0.43, $p = 0.002$) were reduced for robotic surgery. In obese women with endometrial cancer, robotic comprehensive surgical staging is feasible. Importantly, obesity may not compromise the ability to adequately stage patients robotically.[35]

Laparoscopic and robotic-assisted staging seem to be promising in the management of obese and elderly women with carcinoma endometrium.

Learning Curve

A retrospective review of cases by Terry et al suggests that in the laparoscopic staging of carcinoma endometrium, the operating time and hospital stay decrease after 50 cases and continue to drop till 125 cases. While the ability to detect metastatic disease and rate of major complications appear unrelated to operator experience, the conversion rate to laparotomy decreased with operator experience.[36]

There are two articles that report the learning curve for robotic hysterectomy with pelvic and para-aortic node dissection for endometrial cancer staging. Seamon et al have reported number of cases to gain proficiency (approximately 20 cases).[37]

Lowe et al report that the learning curve for robotic hysterectomy with pelvic and aortic node dissection lies between 9 and 20 cases.[19]

Cost Analysis

With regard to costs, there has been one article to date comparing robotic, open and laparoscopic procedures to surgically stage endometrial cancer. In that report, the cost of the robotic system was included in the cost analysis for robotic surgery. Interestingly, there was no statistically significant difference in costs between robotic and laparoscopic approach ($p < 0.06$). Both minimally invasive approaches cost significantly less than an open approach ($p < 0.001$). However, robotics was associated with less perioperative morbidity and quicker return to normal activity.[38]

Uterine Manipulation

Regarding uterine manipulation in laparoscopic hysterectomy, there are conflicting reports.

Querleu et al reported three patients with stage I, noninvasive or superficially invasive endometrial cancer with vaginal cuff recurrence within 9 months of treatment. They raised the concern that the obligatory use of a vaginal manipulator at the time of surgery may lead to antegrade and retrograde dispersal of tumor cells with subsequent vaginal cuff and peritoneal metastasis. No evidence exists to link vaginal recurrence with the use of uterine manipulators or with the omission of tubal occlusion.[39]

Sonoda et al showed that the treatment of low-risk endometrial cancer by laparoscopy is associated with a significantly higher incidence of positive peritoneal cytology when compared with patients operated by laparotomy. The use of an intrauterine manipulator is not necessarily required to perform an adequate laparoscopic-assisted procedure and could prevent the retrograde dissemination of cancer cells into the peritoneal cavity during uterine manipulation.[40]

Gamal H Eltabakh et al in a prospective study of laparoscopic surgical staging of clinical stage 1 endometroid endometrial carcinoma using Pelosi uterine manipulator have reported that it does not increase the incidence of positive peritoneal cytology.[41]

Portsite Metastasis

The incidence of portsite metastasis treated by total laparoscopic hysterectomy is low. Andreas Obermair et al have reported that on a median follow-up of 29.4 months, no port-site metastasis was seen in 215 patients treated with laparoscopy. The disease-free survival was statistically comparable to 284 laparotomy treated controls.[42]

Microlaparoscopy in Surgical Staging of Carcinoma Endometrium

Consecutive patients undergoing surgical staging of endometrial cancer using exclusively 3 mm working ports and a 3 or 5 mm laparoscope at the umbilicus (microlaparoscopy group; N = 23) were compared with historical controls selected from consecutive women who have had staging with conventional laparoscopy (N = 80).

No difference was found in demographics and preoperative variables between the two groups. Conversion from microlaparoscopy to a conventional laparoscopic technique occurred in two cases (9.7%), while there was no conversion to open surgical staging in either group. There were no significant differences between the microlaparoscopy group and the control group with regard to estimated blood loss [100 (10-400) *vs* 100 (10-400), $p = 0.09$], number of pelvic lymph nodes (19.2 ± 7.4 *vs* 18.6 ± 7.2, $p = 0.79$) and complication rate (intraoperative: 0 *vs* 2.5%, $p = 1.0$; postoperative: 8.7 *vs* 13.7%, $p = 0.73$). Operative time was similar between groups when analysis was restricted to the last 20 conventional procedures performed period prior to beginning of the microlaparoscopy trial [155 (110-300) *vs* 160 (115-295), $p = 0.17$]. The median length of hospital stay was 2 (1-10) days for women undergoing microlaparoscopic procedures compared to 3 (1-15) days for those undergoing conventional laparoscopy ($p = 0.001$).

These preliminary results suggest that microlaparoscopy is a safe and adequate surgical option for endometrial cancer staging with the potential to further decrease invasiveness of the conventional laparoscopic approach.[43]

DISCUSSION

The role of minimally invasive surgical staging in the management of patients with apparent early endometrial cancer continues to evolve. From the above-mentioned review of literature, it is evident that comprehensive surgical staging of endometrial cancer can be performed using laparoscopy without increased intraoperative injuries, with fewer postoperative complications, and with shorter hospital stay. This makes attempting laparoscopy, when assumed to be feasible, worth the extraoperative time and surgeon training. The long-term results comparing recurrence-free survival, overall survival and quality of life are also promising. With the advent of robotic surgery, the limitations of the laparoscopic approach is presumed to be overcome.

The conversion rate to laparotomy is less frequent for those patients undergoing the robotic approach when compared to laparoscopy, despite a significantly higher BMI. In addition, the operating room times, length of hospital stay, blood loss and transfusion rates were significantly reduced in the robotic cohort. Therefore, it appears that the robotics platform may offer significant advantages over laparoscopy in the comprehensive surgical management of endometrial cancer. The three-dimensional, magnified images combined with wristed instrumentation, tremor filtration and motion scaling allow the surgeon to recapitulate open surgery. The counterintuitive motions encountered in conventional laparoscopy are eliminated and these advantages are readily apparent even to the advanced laparoscopic gynecologic oncologist. The robotics platform is associated with a shorter learning curve.

While a skilled robotic bedside assistant is essential, the robotic surgeon has the additional advantages of a stable camera and direct control of endoscope movement. Robotics also reduces the poor ergonomics associated with laparoscopy, which leads to surgeon discomfort and risk of chronic musculoskeletal occupational injury, particularly during longer procedures. Although robotics offers many potential advantages for endometrial staging procedures, there are many unknown entities surrounding this new technology. Robotic surgery for gynecology was approved only in April 2005, thus, limited published data exists of long-term survival advantage.

CONCLUSION

In conclusion, the data reported in this review article establishes the role of minimal access surgical staging by laparoscopy and robotics for the treatment of endometrial cancer. This is even more applicable for the obese, elderly women with comorbidities who form a major subset of women with carcinoma endometrium. Robotics has the potential to dramatically expand the minimal access surgical option for women undergoing surgery for endometrial cancer. Although robotics represents a technologic leap over traditional laparoscopy, long-term follow-up data are yet to be published.

REFERENCES

1. Global cancer statistics 2002. CA Cancer J Clin 2005;55(2): 74-108.
2. Barakat RR, Lev G, Hummer AJ, et al. Twelve-year experience in the management of endometrial cancer: A change in surgical and postoperative radiation approaches. Gynecol Oncol 2007; 105:150-56.
3. Masciullo V, Amadio G, Russo LOD, Raimondo I, Giordano A, Scambia G. Controversies in the management of endometrial cancer. Obstet Gynecol int 2010;638165.
4. ASTEC/EN. 5 Study Group. Adjuvant external beam radiotherapy in the treatment of endometrial cancer (MRC ASTEC and NCIC CTG EN. 5 randomised trials): Pooled trial results, systematic review, and meta-analysis. Lancet 2009; 373(9658):137-46.
5. Creasman WT, Odicino F, Maisonneuve P, et al. Carcinoma of the corpus uteri. Int J Gynaecol Obstet (suppl 1) 2003;83: 79-118.
6. American Joint Committee on Cancer: Cancer staging manual (6th ed). New York, NY, Springer-Verlag 2002.
7. The International Journal of Medical Robotics and Computer-assisted Surgery Dec 2010;6(4):382-85.
8. Seamon LG, Cohn DE, Richardson DL, et al. Robotic hysterectomy pelvic-aortic lymphadenectomy for endometrial cancer. Obstet Gynecol 2008;112:1207-13.
9. Cragun JM, Havrilesky LJ, Calingaert B, et al. Retrospective analysis of selective lymphadenectomy in apparent early-stage endometrial cancer. J Clin Oncol 2005;23:3668-75.
10. Dargent D. Laparoscopic surgery and gynecologic cancer. Curr Opin Obstet Gynecol 1993;5:294-300.
11. Querleu D, Leblanc E, Castelain B. Laparoscopic pelvic lymphadenectomy in the staging of early carcinoma of the cervix. Am J Obstet Gynecol 1991;164:579-81.
12. Childers JM, Spirtos NM, Brainard P, et al. Laparoscopic staging of the patient with incompletely staged early adeno-carcinoma of the endometrium. Obstet Gynecol 1994;83: 597-600.
13. Spirtos NM, Schlaerth JB, Spirtos TW, et al. Laparoscopic bilateral pelvic and paraaortic lymph node sampling: An evolving technique. Am J Obstet Gynecol 1995;173:105-11.
14. Joan L walker, et al. J Clin Oncol 2009;27:5331-36. © by American Society of Clinical Oncology.
15. Holub Z, et al. Laparoscopic staging for endometrial cancer. Long term results of a multicentric study. Eur J Gynecol Oncol 2002; 23(4):305-10.
16. C Gurkan Zorlu, et al. Laparoscopy or laparotomy for the management of endometrial cancer. JSLS Oct-Dec 2005;9(4): 442-46.
17. Jassen C Barnett, et al. Adverse event rates between laparoscopic versus open surgery. Am J Obstet Gynecol 2011;204:20.
18. Susanna Granado de La Orden, et al. Laparoscopic hysterectomy in the treatment of endometrial cancer: A systematic review. Journal of Minimally Invasive Gynecology July-Aug 2008;15(4): 395-401.
19. Lowe, et al. A multiinstitutional experience with robotic assisted hysterectomy with staging for endometrial cancer. Am J Obstet Gynecol Aug 2009;114(2):236-43.
20. Pieretti Michelle A, et al. Robotic surgery: Changing the surgical approach for endometrial cancer in a referral cancer center. Journal of Minimally Invasive Gynecology July 2009;16(4): 427-31.
21. Dan SA, et al. Robotic surgery in gynecologic oncology: Program initiation and outcomes after the first year with comparison with laparotomy for endometrial cancer staging. Am J Obstet Gynecol June 2008;198(6):679e1-679e10.
22. Subrahmaniam Akila, et al. A cohort study evaluating robotic versus laparotomy surgical outcomes of obese women with endometrial carcinoma. Journal of Gynecol Oncol.
23. Cardinas Joel, et al. Surgical outcomes of robotic-assisted surgical staging for endometrial cancer are equivalent to traditional laparoscopic staging at a minimally invasive surgical center. Gynecologic Oncology May 2010;117(2):224-28.
24. Seamon Leigh G, et al. Minimally invasive comprehensive surgical staging for endometrial cancer: Robotics or laparoscopy? Gynecologic Oncology April 2009;113(1):36-41.
25. Bogess John F, et al. A comparative study of 3 surgical methods for hysterectomy with staging for endometrial cancer: Robotic assistance, laparoscopy, laparotomy. Am J Obstet Gynecol Oct 2008;199(4):360e1-360e9.
26. Nezhat, et al. Analysis of survival after laparoscopic management of endometrial carcinoma. Journal of Minimally Invasive Gynecology March 2008;15(2):181-87.
27. Zullo Fulvio O, et al. Laparoscopic surgery versus laparotomy for early stage endometrial cancer. Long term data of a randomized control trial. Am J Obstet Gynecol March 2009; 200(3):296e1-296e9.
28. Ghezzi F, et al. Laparoscopic versus open surgery for endometrial cancer: A minimum 3-year follow-up study. Annals of Surgical Oncology 2010;17(1):271-78.
29. Kornblith Alice B, et al. Quality of life of patients with endometrial cancer undergoing laparoscopic international federation of gynecology and obstetrics staging compared with laparotomy: A gynecologic oncology group study. J Clin Oncol 2009;27:5337-42 ©.
30. Janda Monica, et al. Quality of life after total laparoscopic hysterectomy versus total abdominal hysterectomy for stage I endometrial cancer (LACE): A randomised trial. The Lancet Aug 2010;11(8):772-80.

31. Melissa KF, et al. Journal of Minimally Invasive Gynecology April 2011;18(2):200-204.
32. Sribner DR, et al. Surgical management of early stage endometrial cancer in elderly. Is laparoscopy feasible? Gynecologic Oncology Dec 2001;83(3):563-68.
33. Georgine Lamvu, et al. Obesity–physiologic changes and challenges in laparoscopy. American Journal of Obstetrics and Gynecology 2004;191:669e74.
34. Gamal, et al. Hysterectomy for obese women with endometrial cancer: Laparoscopy or Laparotomy? Gynecologic Oncology Sep 2000;78(3):329-35.
35. Seamon, et al. Comprehensive surgical staging for endometrial cancer in obese patients: Comparing robotics and laparotomy. Obstetrics and Gynecology July 2009;114(1):16-21.
36. Melaneez Terry D, et al. Laparoscopic staging of endometrial carcinoma, the learning experience. JSLS Jan-Mar 1997;1(1): 45-49.
37 Seamon, et al. Robotic hysterectomy and pelvic-aortic lymphadenectomy for endometrial cancer. Obstet Gynecol 2008;112: 1207-13.
38. Bell MC, et al. Comparison of outcomes and cost for endometrial cancer staging via traditional laparotomy, standard laparoscopy and robotic technique. Gynecol Oncol 2008;111: 407-11.
39. Querleu D, Occelli B, Leblanc E, Narducci F. Three cases of vaginal cuff recurrence of endometrial cancer after laparoscopic assisted vaginal hysterectomy. Gynecol Oncol 2003;90(2):495-96; author reply 496-97.
40. Sonoda Y, Zerbe M, Smith A, Lin O, Barakat RR, Hoskins WJ. High incidence of positive peritoneal cytology in low-risk endometrial cancer treated by laparoscopically-assisted vaginal hysterectomy. Gynecol Oncol 2001;80(3):378-82.
41. Eltabakh Gamal H, et al. Laparoscopic surgery does not increase the positive peritoneal cytology among women with endometrial carcinoma. Gynecol Oncol Feb 2006;100(2): 361-64.
42. Obermair Andreas, et al. Gynecol Oncol Feb 2006;100(2):361-64.
43. Ghezzi Fabio, et al. Microlaparoscopy: A further development of minimally invasive surgery for endometrial cancer staging—Initial experience. Gynecol Oncol May 2009:113(2):170-75.

10.5005/jp-journals-10007-1135
REVIEW ARTICLE

Role of Minimal Access Surgery in Gestational Trophoblastic Disease

Sini S Venugopal
Consultant, Obstetrics and Gynecologist, Alappuzha, Kerala, India

ABSTRACT

Gestational trophoblastic diseases (GTD) comprise a spectrum of tumor and tumor-like conditions that originate from the fetal chorion. Trophoblastic tumors are fetal allograft in maternal tissues and present unique biological, immunological and pathological problems. Suction and evacuation followed by serial estimation of serum hCG and chemotherapy are the mainstay of treatment. Hysterectomy is the treatment of choice for patients with placental site trophoblastic tumors and also for persistent chemotherapy resistant uterine disease. This treatment may be unacceptable to the woman who wishes to retain her fertility. With quality of life issues becoming more important in medicine, therapies which preserve fertility, without compromising adequate treatment of the disease, should receive serious consideration. Laparoscopic hysterectomy and robotic hysterectomy are good options for women who are considered for surgery. Hysteroscopy also has a role in localizing and obtaining uterine (endometrial/myometrial) tissues for histopathological studies. It also helps in differentiating the diagnosis of gestational trophoblastic neoplasia from other conditions of raised serum hCG like ectopic pregnancy (cornual), incomplete abortion and nongestational trophoblastic tumors.

Aim of study: The aim of this study is to evaluate the role of minimal access surgical procedures like laparoscopy, hysteroscopy and robotic surgery in the management of gestational trophoblastic tumors.

Methodology: (1) Materials: The study was carried out through a literature search using the information technology installations of the World Laparoscopy Hospital, Gurgaon, NCR, Delhi. (2) Time: The study was carried out during a period of 2 weeks between July 12th, 2011 and July 26th, 2011.

Data collection: All the publications used in the current study was accessed from the electronic (virtual) library using the following search engines: Google, SpringerLink, PubMed, Highwire press, Medline.

Abbreviations: (1) GTD: Gestational trophoblastic disease, (2) GTT: Gestational trophoblastic tumor, (3) GTN: Gestational trophoblastic neoplasia, (4) PSTT: Placental site trophoblastic tumor.

Keywords: Gestational trophoblastic tumors, Laparoscopy, Hysteroscopy, Laparoscopic hysterectomy, Robotic hysterectomy.

INTRODUCTION

Gestational trophoblastic diseases comprise of a spectrum of disorders characterized by abnormal and excessive proliferation of the chorionic villi. The spectrum of cellular proliferation includes as follows:

- Hydatidiform mole (complete or partial)
- Invasive mole
- Choriocarcinoma
- Placental site trophoblastic tumor.

If there is any evidence of persistence of gestational trophoblastic disease (GTD), usually defined as persistent elevation of serum beta hCG (human chorionic gonadotrophin), the condition is referred to as gestational trophoblastic neoplasia (GTN). GTN includes invasive mole, choriocarcinoma and placental site trophoblastic tumor (PSTT). GTN are very curable. They arise from the products of conception in the uterus. The most common preceeding pregnancy is a hydatidiform mole. Choriocarcinoma most often follows a molar pregnancy, but can follow a normal pregnancy, ectopic pregnancy, or abortion and should always be considered when a patient has continued vaginal bleeding after the end of a pregnancy. The risk of malignancy after a complete mole is 10 to 15% and after a partial mole is 0.5%.

INVESTIGATIONS

A urine pregnancy test should be performed in all cases of persistent or irregular vaginal bleeding after a pregnancy event. Definitive diagnosis is made by histological examination of the products of conception.

The important investigative modalities are as follows:

- Ultrasound
- Serum beta-hCG levels
- CT scanning for liver or other intra-abdominal metastases
- MRI or CT scanning for brain metastases
- Histology.

DIAGNOSIS OF POSTMOLAR GTN

The diagnosis of GTN is made on the basis of elevated hCG levels, supported, but not necessarily by histologic or radiologic evidence. The criteria for the diagnosis of postmolar GTN are as follows:

- When there is plateau of hCG for > 4 weeks
- When there is rise in hCG on three consecutive measurements
- If hCG > 20,000 IU/l weeks after evacuation
- If hCG remains positive even after 16 weeks of evacuation
- When there is histological evidence of choriocarcinoma.

MANAGEMENT

- *Suction curettage:* Suction and evacuation followed by gentle curettage is the first line of management for hydatidiform mole. Patient follow-up is very important and essential in these cases. Serum beta-hCG is estimated one day prior to and one day after suction and evacuation to detect the initial level. Then serum hCG serial estimation is done every two weeks till the levels are undetectable. Then serum hCG is done once a month for 6 months if the levels are negative and without any clinical symptoms.
- Chemotherapy for evidence of malignant disease.
- Hysterectomy is the treatment of choice for patients with:
  - Placental site trophoblastic tumor (they are relatively resistant to chemotherapy)
  - Persistent chemotherapy resistant tumor
  - Women who has completed her childbearing
  - Uncontrolled vaginal or intra-abdominal bleeding due to the tumor
- Radiotherapy (for some cases of distant metastases like brain metastases).

REVIEW OF LITERATURE

Kanazawa et al[1] evaluated 22 patients with local myometrial resection of invasive moles. All patients had lesions localized in the myometrium, defined by pelvic angiography, ultrasound and CT scans. Any patient considered for this procedure should be carefully evaluated for systemic metastases and the uterine lesions should be localized by imaging and hysteroscopy. A normal laparoscopy can reasonably rule out an ectopic pregnancy (tubal, ovarian or abdominal). Nongestational trophoblastic neoplasia associated with raised serum hCG includes ovarian or extragonadal germ cell tumors containing trophoblastic components and many nongynecological tumors, like lung, bladder, liver, pancreas and stomach. These tumors are associated with low serum hCG, although concentrations up to 750,000 IU/l have been reported. A normal laparoscopic finding can reasonably exclude these diagnoses as well.[2]

Lang J et al[3] reported a case of performing laparoscopic hysterectomy in a woman with persistent GTN.

A retrospective descriptive analysis of data was done using charts of diagnosed cases of GTN from 1996 to 2006 by Cagayan MS et al[5] The patients were classified according to FIGO staging and WHO prognostic scoring. A total of 129 patients out of 420 cases of GTN underwent adjuvant hysterectomy. The overall survival was 98.4% with 2 of the 11 patients who had hysterectomy for chemotherapy-resistant disease dying. So, they concluded that with the increasing use of early surgical intervention combined with chemotherapy, the benefits of the patients were being maximized.

Lurain et al[6,12] from the Brewer Trophoblastic Disease Centre reported that 24 (48%) of 50 patients with high-risk GTN treated with EMA-CO as primary or secondary chemotherapy underwent surgical procedures and 21(87.5%) were cured. Much et al[13] reported curing 10 (71%) of 14 patients who underwent hysterectomy as part of treatment for recurrent GTN at the South-Eastern Regional Trophoblastic Disease Centre, The Sheffield, UK. Trophoblastic Disease Centre reported that 9(75%) of 12 patients who underwent hysterectomy because of chemotherapy resistant uterine disease had a complete clinical response to surgery. Deumplis et al[14] evaluated the role of hysterectomy in the management of 25 patients with GTN at the Charing Cross Trophoblastic Disease Centre over a 13-year period. Histology was choriocarcinoma in 9, PSTT in 6 and hydatidiform mole in 10. The two main reasons for surgery were chemoresistance during initial treatment and relapse after treatment. Postoperative chemotherapy was given to 21 of the 25 patients although the hysterectomy appeared to be therapeutic as demonstrated by a rapid return of the hCG levels to normal in 22 of the 25 patients. Survival rate was 88% (22/25). Of the three who died, all had high-risk metastatic disease, one of whom had a PSTT. Intensive multimodality therapy of patients with high-risk GTN using EMA-CO chemotherapy (or some variations of it) along with adjuvant radiotherapy for brain metastasis results in primary remission rates of 65 to 80%. Approximately, 20 to 35% of high-risk patients will therefore fail first-line therapy or relapse from remission. Most of these patients will have a clinicopathologic diagnosis of choriocarcinoma, a large tumor burden reflected by a high serum hCG level and multiple metastases to sites other than lungs and pelvis, resulting in very high FIGO scores. Salvage chemotherapy with platinum/etoposide-containing drug regimens often combined with surgical resection of sites of persistent tumor (usually in the uterus and lungs) will result in high cure rates in these patients (approaching 90%).

Feng et al[15] reported a study of 27 patients with suspected diagnosis of GTN at Peking Union Medical College Hospital from Sep 2003 to Mar 2006. Clinical data of these patients were reviewed. Most patients had abnormal vaginal bleeding and persistently elevated serum hCG levels. Ultrasound revealed lesions with affluent blood flow in the intrauterine aspect, unilateral horn of the uterus or myometrium. No negative findings were revealed by CT scan or X-ray chest in all these patients. A total of 11 patients underwent evacuation under hysteroscope, 10 patients were diagnosed and treated by laparoscopy and six by hysteroscopy and laparoscopy. Choriocarcinoma was diagnosed in four patients, who achieved complete remission by chemotherapy later. The diagnosis of GTN was ruled out in the other 23 patients including cornual pregnancy in 12, pregnancy in the rudimentary horn in one and incomplete abortion in 10, who were cured by hysteroscopic and laparoscopic surgery and postoperative adjuvant single dose methotrexate. The major causes of pregnancy-related abnormal bleeding and elevated serum hCG levels include incomplete abortion, ectopic pregnancy and GTN. This study shows that hysteroscopy and laparoscopy are effective

alternative for diagnosis in the differentiation of GTN from nonGTN and can also offer therapeutic benefits.

L Savelli et al[7] reported a case of a 34-year-old woman admitted for persistent vaginal bleeding and slightly raised serum hCG on five different occasions, 6 months after second cesarean section. Transvaginal sonography showed a slightly enlarged uterus and the presence of an inhomogenous lesion, measuring 3 cm in mean diameter in the myometrium of the posterior uterine wall, displacing the endometrium. Pelvic MRI confirmed the presence of the lesion. The patient underwent a diagnostic hysteroscopy which disclosed the presence of irregularly shedding friable endometrium. Endometrial biopsy revealed only necrotic inactive endometrium and fibrin deposits. An operative hysteroscopy was done and with a monopolar hook the lesion was resected out. The histological diagnosis was PSTT. The patient then underwent total laparoscopic hysterectomy.

Devin et al[8] reported a case of a patient with elevated serum hCG despite therapy with methotrexate. A dilatation and curettage could not provide pathological diagnosis. A mass was found in the uterus by ultrasound and CT scan but there was no evidence of extrauterine disease. GTD was suspected. The patient underwent robotic hysterectomy for both therapy and diagnosis of suspected GTD. The final pathological diagnosis was PSTT. The robotic approach[16,17] allows for a minimally invasive surgical procedure with thorough examination of the pelvic cavity and adnexa. There is better visualization of the operative field with increased dexterity allowing more precise and controlled movements of the surgical instrument maneuvers. This minimizes the pain and risk associated with large incisions. It increases the likelihood of a fast recovery and excellent clinical outcome. It does not require an uterine manipulator which may be contraindicated in the setting of uterine GTD.

A Corusic et al[9] reported a case of a patient where after four cycles of methotrexate chemotherapy, a vascular tangle was noted that emerged from the right uterine horn, invading the broad ligament adjacent to the uterine artery. Doppler ultrasound along with magnetic resonance arteriography confirmed the diagnosis. The location, size and relation of this arteriovenous malformation to the uterine vasculature demanded urgent intervention. Laparoscopy was performed and bipolar coagulation of the ovarian and uterine artery feeding branches was achieved after surgical resection of the tumor.

Lindholm et al[10] reported a study where three cases with elevated serum hCG had negative ultrasound and color Doppler studies. In these cases, myometrial biopsies containing tumors were obtained by means of hysteroscopy. Michael R et al[11] reported a case where a patient after methotrexate injection for ectopic pregnancy reached a plateau level of serum hCG 3 weeks later and then the level started to increase. She underwent dilatation and curettage that did not reveal any trophoblastic tissue. A diagnostic hysteroscopy that followed revealed occlude ostia of the left tube. The patient then had diagnostic laparoscopy that confirmed a mass in the left cornua, which was removed with wide wedge resection and histopathological examination revealed choriocarcinoma.

DISCUSSION

Despite advances in chemotherapy regimens for treating malignant GTN, hysterectomy and other extirpative procedures continue to play a role in the management of patients with both low-risk and high-risk GTN. Primary hysterectomy can reduce the amount of chemotherapy required to treat low-risk disease,[4] whereas surgical resection including hysterectomy, pulmonary resection and other extirpative procedures can be invaluable for treating highly selected patients with persistent drug-resistant disease. Conservative myometrial resection combined with uterine reconstruction might be considered in highly selected patients with nonmetastatic GTN who wish to avoid hysterectomy. In a postpartum woman with urine pregnancy test positive but transvaginal sonography showing no intrauterine or extrauterine pregnancy, laparoscopy has an important role.[2] A normal laparoscopy can reasonably rule out an ectopic pregnancy and many nongestational trophoblastic neoplasia associated with raised serum hCG. Majority of women undergoing hysterectomy for malignant GTD are treated with abdominal hysterectomy. Laparoscopic-assisted vaginal hysterectomy and total laparoscopic hysterectomy has been used in few patients with GTN. This technique allows surveillance of the upper abdomen combined with shorter convalescence than abdominal hysterectomy. This procedure offers advantage that proper intra-abdominal inspection is possible, morcellation can be avoided (in laparoscopic-assisted vaginal hysterectomy) and the uterine arteries were transacted at their origin before uterine manipulation to avoid potential tumor embolization. In addition, an abdominal incision is not required and so the patient has shorter hospitalization, less pain, shorter convalescence and faster recovery for an earlier start of chemotherapy if required. With robotic hysterectomy, there is better visualization of the operative field with increased dexterity allowing more precise and controlled movements of the surgical instrument maneuvers. It does not require an uterine manipulator which may be contraindicated in the setting of GTD. It has faster recovery and excellent clinical outcome. Hysteroscopy can also play a role in some selective and peculiar situations of GTD both for diagnosis and therapeutic purpose.

CONCLUSION

GTN are very chemosensitive. Despite success of chemotherapy in inducing remission in most patients with GTN, surgical procedures play an important role in the management. Hysterectomy has a definitive role in PSTT, persistent chemoresistant GTN, in cases with uncontrolled vaginal bleeding, high-risk patients with disease confined to the uterus,

also in high-risk patients with uterine disease with metastases to reduce the tumor load prior to chemotherapy and in patients who do not wish to retain their fertility. Approximately, one-half of patients with high-risk GTN (FIGO stage 2-4, WHO risk score ≥ 7) will require some form of surgical procedure during the course of therapy to either remove disease or treat complications. These results in cure rates approaching 90% in the high-risk patients. Hysteroscopy and laparoscopy though not the mainstay of diagnosis and management are effective aids in certain selective and peculiar situations of GTN both diagnostically and therapeutically. For patients who are candidates for surgery, a minimal invasive procedure like laparoscopic-assisted vaginal hysterectomy, laparoscopic hysterectomy or robotic hysterectomy offers advantage when compared to the traditional abdominal hysterectomy. Minimal access surgical procedures have various benefits like better and thorough visualization of the abdominal and pelvic cavity, cost-effectiveness (including indirect costs), shorter convalescence time, faster return to work, earlier initiation of postoperative chemotherapy (if required), improved cosmetic effects and better patient satisfaction.

REFERENCES

1. Kanazawa K, Sasawaga M, Suzuki T, et al. Clinical evaluation of focal excision of myometrial lesion for treatment of invasive hydatidiform mole. Acta Obstet Gynecol Scand 1988;67: 487-92.
2. Rozenholc Alexandre, Petignat Patrick. Normal pregnancy or neoplasia. BMJ 2008;337:a2107.
3. Lang J, Childers J, Survit E. Laparoscopic hysterectomy for persistent gestational trophoblastic noeplasia. The Journal of the American Association of Gynecologic Laparoscopists 1995;2(4):475-77.
4. Sergent F, Verspyck E, Lemoine JP, Marpeau L. Place of surgery in the management of gestational trophoblastic tumours. Gynecologic Obstetrique Fertilite 2006;34(3):233-38.
5. Cagayan MS, Magallanes MS. The role of adjuvant surgery in the management of gestational trophoblastic neoplasia. The Journal of Reproductive Medicine 2008;53(7):513-18.
6. Lurain John R, Singh Diljeet K, Schink Julian C. Role of surgery in the management of high risk getational trophoblastic neoplasia. The Journal of Reproductive Medicine 2006;51(10): 773-76.
7. Savelli L, Pollastri P, Mabrouk M, Serracchioli R, Venturoli S. Placental site trophoblastic tumour diagnosed on transvaginal sonography. Ultrasound Obstet Gynecol 2009;34:234-36.
8. Namaky Devin, Basil Jack, Pavelka James. Placental site trophoblastic tumour presenting as an intramural mass with negative markers: An opportunity for novel diagnosis and treatment with robotic hysterectomy. J Robotic Surg 2010;4(1): 57-59.
9. Ante Corusic, Dubrevko Barisic, Helena Lovrik, Albert. Successful laparoscopic bipolar coagulation of a large arteriovenous malformation due to invasive trophoblastic disease: A case report. The Journal of Minimally Invasive Gynecology May 2009;16(3):368-71.
10. Lindholm H, Radestad A, Flam F. Hysteroscopy provides proof of trophoblastic tumours in three cases with negative color Doppler images. Ultrasound Obstet Gynecol Jan 1997;9(1): 59-61.
11. Michael Rotas, Neekinaund Khulpateea, David Binder. Gestational choriocarcinoma arising from a cornual ectopic pregnancy: A case report. Archives of Gynecology and Obstetrics 276(6):645-47.
12. Lurain JR. Advances in management of high-risk gestational trophoblastic tumors. J Reprod Med 2002;47:451-59.
13. Mutch DG, Soper JT, Babcock CJ, et al. Recurrent gestational trophoblastic disease. Experience of the South-Eastern Regional Trophoblastic Disease Center. Cancer 1990;66:978-82.
14. Doumplis D, Al Khatib K, Sieunarine K, et al. A review of the management of hysterectomy of 25 cases of gestational trophoblastic tumours from March 1993 to january 2006. Br J Obstet Gynecol 2007;114:1168-71.
15. Feng FZ, Xiang Y, He HJ, Wan XR, Yang XY. Value of hysteroscopy and laparoscopy in differential diagnosis of gestational trophoblastic neoplasia. Zonghua Fu Chan Ke Za Zhi July 2007;42(7):464-67.
16. Chen, Grace Chi Chiung, Falcone, Tommaso. Robotic gynecologic surgery: Past, present and future. Clinical Obstetrics and Gynecology Sep 2009;52(3):335-43.
17. Bandera, Christina Aa, Magrina, Javier Fb. Robotic surgery in gynecologic oncology. Current Opinion in Obstetrics and Gynecology Feb 2009;21(1):25-30.

10.5005/jp-journals-10007-1136
REVIEW ARTICLE

Role of Minimal Access Surgery in Management of Infective Pancreatic Necrosis

[1]Kiran Somani, [2]Dnyanesh M Belekar

[1]Associate Professor and Unit Head, Department of Surgery, KJ Somaiya Medical College, Mumbai, Maharashtra, India
[2]Associate Professor, Department of Surgery, KJ Somaiya Medical College, Mumbai, Maharashtra, India

ABSTRACT

Aim: To study various minimal access surgical techniques of pancreatic debridement for infected pancreatic necrosis (IPN).

Method: A review of literature is done using various search engines like Google, Yahoo, PubMed, etc. by using keywords: Pancreatic necrosectomy, laparoscopic, endoscopic pancreatic necrosectomy.

This article reviews various methods of minimally access pancreatic necrosectomy (MAN) can be classified by the type of scope used flexible endoscope, laparoscope, nephroscope and the route of access transperitoneal, transgastric, retroperitoneal. Each of the scopes and access routes has its advantages and disadvantages.

Result and conclusion: Only few large series of cases of MAN have been published, rest are limited to case reports. There are no comparisons of results, either with open surgery or among different minimal access surgeries but a body of evidence now suggests that acceptable outcomes can be achieved and minimal access necrosectomy is technically feasible, well tolerated and beneficial for patients when compared with open surgery.

Keywords: Infected pancreatic necrosis, Minimal access pancreatic necrosectomy.

INTRODUCTION

The gold standard for treatment of infected pancreatic necrosis (IPN) is surgical debridement. It can be achieved by open and minimal access surgical approaches. Open surgery for this condition carries a mortality rate of up to 50%,[1,2] therefore, a number of such techniques have been developed.

Pancreatic necrosis is defined as a diffuse or focal area of nonviable pancreatic parenchyma that typically is associated with peripancreatic fat necrosis.[3] Necrosis can be sterile or infected. IPN is the leading cause of death associated with severe acute pancreatitis. The incidence of acute pancreatitis varies from 10 to 40 per 100,000 population. The proportion of patients that develop pancreatic necrosis is approximately 15 to 20%. Approximately, 40% of these patients go on to develop infection of the necrosis. The overall mortality of edematous pancreatitis is 1% or less, that of sterile necrosis 5% and that of infected necrosis 10 to 20% in centers of excellence.

PATHOGENESIS OF IPN

Pancreatic necrosis occurs within the first few days of the onset of acute pancreatitis. Out of all the patients who develop pancreatic necrosis, 70% have evidence of this by 48 hours of the onset of abdominal pain and all of them by 96 hours. The premature activation of proteolytic enzymes within the acinar cells and interstitium of the lobule results in extensive necrosis of acinar cells and the substantial interstitial and intravascular accumulation and activation of leukocytes.

There are a number of factors that contribute to the failure of the pancreatic microcirculation, which is evident histologically as stasis and/or thrombosis of intrapancreatic vessels. The failure of the pancreatic microcirculation leads to ischemia, which compounds the enzymatic and inflammatory injury and leads to the full syndrome of necrotizing pancreatitis. During this first week or two, in the so-called vasoactive phase, there is the release of proinflammatory mediators that contribute to the pathogenesis of pulmonary, cardiovascular and renal insufficiency. This early systemic inflammatory response and multiorgan dysfunction are found frequently in the absence of pancreatic infection. In the later septic phase, which occurs in some patients after 3 to 4 weeks, these systemic events occur as a consequence of pancreatic infection.

There are five routes by which bacteria can infect pancreatic necrosis. These are as follows:

- Hematogenous through mesenteric vessels to the portal circulation
- Transpapillary reflux of enteric content into the pancreatic duct
- Translocation of intestinal bacteria and toxins via the mesenteric lymphatics to the thoracic duct and the systemic circulation
- Reflux of bacteriobilia via a disrupted pancreatic duct into the necrotic parenchyma and
- Transperitoneal spread.

Cultures of infected pancreatic necrosis yield monomicrobial flora in three-quarter of patients. Gram-negative aerobic bacteria usually are responsible (e.g. *Escherichia coli*, *Pseudomonas spp.*, *Proteus* and *Klebsiella spp.*), and this strongly suggests an intestinal origin, but Gram-positive bacteria (e.g. *Staphylococcus aureus*, *Streptococcus faecalis* and *Enterococcus*), anaerobes and occasionally, fungi also have

been documented. The spectrum of bacteria cultured from infected necrosis has altered with the more widespread use of prophylactic antibiotics, with a shift toward Gram-positive bacteria and fungal infections.[5]

The necrotizing process can extend widely to involve retroperitoneal fat, small and large bowel mesentery and the retrocolic and perinephric compartments.

DIAGNOSING OF IPN

The clinical symptoms and signs of pancreatic necrosis are indistinguishable from those of other patients presenting with acute pancreatitis. Abdominal pain, distension and guarding are associated with a low-grade fever and tachycardia. The severity of pain and the extent of hyperamylasemia do not correspond with the severity of acute pancreatitis. Patients presenting late with severe disease often will have established multiorgan dysfunction.

The classic skin signs of retroperitoneal necrosis are discoloration at umbilicus (Cullen's sign), the flanks (Grey-Turner's sign) and the inguinal region (Fox's sign), are rare and often not seen until the second or third week. The diagnosis of pancreatic necrosis requires more than clinical acumen.

The gold standard for the diagnosis of pancreatic necrosis is contrast-enhanced CT scanning demonstrating hypo-perfusion in the arterial phase. In the absence of a specific marker of pancreatic necrosis, many serum predictors have been proposed C-reactive protein (CRP) as the most widely used predictor of pancreatic necrosis and is useful as a daily monitor of disease progress. The accuracy in detecting necrosis is about 85%, but it requires 3 to 4 days to reach this level. The threshold values depend on the assay and the study used. The most commonly used threshold is greater than 120 mg/l.

Other prognostic markers, none of which has been proven to outperform CRP, include interleukin-6 (threshold > 14 pg/ml) which peaks a day earlier than polymorphonuclear elastase (threshold > 120 gm/l), which peaks early and reflects neutrophil activation and degranulation; and phospholipase A_2 type II (threshold > 15 units/l). Urinary trypsinogen-activating peptide and serum amyloid-A have also been studied as early marker for severity prediction.[4]

In practice, the indications for a CT scan to diagnose and determine the extent of pancreatic necrosis are the prediction of severe pancreatitis (usually during the second week), when a patient fails to improve with initial resuscitation and/or when the CRP has crossed the diagnostic threshold (see above). The CT scan can be used to grade the severity of acute pancreatitis [CT Severity Index (CTSI)] based on the extent of extrapancreatic changes and pancreatic necrosis.

The importance of the diagnosis of pancreatic necrosis is to initiate intensive-care management, which may necessitate transfer of the patient to a tertiary unit. The diagnosis of infected necrosis is imperative because it is an absolute indication for surgical intervention. It is more usual to suspect pancreatic infection with a secondary deterioration, often during the third and fourth weeks of admission. This is often heralded by a significant rise in CRP.

A CT scan often will confirm the presence of a tense collection with rim enhancement arising from a region of pancreatic necrosis. The presence of gas within the tissues confirms infection, with an 'air bubble' appearance, but this is present in the minority of cases. Infected necrosis usually is confirmed by fine-needle aspiration (FNA) for Gram's stain and bacterial culture. This can be guided by US or CT scan and is considered safe and reliable.

MANAGEMENT OF IPN

The goals of surgical management are to remove necrotic and infected tissue, drain pus, lavage the peritoneal cavity and avoid blood loss and injury to other organs. Few advocate only observational nonoperative intensive approach to manage IPN.[7] Preservation of vital intact pancreatic tissue is important. The choice of operation is determined by the location, extent and maturity of the necrotic material; status of the infection; the patient's condition, the degree of organ dysfunction and the preference and experience of the surgeon.

A number of different approaches have been described some of which are only of historical interest. Necrosectomy is complex, fraught with potentially life-threatening complications and should be left to the experienced surgeon. None of these surgical methods have been subjected to a randomized, controlled trial, and the minimal access approaches are still evolving. The latter are best suited to treatment of well-demarcated and localized necrosis in the later stage of the disease.

One possible benefit of this approach is a reduction in the number of patients who need intensive-care support. The minimal access surgical approaches to pancreatic necrosectomy can be classified according to the type of optical system (flexible endoscope, laparoscope or operating nephroscope) and the route used (via the stomach, peritoneum or retroperitoneum).

Open and Minimal Access Approaches to the Treatment of Pancreatic Necrosis

As per review of literature,

- Open approaches:
  - Pancreatic resection
  - Necrosectomy + wide tube drainage[8]
  - Necrosectomy + staged laparotomy (reexploration)
  - Necrosectomy + drainage + relaparotomy
  - Necrosectomy + laparotomy + open packing[10]
  - Necrosectomy + drainage + closed continuous lavage[9]
  - Retroperitoneal routed necrosectomy[11,12]
- Minimal access approaches:
  - Laparoscopic necrosectomy
  - Laparoscopic intracavitary necrosectomy
  - Laparoscopic-assisted percutaneous drainage
  - Laparoscopic transgastric necrosectomy

  - Laparoscopic transmesocolic necrosectomy
  - Laparoscopic transgastrocolic necrosectomy
  - Endoscopic transgastric necrosectomy
  - Endoscopic transduodenal necrosectomy
  - Percutaneous necrosectomy and sinus tract endoscopy[15]
  - Translumbar retroperitoneal endoscopic necrosectomy[13]
- Radio-guided surgical approaches:
  - MRI-assisted necrosectomy[6]
  - Video-assisted retroperitoneoscopic debridement[17]
  - Nephroscopic retroperitoneal[16]
  - Endoscopic transgastric necrosectomy
  - Endoscopic transduodenal necrosectomy
  - Endoscopic transpapillary necrosectomy
  - Endoscopic transmural necrosectomy
  - Combined method
  - EUS-guided drainage.

TIMING OF SURGERY

There has been a change in the treatment standard for necrotizing pancreatitis from an aggressive policy favoring early surgical intervention to a more conservative strategy of delayed and less invasive intervention.[7] Early surgery was advocated in order to remove the focus of infection and terminate the inflammatory process.

However, the inflammatory cascades are not easily switched off and are compounded by the surgery itself. Early surgery is more difficult because necrotic tissue is immature and not easily separated from viable tissue, resulting in a significant risk of bleeding. Additionally, early surgery may infect sterile necrosis. Delayed surgery may allow time for stabilization of the patient and the more easy removal of well-demarcated necrosum.

There is a balance between operating too early and leaving it too late and the decision needs to be individualized. The decision is aided by close surveillance of the patients' clinical trajectory with frequent clinical review and daily CRP measurements.

From a review of published studies, the lowest mortality is associated with surgery after 3 to 4 weeks. However, the clinical picture (severity and evolution) should be the primary determinant of the timing of intervention.

BASIC PRINCIPLES OF PANCREATIC NECROSECTOMY BY OPEN TECHNIQUE

Pancreatic resection is a historical approach that has been associated with unacceptable complication and mortality rates. Pancreatic necrosectomy involves removing the devitalized pancreatic and peripancreatic tissue and drainage of associated pus. The usual approach to the pancreas is through the gastrocolic omentum into the lesser sac.

Sometimes, it is easy to enter the region through the transverse mesocolon from the greater sac and to the left of the DJ flexure. At the same time, it is useful to take down both colonic flexures, providing better exposure and reducing the risk of subsequent injury to the colon from tube drains.

The head of the pancreas then can be approached anteriorly and posteriorly (after Kocherization). If the abdomen is opened though a bilateral subcostal incision, inline with the opening to the lesser sac, subsequent laparotomies do not need to disturb the greater peritoneal sac or the upper abdomen.

It is not necessarily a one-stage procedure, especially if an early necrosectomy is embarked on. Necrosectomy is a careful process, best accomplished by an educated finger. The extent of the cavity can be explored and the gentle separation of necrotic material accomplished. Necrotic extensions from the primary cavity need to be explored, often into the root of the small bowel mesentery and down the retrocolic gutters.

Care must be taken to remove only what easily separates and to avoid injury to major vessels. The removal of necrotic material may be assisted by irrigation, pulsatile irrigation, gauze and sponge forceps. When contained by a mature wall, it is advisable to avoid opening up the area too widely. The next step is placement of large-bore, soft, dependent drains to cover all the regions of what is often a complex area.

Continuous lavage with peritoneal dialysis fluid, at flow rates of 300 to 1000 ml/h, may reduce the need to reoperate and often is continued for 2 to 3 weeks. The most common postoperative complications are hemorrhage and fistulization (pancreas, small and large intestine). The use of packing is lifesaving for major hemorrhage that occurs at the time of necrosectomy, but when used routinely, it is associated with a higher incidence of enteric fistulas.[3]

NEPHROSCOPIC RETROPERITONEAL PANCREATIC NECROSECTOMY[16]

Under CECT guidance, access to the necrotic cavity is obtained via the predetermined approach. Under local anesthetic (in the absence of mechanical ventilation), an Accustick set is used to access the area of necrosis. This is subsequently exchanged (with the use of a guidewire) for a percutaneous drainage catheter. The patient is transferred to the operating suite.

Depending on the patient's condition, the following procedure can be performed under either general anesthetic or local anesthetic infiltration with IV sedation (anesthetist controlled). The patient is placed supine and a sandbag can be used under the site of catheter entry to improve access to the tract with the operating nephroscope. The entry site is prepared in a sterile fashion using a waterproof drape with a catch all as used for urological procedures as large amounts of irrigation are required. Under fluoroscopic control, the previously placed percutaneous catheter is exchanged for a guidewire.

Using a Seldinger technique the tract can then be dilated to 30 French using a renal dilatation set. It is important to reinforce the guidewire with the supplied plastic tapered sheath to prevent buckling and misplacement of the wire. A three-dimensional concept of the surrounding structures as shown by the CE-CT

is crucial to avoid inadvertent injury to surrounding vessels and viscera.

There should be very little resistance to dilatation and any resistance encountered should lead to reevaluation to the line of dilatation. The exception to this is during introduction of the dilators through the skin, subcutaneous tissues and rib space and if this creates a problem increasing the size of the wound and dissecting down to the entry site may aid insertion.

With the tract dilated, an Amplatz sheath is placed over the dilator and a rigid operating nephroscope can be introduced into the cavity. The scope requires both an irrigation and biopsy channel. With continuous irrigation (warm sterile 0.9 % saline, 10–20 liters) under direct vision the necrosis can be removed piecemeal. It is vitally important that granulating tissue, visible vessels (aorta, superior mesenteric artery, splenic artery) or adherent tissue is not biopsied as it may result in catastrophic bleeding.

Often at the first procedure, minimal necrosis can be removed and it is prudent to be conservative with this attempt. The procedure should be repeated on a weekly basis until the cavity appears clear and all visible necrosis is removed. At the end of each procedure, an irrigating system is constructed using a 28 French chest drain with extra side holes (cut to shape) sutured to a 10 French nasogastric tube. This is passed along the established tract until resistance is met and then secured with a suture to the skin. Post-operatively, this can be irrigated with 0.9% saline via the nasogastric tube at a rate of 50 to 250 ml/hour depending on the degree of contamination.

PERCUTANEOUS NECROSECTOMY AND SINUS TRACT ENDOSCOPY IN THE MANAGEMENT OF INFECTED PANCREATIC NECROSIS[15]

Percutaneous Drainage

Percutaneous drains placed by the interventional radiologist in the treatment of infected necrosis should be used cautiously. The catheter size will not cope with the solid necrotic tissue. It achieves drainage and not necrosectomy. There are two settings in which percutaneous drainage is useful. The first is in an unstable septic patient with evidence of a tense rim-enhanced collection (pancreatic abscess) with a significant fluid component on CT scanning.

Percutaneous drainage in this setting may take the 'heat out of the fire', allow stabilization of the patient and 'buy time' until necrosis is more amenable to surgical removal. The second setting in which percutaneous drainage is important is to establish the optimal route for dilatation and subsequent percutaneous necrosectomy, should this be appropriate. This will require careful discussion between the radiologist and surgeon. It usually involves a left-flank puncture and a route along the axis of the body/tail of the pancreas.

Percutaneous Necrosectomy

Under computed tomography guidance, an 8 French pigtail nephrostomy catheter is inserted into the infected cavity, the surgeon having carefully selected a path that will allow subsequent dilatation. Correct route is to enter the area of infected necrosis between the lower pole of the spleen and the splenic flexure. In predominately right-sided pancreatic head necrosis, a route through the gastrocolic omentum, anterior to the duodenum is selected.

However, this results in a more technically difficult necrosectomy and prevents dependent postoperative drainage. The catheter is secured and the patient transferred to the operating room. With the patient under general anesthesia, access to the abscess cavity is maintained using a guidewire, over which the catheter tract is then dilated to 30 French using graduated dilators and radiologic guidance.[12] This allows a 30 French Amplatz sheath to be inserted. An operating nephroscope that allows intermittent irrigation and suction, with a 4 mm working channel, is then passed along the Amplatz sheath into the abscess cavity. Piecemeal removal of solid material is then performed using soft grasping forceps through the working channel by repeatedly passing the instrument into the cavity until all loose necrotic tissue is removed.

Finally, an 8 French umbilical catheter sutured to a 28 French tube drain is then passed over a 12 French stiffener to the distal end of the cavity to allow continuous postoperative lavage (500 ml/hr) through the umbilical catheter. Because of the high-volume lavage, we use a fluid normally used for peritoneal lavage to minimize the potential of electrolyte imbalance. The lavage is continued at this rate until the lavage fluid clears or until a further procedure.

SINUS TRACT ENDOSCOPY

In patients with a previous primary debridement, either at open laparotomy or after the above technique, in whom residual sepsis is suspected, a second computed tomogram is obtained and, provided there are no satellite collections, secondary sinus tract endoscopy is performed. In the operating room and under general anesthesia, the previously sited drain or drains are removed. Either a flexible or a rigid endoscopic system is used, depending on the suspected amount of residual necrosis.

Sinus tract endoscopy using a flexible endoscope is tedious and only small fragments of necrotic tissue can be removed with each pass of the endoscope. As a result, we have moved to using the operating nephroscope as described above for most primary explorations. The major alteration in the technique is that the Amplatz sheath is not required. Access to pockets of necrosis is occasionally limited by the rigidity of the system, and flexible endoscopy remains useful to check the tract before drain removal if residual necrosis is not suspected.

For flexible endoscopy, each tract is dilated to 45 French using a balloon dilator. A twin-channel endoscope is then passed through the skin opening. Further endoscopic antegrade dilatation of the tract is then performed until the entire length of the drain tract can be visualized. Jet irrigation using a heater probe and suction allows fluid collections to be cleared, and residual solid necrotic tissue or adherent slough can be teased away using a variety of endoscopic instruments (e.g. snares, stent retrieval forceps). A guidewire is then passed through the endoscope and an 8 French umbilical catheter sutured to a 28 French tube drain is placed in the cavity, after which lavage begins again.

Method of EUS-Guided Endoscopic Transgastric Pancreatic Necrosectomy[18]

Pancreatic pseudocyst drainage was the first therapeutic application of EUS. The cyst is punctured under ultrasound guidance, contrast injected and a guidewire inserted. Initial dilation to 8 mm is performed over the wire. The EUS scope is then exchanged over the wire for a forward viewing endoscope. A second dilation to 18 mm is performed. This enables entry of the endoscope into the cyst perform cystoscopy, debridement if necessary and insertion of multiple large bore double pigtail stents.

We report on the use of the prototype forward viewing echoendoscope in six consecutive patients who were referred for pancreatic cyst drainage. Here, you see endoscopic view indistinguishable from that of a gastroscope showing a bulge where the cyst impinges against the posterior gastric wall. Power Doppler is switched on and highlights multiple vessels interposed in the wall. This allows selection of a safe vessel-free window for a cyst puncture. A 19 G needle is advanced into the cyst lumen. A sample of contents is aspirated for fluid analysis.

A guidewire under ultrasound guidance is inserted into the cyst. An 18 mm balloon is coaxially thread over the wire and advanced across the cyst wall. Note that resistance is encountered, but the forward transfer of force overcome this. The dilation is performed under forward viewing endoscopic and ultrasound guidance. As the balloon is maximally inflated we see the cystogastrostomy open up. The balloon is then deflated while simultaneously advancing the scope into the cyst cavity.

Cystoscopy is now performed showing the cyst contents to be filled with pasty wall-adherent necroses. Pulsed power Doppler is switched on, we can see and hear arterial flow vessels within the wall of the cyst. This identifies sensitive areas at bleeding risk when performing debridement. In this case, vigorous water jet irrigation is performed through an accessory water irrigation channel built into the echoendoscope.

This issued to clear nonadherent debris. Our experience has shown that it is not necessary to actively remove wall-adherent debris using extraction tools as such Dormia or Roth net basket to achieve cyst resolution. Three large bore 10 French double pigtail stents are now inserted into the cyst under direct endoscopic guidance. The first stent is delivered over a guide catheter then the second stent and lastly the third stent. All three stents are deployed. Finally, a nasocystic catheter is inserted for maintenance of irrigation.

DISCUSSION

If acute pancreatitis is a model of sepsis, then conventional surgery with its high complication rates is the second hit[14] which could in part accountable for high mortality.

In IPN, maximal optimal intensive care may not be able to halt/reverse disease progression in some patients. Most of the deaths occurring earlier in the course of the disease are due to multiple organ dysfunction syndromes (MODS). Infection is the superadded compounding insult for the survivors. Prediction of severity is core to the management.

The Ranson and Imrie scoring systems have sensitivity of about 80% at 48 hours, and acute physiology and chronic health evaluation (APACHE) II system has a sensitivity of around 85% for score > 9 on admission. Serum biomarkers, such as C-reactive protein (> 150 mg/l at 48 hr), IL-8, IL-6, procalcitonin, IL-10 and IL-1 beta-receptor antagonist are predictors of severity.

Infection in the pancreatic necrosis is not a clinical diagnosis, due to overlap of features with systematic inflammatory response syndrome; the latter would be evident. Acute infective pancreatic necrosis is an objective diagnosis following positive culture or contrast-enhanced CT showing gas pockets in/around the necrosum. Serum procalcitonin is a biomarker of infection and is a valuable tool.

Sterile necrosis can either resolve from peripancreatic fluid collections, pseudocyst or can become infected. Patients with necrotising pancreatitis should be managed intensively as they have a potential for developing MODS. The demarcation of necrotic tissue takes at least one week after the acute attack, and hence, surgery should be delayed until at least the second week of the attack, when possible.

Removing the necrotic tissue removes the toxic inflammatory mediators that can gain systemic access via portal circulation or retroperitoneal lymphatics. The current consensus is for the removal of necrosum and preservation of viable pancreas along with maximal physiological support. In the past, surgical management consisted of tissue sparing procedures to total pancreatectomy.

Minimal access pancreatic necrosectomy has its own limitations. Each of the scopes and access routes has its advantages and disadvantages. The scopes can be compared for field of view, working channel for instruments and irrigation, external diameter, length, flexibility and angulation.

The routes can be compared for ease of access, risk of collateral injury and unnecessary contamination, and the ability to deal with multiple and complex collections. The two

approaches that have risen to favor are the endoscopic transgastric and nephroscopic retroperitoneal routes, probably because they are based on conventional operations.

The former is an adaptation of an open surgical approach, developed to treat retrogastric pseudocysts, that has been extended to include endoluminal ultrasonographically-guided transgastric puncture of the lesion, balloon dilatation of the track, insertion of multiple stents, direct basket extraction of necrosum and transpapillary stenting of the pancreatic duct. These technically demanding endoscopic maneuvers are likely to become more widespread and supercede the laparoscopic transgastric operation.

The endoscopic transgastric procedure avoids peritoneal contamination and external pancreatic fistula formation, but it may not be possible if there is no abutment of the lesion against the stomach or duodenal wall. The nephroscopic retroperitoneal procedure has been advocated by the Glasgow group and appears now to be the most popular MAN approach. It is an adaptation of the open lumbotomy technique to left sided organized pancreatic necrosis.

MAN has now passsed the stage of feasibility testing and it can be done. What is now needed is evidence to guide the decision about which technique should be selected for which patient and about the timing of its application.

It appears to be associated with a reduction in duration of stay in the intensive care unit. Another challenge to progress is technical and involves the extraction of necrosum. With MAN, the 'educated finger' cannot be deployed for digital debridement. The small forceps and baskets currently in use mean tedious, piecemeal extraction.

Now, with the advent of robotic surgery even within few years it will be possible to perform the IPN surgery with maximum accuracy. However, a prospective double-blind study is required for the same over a span of at least 5 years with meticulous follow-up and data recording.

CONCLUSION

Pancreatic necrosectomy by minimal access surgery is feasible and on the available evidence there is no doubt that it has a major role to play in reducing both systemic insult and the subsequent mortality, but it demands technical expertise and availability of skilled interventionist. It requires multiple sessions as it is difficult to remove necrosum in a single sitting.

Currently, majority of patients are suitable for minimal access surgery and with the development of better instruments and increasing experience this number is likely to increase, although it is unlikely to completely replace open necrosectomy.

ACKNOWLEDGMENT

The guidance provided by Professor Dr RK Mishra, Director, Laparoscopy Hospital, Tilak Nagar, Delhi, is sincerely appreciated and acknowledged.

REFERENCES

1. Slavin J, Ghaneh P, Sutton R, et al. Management of necrotizing pancreatitis. World J Gastroenterol 2001;7:476-81.
2. Rau B, Steinbach G, Gansauge F, et al. The potential role of procalcitonin and interleukin 8 in the prediction of infected necrosis in acute pancreatitis. Gut 1997;41:832-40.
3. Traverso LW, Kozarek RA. Pancreatic necrosectomy: Definitions and technique. J Gastrointest Surg 2005;9:436-39.
4. Mayer JM, Raraty M, Slavin J, et al. Serum amyloid A is a better early predictor of severity than C-reactive protein in acute pancreatitis. Br J Surg 2002;89:163-71.
5. Götzinger P, Wamser P, Barlan M, et al. Candida infection of local necrosis in severe acute pancreatitis is associated with increased mortality. Shock 2000;14:320-23.
6. Freeny PC, Hauptmann E, Althaus SJ, Traverso LW, Sinanan M. Percutaneous CT-guided catheter drainage of infected acute necrotizing pancreatitis: Techniques and results. Am J Roentgenol 1998;170:969-75.
7. Bradley EL, Allen K. A prospective longitudinal study of observation versus surgical intervention in the management of necrotizing pancreatitis. Am J Surg 1991;161:19-24.
8. Altemeier WA, Alexander JW. Pancreatic abscess. A study of 32 cases. Arch Surg 1963;87:80-89.
9. Beger HG, Büchler M, Bittner R, et al. Necrosectomy and postoperative local lavage in necrotizing pancreatitis. Br J Surg 1988;75:207-12.
10. Bradley EL. Management of infected pancreatic necrosis by open drainage. Ann Surg 1987;206:542-50.
11. Fagniez PL, Rotman N, Kracht M. Direct retroperitoneal approach to necrosis in severe acute pancreatitis. Br J Surg 1989;76:264-67.
12. Villazón A, Villazón O, Terrazas F, Raña R. Retroperitoneal drainage in the management of the septic phase of severe acute pancreatitis. World J Surg 1991;15:103-07.
13. Castellanos G, Piñero A, Serrano A, et al. Translumbar retroperitoneal endoscopy: An alternative in the follow-up and management of drained infected pancreatic necrosis. Arch Surg 2005;140:952-55.
14. Wilson PG, Manji M, Neoptolemos JP. Acute pancreatitis as a model of sepsis. J Antimicrob Chemother 1998;41:51-63.
15. Carter CR, McKay CJ, Imrie CW. Percutaneous necrosectomy and sinus tract endoscopy in the management of infected pancreatic necrosis: An initial experience. Ann Surg 2000;232: 175-80.
16. Connor S, Ghaneh P, Raraty M, et al. Minimally invasive retroperitoneal pancreatic necrosectomy. Dig Surg 2003;20:270-77.
17. Risse O, Auguste T, Delannoy P, et al. Percutaneous video-assisted necrosectomy for infected pancreatic necrosis. Gastroenterol Clin Biol 2004;28:868-71.
18. Binmoeller KF (May 19, 2008). Pancreas-endoscopic transgastric pancreatic necrosectomy using a forward viewing echoendoscope. The DAVE Project.

10.5005/jp-journals-10007-1137
REVIEW ARTICLE

The Role of Mechanical Bowel Preparation in Gynecologic Laparoscopy

JA Maseloane

Consultant, Department of Obstetrics and Gynecology, Tembisa Hospital, Tembisa, South Africa

ABSTRACT

Various combinations of dietary restriction, antibiotic regimens and mechanical preparations have become routine in preoperative surgical planning for elective colon surgery. This practice has also become commonplace in the field of gynecology, either for planned bowel surgery or in complex cases that are believed to be high risk for inadvertent bowel injury. As the trend in gynecologic surgery shifts toward more minimally invasive approaches, the complexity of cases being performed by laparoscopy and robotics continues to increase. In addition, laparoscopic surgical techniques have a different set of inherent risks and challenges as compared with open pelvic operations. This review summarizes the available data surrounding the use of mechanical bowel preparations, specifically with regard to gynecologic laparoscopy.

Keywords: Mechanical bowel preparation, Minimally invasive gynecological surgery, Laparoscopic surgery.

INTRODUCTION

Although therapeutic colonic cleansing has been documented as far back as 1500 BC in Egyptian medical writings,[1] the modern application of bowel preparation to elective surgery was refined as recently as the 1950s. Innovative surgeons of the time were searching for ways to decrease postoperative mortality given that the mortality rate for a primary colectomy in 1940 was estimated to be 30%.[2] Since then, various combinations of dietary restriction, antibiotic regimens and mechanical preparations have become routine in preoperative surgical planning for elective colon surgery. This practice has also become commonplace in the field of gynecology, either for planned bowel surgery or in complex cases that are thought to be high risk for inadvertent bowel injury. As the trend in gynecologic surgery shifts toward more minimally invasive approaches, the complexity of cases being performed by laparoscopy and robotics continues to increase. In addition, laparoscopic surgical techniques have a different set of inherent risks and challenges as compared with open pelvic operations. This review summarizes the available data surrounding the use of mechanical bowel preparations, specifically with regard to gynecologic laparoscopy.

Regimens for Bowel Preparation

Mechanical bowel preparation aims to decrease the volume of fecal content in the colon, which thereby decreases the total colony count of bacteria. Various regimens exist, consisting of diets such as low residue or clear liquid in the day(s) prior to surgery or cathartic pharmacotherapy that may be delivered orally or per rectum. Medications commonly used include emollients that soften the stool, allowing it to move more freely through the colon (e.g. ducosate); osmolar agents that cause colonic water retention [e.g. sodium or magnesium preparations, polyethylene glycol (PEG), lactulose, sorbitol, glycerine]; and stimulants that increase intestinal peristalsis (e.g. casanthranol, senokot, bisacodyl and castor oil). Many of the regimens mentioned above are limited by patient tolerance, including issues, such as gastrointestinal distress, dehydration and electrolyte disturbances. In elderly patients or those with underlying renal dysfunction, mechanical bowel preparation may incur a significant risk of fluid shifts and severe electrolyte derangement.[1] Regarding choice of cathartic, sodium phosphate has been compared with PEG and found to be associated with lower complication rate, less intraoperative bowel spillage and improved patient tolerance.[3,4]

Although not the primary focus of this review, the goal of antibiotic pretreatment is to decrease the concentration of bacteria in the colon. A landmark meta-analysis published in 1981 concluded that the evidence supporting antibiotic bowel preparation prior to colorectal surgery was such that further studies including no treatment control groups should be considered unethical.[5] Antibiotic pretreatment can be accomplished via oral and/or parenteral administration; the relative merits of each approach remain an area of debate among colorectal surgeons. Preoperative oral antibiotics have been shown to produce a four to five log decrease in enteric bacterial concentration in resected colon,[6] though proponents of parenteral administration emphasize the importance of achieving adequate systemic antibiotic levels while minimizing symptomatic gastrointestinal distress.[7] Oral antibiotic bowel preparation regimens that were popularized in the 1970s included erythromycin and neomycin; however, many regimens have been subsequently studied without a consensus on the optimal agent. A recent Cochrane review on the topic concluded that antibiotics should be given prior to colorectal surgery and should include coverage for anaerobic as well as aerobic bacteria.[8] This review suggests that a combination of oral and

intravenous antibiotics will likely give the best results, though timing of oral antibiotics remains unclear. Confounding the issue further, oral antibiotic preparation has not been studied in isolation from mechanical bowel preparation.

Mechanical Bowel Preparations: Controversy From General Surgery Literature

Since, first proposed by Sir William Halsted in 1887, the use of some form of mechanical bowel preparation to decrease infectious complications and anastomotic breakdown in elective colorectal surgery has been considered surgical dogma.[9] Benefits of decreased fecal content of the bowel were thought to include minimized bacterial contamination, decreased passage of hard stool over newly formed anastomotic sites and facilitation of intraoperative bowel manipulation.[10] Initial data supporting this practice were mainly observational; it was not until the 1970s that this practice was called into question when a randomized trial demonstrated no benefit of mechanical bowel preparation with regard to wound infection, peritonitis or death when used in elective colorectal surgery.[11] Data from emergency colorectal surgery in the 1980s further supported the view of bowel preparation as unnecessary. Traditionally, emergency surgery on unprepared bowel was treated with a diverting colostomy, extensive resection of ascending colon and/or intraoperative colonic lavage. Observations from emergency left-sided colorectal surgery, often performed due to obstructions caused by malignancy, supported the safety of primary anastomosis in these settings.[12] Further randomized trials in patients undergoing elective colorectal surgery suggested increased morbidity when mechanical bowel preparation was used, including increased postoperative infections, extraabdominal complications and longer hospital stays.[10] Suggested mechanisms for the increased infectious morbidity associated with mechanical bowel preparations include enhanced bacterial translocation across the lumen and increased bowel inflammation.[13-15] It has also been reported that inadequate mechanical bowel preparation results in higher incidence of liquid bowel content with a corresponding increase in peritoneal spillage intraoperatively.[16] The 2009 updated Cochrane review concluded that prophylactic mechanical bowel preparations have no proven benefit and should be abandoned in most cases.[8] Potential situations where bowel preparations may remain useful include those wherein an intraoperative colonoscopy is performed. The Cochrane review further comments that future research on this topic is needed, specifically with well-designed trials that include allocation concealment, stratification of colon versus rectal surgery, comments on history of radiation and inclusion of laparoscopic surgery. Despite the large pool of data supporting the omission of mechanical bowel preparations and changing guidelines, clinical practice has been slow to change; a 2005 survey of Northern European surgeons found that between 50 and 95% continue to use preoperative bowel preparation.[17]

Mechanical Bowel Preparations in Gynecologic Laparoscopy

Although the majority of the evidence regarding bowel preparations is found in colorectal surgery literature, studies have also been performed specifically targeting a gynecologic population. With regard to gynecologic laparoscopy in particular, one proposed role for bowel preparation includes cases where bowel resection is planned or thought to be high risk for inadvertent bowel injury (e.g. severe adhesive disease, endometriosis, previously irradiated operative field, malignancy). Bowel injury is a rare complication of laparoscopy; the incidence has been reported at 0.13% by a 2004 literature review.[18] Compounding this fact that only a limited number of gynecologic cases that will result in bowel injury, the data from colorectal surgery support abandoning routine mechanical bowel preparation.

In addition, it has been proposed that clearing of bowel contents may aid in visualization and handling of intestines during laparoscopic surgery. In a randomized trial, Muzii et al studied the effects of bowel preparation with oral sodium phosphate solution in patients undergoing laparoscopy for benign gynecologic indication; the authors did not find any advantage regarding preparation of surgical field, operative time, intra or postoperative complications or length of stay.[19] Conversely, the mechanical bowel preparation group reported significantly greater preoperative discomfort. Another randomized study compared mechanical bowel preparation to a 7-day minimal residue diet in patients undergoing laparoscopy for benign gynecologic disease.[20] The precolonoscopy, low-residue diet demonstrated minimal colonic fecal residue and may potentially decrease colonic gaseous distension. In the study mentioned, both groups were found to have similar surgical field exposure; however, the low-fiber diet was better tolerated.

SUMMARY AND RECOMMENDATION

An emerging body of evidence suggests lack of benefit—and potential for harm—with routine use of mechanical bowel preparation in colorectal surgery. Despite a paucity of literature specific to gynecologic surgery, it is reasonable to extrapolate from the general surgery data a recommendation against mechanical bowel preparation for the indication of decreasing infectious complications related to bowel injury or resection.[21] Antibiotic bowel preparation, however, has been proven beneficial in colorectal surgery and can reasonably be used in complicated gynecologic cases at high risk for bowel involvement. A caveat to this recommendation is the importance of understanding the clinical practices of consulting colorectal surgeons at individual institutions. Should an unexpected bowel injury occur in a patient who did not undergo preoperative mechanical bowel preparation and who requires the services of a surgical consultant to assist with repair? The

decision whether to proceed with primary anastomosis *versus* fecal diversion may be taken out of the hands of the gynecologist. Despite recommendations and data supporting the safety of primary anastomosis on unprepared bowel, clinical practice patterns among surgeons vary greatly. In situations where the patient is thought to be at high-risk for inadvertent bowel injury, it may be prudent to perform a mechanical bowel preparation to avoid the possibility of fecal diversion, depending on the pervasive local practice patterns of consulting surgeons. It may also be a good idea to have a discussion with the local team of surgeons to discuss what influence, if any, the lack of a mechanical bowel preparation might have on their surgical management of an inadvertent bowel injury.

A novel role for bowel preparation in pelvic laparoscopic surgery is the evacuation of intestinal contents to allow for a clearer operative field. Based on a single, randomized, controlled trial, there does not appear to be any advantage of mechanical bowel preparation on surgeon perception of appropriateness of surgical field.[19] As the field of minimally invasive gynecologic surgery continues to evolve and encompass more complex surgical techniques, further research is needed to better define optimal pre and intraoperative management. As suggested by the Cochrane review, well-designed randomized studies regarding mechanical bowel preparation in laparoscopy are needed, regarding both oncologic and benign gynecologic indications.

REFERENCES

1. Botha MH. Mechanical bowel preparation in gynaecological surgery—are we doing more harm than good? S Afr Med J 2007;97:1040, 1042-43.
2. Leo WA, Von Riesen VL, Roberts GG, Schloerb PR. Twenty-four hours preparation of the large bowel for surgery using neomycin-sulfathalidine or neomycin-oxytetracycline: A comparative evaluation. Ann Surg 1958;147:359-65.
3. Itani KM, Wilson SE, Awad SS, et al. Polyethylene glycol versus sodium phosphate mechanical bowel preparation in elective colorectal surgery. Am J Surg 2007;193:190-94.
4. Chaleoykitti B. Comparative study between polyethylene glycol and sodium phosphate solution in elective colorectal surgery. J Med Assoc Thai 2002;85:92-96.
5. Baum ML, Anish DS, Chalmers TC, et al. A survey of clinical trials of antibiotic prophylaxis in colon surgery: Evidence against further use of no-treatment controls. N Engl J Med 1981;305: 795-99.
6. Bartlett JG, Condon RE, Gorbach SL, et al. Veterans administration cooperative study on bowel preparation for elective colorectal operations: Impact of oral antibiotic regimen on colonic flora, wound irrigation cultures, and bacteriology of septic complications. Ann Surg 1978;188:249-54.
7. Espin-Basany E, Sanchez-Garcia JL, Lopez-Cano M, et al. Prospective, randomised study on antibiotic prophylaxis in colorectal surgery. Is it really necessary to use oral antibiotics? Int J Colorectal Dis 2005;20:542-46.
8. Guenaga KK, Matos D, Wille-Jørgensen P. Mechanical bowel preparation for elective colorectal surgery.Cochrane Database Syst Rev 2009;1 CD001544.
9. Halsted WS. Circular suture of the intestine: An experimental study. Am J Med Sci 1887;94:436-61.
10. Bucher P, Gervaz P, Soravia C, et al. Randomized clinical trial of mechanical bowel preparation versus no preparation before elective left-sided colorectal surgery. Br J Surg 2005;92:409-14.
11. Hughes ES. Asepsis in large-bowel surgery. Ann R Coll Surg Engl 1972;51:347-56.
12. Dorudi S, Wilson NM, Heddle RM. Primary restorative colectomy in malignant left-sided large bowel obstruction. Ann R Coll Surg Engl 1990;72:393-95.
13. Poole GV. Spontaneous bacterial peritonitis during bowel preparation: An example of clinical translocation. South Med J 1991;84:1412-13.
14. Kale TI, Kuzu MA, Tekeli A, et al. Aggressive bowel preparation does not enhance bacterial translocation, provided the mucosal barrier is not disrupted: A prospective, randomized study. Dis Colon Rectum 1998;41:636-41.
15. Bucher P, Gervaz P, Egger JF, et al. Morphologic alterations associated with mechanical bowel preparation before elective colorectal surgery: A randomized trial. Dis Colon Rectum 2006;49:109-12.
16. Mahajna A, Krausz M, Rosin D, et al. Bowel preparation is associated with spillage of bowel contents in colorectal surgery. Dis Colon Rectum 2005;48:1626-31.
17. Lassen K, Hannemann P, Ljungqvist O, et al. Patterns in current preoperative practice: Survey of colorectal surgeons in five Northern European countries. BMJ 2005;330:1420-21.
18. van der Voort M, Heijnsdijk EA, Gouma DJ. Bowel injury as a complication of laparoscopy. Br J Surg 2004;91:1253-58.
19. Muzii L, Bellati F, Zullo MA, et al. Mechanical bowel preparation before gynecologic laparoscopy: A randomized, single-blind, controlled trial. Fertil Steril 2006;85:689-93.
20. Lijoi D, Ferrero S, Mistrangelo E, et al. Bowel preparation before laparoscopic gynaecological surgery in benign conditions using a 1 week low-fibre diet: A surgeon blind, randomized and controlled trial. Arch Gynecol Obstet 2009;280:713-18.
21. Gadducci A, Cosio S, Genazzani AR. The perioperative management of patients with gynaecological cancer undergoing major surgery: A debated clinical challenge. Crit Rev Oncol Hematol 2010;73:126-40.

10.5005/jp-journals-10007-1138
REVIEW ARTICLE

Laparoscopic Partial Nephrectomy: Expanding Role in the Treatment of Localized Renal Cell Carcinoma

Mohamed Abdellateef
Consultant, Department of Urology, Dar Al Shifa Hospital, Kuwait

ABSTRACT

Context: The increasing incidence of localized renal cell carcinoma (RCC) over the last three decades have been well evident and have called for different treatment modalities among which laparoscopic partial nephrectomy has evolved.

Objective: To review the development, techniques, outcomes and current status of laparoscopic partial nephrectomy for the treatment of renal tumors.

Materials and methods: A literature search of English-language publications was performed using the Medline database and website PubMed. Many papers were identified of which 64 papers were selected for review based on their contribution and relevance.

Conclusion: Laparoscopic partial nephrectomy provides perioperative results as well as intermediate and long-term oncologic and functional outcomes comparable with the reference standard (open partial nephrectomy) with significantly decreased patient morbidity. Today, the indications for laparoscopic partial nephrectomy have expanded to include larger, more complex and higher-stage tumors.

Keywords: Laparoscopic partial nephrectomy, Localized renal cell carcinoma, Partial nephrectomy, Nephron-sparing surgery.

INTRODUCTION

Renal cell carcinoma (RCC) accounts for nearly 3% of all adult malignancies. The incidence of renal cell carcinoma (RCC) has increased steadily between 1975 and 2002.[1,2] Incidence has increased most rapidly for localized tumors, probably because of improved noninvasive diagnostic imaging.[1] From 1988 to 2002, the average renal tumor size decreased from 67 to 59 mm, according to an analysis of data from the surveillance, epidemiology and end results (SEER) database. Analysis of a large European cohort showed that the general incidence of surgically removed renal cancers increased from 6.2 to 7.5 per 100,000 patients, the incidence of T1 tumors increased from 36.6 to 44.2% and advanced tumors decreased from 46.4 to 33.7% during the period 1995 to 2005.[3] The number of patients presenting with tumors < 4 cm increased from 30 to 39%. Improved survival in more recently diagnosed patients could be attributed to these trends.[2] Incidentally diagnosed small (≤ 4 cm) renal masses are currently the most commonly encountered renal tumors in urologic practice.[1] This has lead to an increased incidence of asymptomatic organ-confined small renal masses (SRMs).[1] A SRM is generally defined as a contrast-enhancing mass within the kidney with the largest dimension ≤4 cm.[4]

Although there is controversy on the mortality rate of RCC, cancer statistics shows that mortality rates are decreasing (38% in 1997 *vs* 25% in 2007).[5]

The current standard of care for clinically localized RCC is surgical, preferably with nephron-sparing surgery (NSS) because of the reported excellent oncologic outcome and overall survival. Active surveillance and minimally invasive ablative technologies have emerged as potential alternatives to surgery in selected patients.[6]

DISCUSSION

Active surveillance is considered an appropriate strategy for elderly patients or patients with significant comorbidities who are not good surgical candidates.[7,8] Gill et al recently suggested that active surveillance also seems a reasonable option for masses ≤ 1 cm in diameter, regardless of the patient's life expectancy.[4] Surveillance is currently not recommended in fit and young patients.[9] Surveillance requires excellent patient compliance and rigorous follow-up with contrast-enhanced computed tomography (CT) or magnetic resonance imaging (MRI).

Energy ablative therapies for localized renal cell carcinoma, cryosurgery and radiofrequency ablation (RFA) by open, laparoscopic or percutaneous approaches are promising minimally invasive nephron-sparing treatment options for localized RCC for most small (mainly < 3.0 cm) low-grade renal tumors in patients who are at high surgical risk. Potential advantages of ablative procedures are reduced morbidity, shorter hospitalization, faster convalescence, preservation of renal function, lower costs, and the ability to treat patients who are at high-risk for surgery, but a primary concern is the higher local recurrence rate with cryoablation and RFA when compared with surgical excision.[11] A second concern is the controversy over the validity of the radiographic definition of postablative success.[12] Another weakness is the absence of histopathologic

confirmation of complete tumor destruction and negative surgical margins.[13] Finally, ablative procedures may preclude or complicate subsequent surgical salvage due to perinephric fibrosis.[13]

Other minimally invasive techniques, such as high-intensity focused ultrasound (HIFU), radiosurgical ablation (CyberKnife), microwave thermotherapy, laser ablation and pulsed-cavitational ultrasound should be considered experimental and pending to determine their oncologic and functional role in the management of localized RCC.

Radical nephrectomy has been the traditional approach for localized RCC in patients with a normal contralateral kidney. During the last decade, the status of radical nephrectomy has been questioned because of several factors including: (1) Equal oncologic efficacy as partial nephrectomy for renal tumors < 4 cm,[14,15] and tumors between 4 and 7 cm,[16,17] (2) increased incidental detection of SRMs (< 4 cm) with a significant proportion of benign tumors (up to 20%),[18] (3) possibility of late recurrence of RCC in the contralateral kidney, and (4) a higher risk of new-onset chronic kidney disease or worsening of chronic kidney disease following RN that leads to more cardiovascular events and worse survival.[19-22] Radical nephrectomy might no longer be regarded as the gold standard treatment for SRMs and should be reserved for patients with massive renal tumors in whom partial PN is not an option.[19]

Partial nephrectomy has the advantages of preservation of renal function, a reduced risk of chronic kidney disease and avoidance of overtreatment of benign renal masses by nephrectomy and better quality of life than after radical nephrectomy.[23] A significant concern with the use of partial nephrectomy for RCC is the potential risk of local recurrence in the ipsilateral kidney due to incomplete resection, but there are reports demonstrating low rates of recurrence following partial nephrectomy particularly when performed for tumors < 4 cm.[24] Many so-called local recurrences are not due to incomplete removal but are rather *de novo* tumors, such as multifocal papillary RCC. A second concern is the occurrence of positive surgical margins. It has been shown that a normal tissue margin of just 1 mm when performing partial nephrectomy may be sufficient to prevent local recurrence and disease progression from RCC.[24] During the last decade elective partial nephrectomy has become the gold standard for the treatment of T1a tumors (< 4 cm) in patients with a normal contralateral kidney.[15] When partial nephrectomy is performed in carefully selected patients in specialized centers, indications can be expanded to include, T1b tumors (4-7 cm).[13,16,17,25-33] Recently, a study revealed that partial nephrectomy can be safely performed and provide effective tumor control for selected patients with renal tumors ≥ 7 cm.[34]

Laparoscopic partial nephrectomy was first performed transperitoneally by Winfield et al[35] and retroperitoneally by Gill et al.[36] Advances in laparoscopic skills made it possible to transfer the techniques of open partial nephrectomy to laparoscopic partial nephrectomy to treat SRMs laparoscopically. In selected centers, laparoscopic partial nephrectomy today is an established alternative treatment for T1a tumors.[37] Laparoscopic partial nephrectomy can be performed retroperitoneoscopically or preferentially and transperitoneally. The choice of approach is based on the tumor location and size as well as the experience of the surgeon.[38,39] Ng et al compared transperitoneal and retroperitoneal laparoscopic partial nephrectomy and observed similar results in terms of analgesic use, blood loss and perioperative complications.[40] Laparoscopic partial nephrectomy has the advantages of reduced operative time, decreased operative blood loss and a shorter hospital stay compared with open partial nephrectomy,[41] but laparoscopic partial nephrectomy is technically demanding, and longer ischemic time and hemostasis concerns remain.

In a recent multicenter study, Gill et al compared the most recent 1039 patients undergoing open partial nephrectomy with the very initial 771 patients undergoing laparoscopic partial nephrectomy for a single renal tumor < 7 cm.[41] Postoperative renal function was similar (97.9% *vs* 99.6% functioning renal units after 3 months), but urologic complications were more common in the laparoscopic partial nephrectomy group [odds ratio (OR): 2.14; 95% CI, 1.39-3.31]. For postoperative hemorrhage, the OR was 3.51 (95% CI, 1.82-6.77), favoring the open partial nephrectomy group. However, equivalent functional and early oncologic outcomes were achieved.

In their retrospective analysis, Simmons et al evaluated the use of laparoscopic partial nephrectomy for tumors > 4 cm in size (n = 58).[42] There were no increased risks for positive margins or intraoperative or postoperative genitourinary complications for tumors > 4 cm when compared with two groups—one with tumor size < 2 cm (n = 89) and the other with tumor size 2 to 4 cm (n = 278).

The initial laparoscopic partial nephrectomy data indicated somewhat longer ischemia times compared with open partial nephrectomy. However, the increasing experience with laparoscopic partial nephrectomy and the development of an 'early unclamping' technique has significantly decreased ischemia times, allowing superior laparoscopic partial nephrectomy outcomes. Specifically, laparoscopic partial nephrectomy ischemia times have now been decreased by > 50%, to a mean of 14 minutes currently.[43-45] Most recently, Gill et al reported the initial experience of 'zero ischemia' laparoscopic partial nephrectomy, a technique that does not involve hilar clamping even for technically complex tumors. This novel technique involves two innovative concepts: (1) Anatomic microdissection to isolate and superselectively control tumor-specific tertiary or higher-order renal artery branches with neurosurgical micro-bulldog clamps and (2) adjunctive transient controlled reduction of blood pressure, if necessary.[46]

Gill et al recently reported a single-surgeon series of 800 laparoscopic partial nephrectomy cases encompassing a 9-year

period (1999-2008). The authors divided the entire cohort into three chronologic eras: Era I (1999-2003; n = 276), era II (2004-2006; n = 289) and era III (2007-2008; n = 235). In comparing eras I, II and III, tumors in the most recent era were larger (more commonly > 4 cm) and central, with peripheral masses < 4 cm less common ($p < 0.05$ for all). Despite this increasing tumor complexity, mean warm ischemia times were shorter in the most recent era: 32 minutes, 32 minutes and 14 minutes, respectively ($p < 0.0001$). Overall, postoperative and urologic complications were significantly lower in the most recent era. Finally, renal functional outcomes were superior in era III, as documented by a lesser percent decrease in estimated GFR (18%, 20% and 11% respectively).

Intermediate-term oncologic outcomes of laparoscopic partial nephrectomy are comparable with those achieved with open partial nephrectomy.[47] The rate of positive surgical margins after laparoscopic partial nephrectomy is similar to that observed with open partial nephrectomy.[48]

These contemporary data suggest that despite increasing tumor complexity, three key outcomes of contemporary laparoscopic partial nephrectomy (ischemia time, complications and renal function) have improved significantly. In experienced hands, laparoscopic partial nephrectomy now rivals open partial nephrectomy, albeit with vastly decreased patient morbidity. Laparoscopic partial nephrectomy delivers 5 and 7 years oncologic results similar to open partial nephrectomy.[49]

Absolute indications for laparoscopic partial nephrectomy include synchronous bilateral RCC, tumor in a solitary kidney or unilateral tumor with a poorly or nonfunctioning contralateral kidney, wherein radical nephrectomy would render the patient anephric.[50]

Relative indications exist where the contralateral kidney is at risk for future compromise: Hereditary RCC, genetic diseases with risk of metachronous kidney cancer, diabetes, hypertension, stone disease or renovascular disease. Elective indications for partial nephrectomy comprise renal tumors ≤ 4 cm or indeterminate cysts with malignant potential in the presence of a normal contralateral kidney.[50]

Increasing experience and advances in laparoscopic techniques have led to refinements in renal hilar control, tumor excision, pelvicaliceal repair and hemostatic reconstruction of the parenchymal defect.[51,52] With increasing experience, these indications have been extended to include tumors infiltrating well into the renal sinus, completely intrarenal tumors, hilar tumors, tumors in a solitary kidney, large tumors and tumors in the presence of renovascular disease.[53-57]

Current contraindications for LPN include a completely central intrarenal tumor, tumors with a caval thrombus and prior open kidney surgery. Morbid obesity and the presence of more than two tumors increase the technical difficulty of laparoscopic partial nephrectomy. Patients with a coagulopathy and platelet dysfunction must be approached with caution.[50]

In their first 200 laparoscopic partial nephrectomies, Ramani et al reported perioperative complications in 66 patients (33%).[58] Open conversion was required in two patients (1%). Reoperative laparotomy was necessary in four patients (2%). Overall, hemorrhagic complications occurred in 19 patients (9.5%). Urine leak occurred in nine patients (4.5%). Other urologic and nonurologic complications occurred in 4.5 and 15% respectively.

Presence of a solitary kidney, prolonged warm ischemia time, and increased intraoperative blood loss were found to be independent risk factors on multivariate analysis for the development of postoperative complications after laparoscopic partial nephrectomy.[59]

Robot-assisted partial nephrectomy allows magnified stereoscopic visualization and the use of articulated robotic instruments under precise control; reducing the technical challenges associated with tumor dissection and parenchymal reconstruction during laparoscopic partial nephrectomy. Although the first experiences of robot-assisted partial nephrectomy are encouraging, oncologic outcomes are still immature and larger series with longer follow-up are awaited to confirm the preliminary results.[60-62]

Renal biopsy; the impact of renal biopsy on treatment of small renal lesions is still controversial. Renal biopsy is only useful if the result will change the course of treatment. Because small, incidentally discovered renal lesions may be benign in a substantial percentage of patients, biopsy to confirm malignancy is important either prior to or at the time of utilization of minimally invasive ablation techniques.

In summary, the literature shows that biopsy of renal masses can provide an accurate differentiation between malignant and benign tissue in > 90% of cases. The rate of inconclusive biopsies ranges from 3 to 20%. Significant bleeding is unusual, and most biopsies are performed under CT guidance. Limitations of biopsy are hybrid tumors and cystic tumors where malignant tissue is hit by chance. Larger tumor size (< 4 cm) and a solid pattern are significant predictors of a diagnostic result for biopsies of renal tumors.[63] Tumor seeding after renal biopsy has a low incidence with overall estimated risk < 0.01%.[64] Accuracy and standardization of criteria for renal biopsy have to be further investigated, especially for nondiagnostic biopsies and the diagnosis of benign tumors.

Nearly 20 to 30% of all renal tumors that are subjected to NSS are actually benign on final histopathology. These patients could potentially avoid an operation and its associated morbidity if we had a consistent method to discriminate benign from malignant masses preoperatively. Optical coherence tomography (OCT) has been shown to provide an optical biopsy of tissues in various nonurologic fields. However, its potential application in the setting of laparoscopic partial nephrectomy is not currently clear.[50]

CONCLUSION

An increasing number of SRMs today are detected in asymptomatic patients by noninvasive abdominal imaging. Surgical removal is the standard of care for small renal tumors.

The choice of treatment for the patient with localized RCC needs to be individualized. Preservation of renal function without compromising the oncologic outcome should be the most important goal in the decision-making process.

Laparoscopic partial nephrectomy is technically challenging and requires advanced, time-sensitive laparoscopic skills. In experienced hands indications for LPN have expanded significantly and current emerging data indicate that in experienced hands, laparoscopic partial nephrectomy has shorter ischemia times, a lower complication rate, and equivalent long-term oncologic and renal functional outcomes, yet with decreased patient morbidity compared with open partial nephrectomy. Robotic partial nephrectomy is being explored at selected centers, and cryotherapy and radiofrequency ablation are options for carefully selected tumors. Active surveillance is an option for selected high-risk patients. Percutaneous needle biopsy is likely to gain increasing relevance in the management of small renal tumors.

REFERENCES

1. Chow WH SSD, Warren JL, Fraumeni JF Jr. Rising incidence of renal cell cancer in the United States. JAMA 1999;281: 1628- 31.
2. Nguyen MM ISG, Ellison LM. The evolving presentation of renal carcinoma in the United States: Trends from the surveillance, epidemiology, and end results program. J Urol J 2006;176: 2397-400.
3. Kummerlin IP FJtK, Wijkstra H, de la Rosette JJ, Laguna MP. Changes in the stage and surgical management of renal tumours during 1995–2005: An analysis of the Dutch national histopathology registry. BJU Int 2008;102:946-51.
4. Gill IS MA, Gervais DA, Jewett MA. Clinical practice. Small renal mass. N Engl J Med 2010;362:624-34.
5. Jemal A RS, Ward E, Murray T, Xu J, Thun MJ. Cancer statistics 2007. CA Cancer J Clin 2007;57:43-66.
6. Hein Van Poppel FBb, Cadeddu Jeffrey A, Gill Inderbir S, Janetschek Gunther, Jewett Michael AS, Laguna M Pilar, et al. Treatment of Localised Renal Cell Carcinoma. Eur Urol 2011.
7. Ljungberg B NCC, Hanbury DC, et al. EAU guidelines on renal cell carcinoma: The 2010 update. Eur Urol 2010;58:398-406.
8. Campbell SC ACN, Belldegrun A, et al. Guideline for management of the clinical T1 renal mass. J Urol 2009;182:1271-79.
9. Jewett MA AZ. Renal tumor natural history: The rationale and role for active surveillance. Urol Clin North Am 2008;35: 627- 34.
10. Aron M ISG. Minimally invasive nephron-sparing surgery (MINSS) for renal tumours. Part II: Probe ablative therapy. Eur Urol 2007;51:348-57.
11. Kunkle DA BLE, Uzzo RG. Excise, ablate or observe: The small renal mass dilemma—a meta-analysis and review. J Urol 2008;179:1227-34.
12. Weight CJ JHK, Hegarty NJ, et al. Correlation of radiographic imaging and histopathology following cryoablation and radio frequency ablation for renal tumors. J Urol 2008;179:1277-83.
13. Nguyen CT SCC, Novick AC. Choice of operation for clinically localized renal tumor. Urol Clin North Am 2008;35:645-55.
14. Lau WK MLB, Weaver AL, Torres VE, Zincke H. Matched comparison of radical nephrectomy *vs* nephron-sparing surgery in patients with unilateral renal cell carcinoma and a normal contralateral kidney. Mayo Clin Proc 2000;75:1236-42.
15. Lee CT JK, Shi W, Thaler HT, Reuter VE, Russo P. Surgical management of renal tumors 4 cm or less in a contemporary cohort. J Urol 2000;163:730-36.
16. Leibovich BC MLB, Cheville JC, Lohse CM, Weaver AL, Zincke H. Nephron sparing surgery for appropriately selected renal cell carcinoma between 4 and 7 cm results in outcome similar to radical nephrectomy. J Urol 2004;171:1066-70.
17. Dash A AJV, Schachter LR, Bach AM, Snyder ME, Russo P. Comparison of outcomes in elective partial vs radical nephrectomy for clear cell renal cell carcinoma of 4 to 7 cm. BJU Int 2006;97:939-45.
18. Hollingsworth JM DCM, Daignault S, Hollenbeck BK. Rising incidence of small renal masses: A need to reassess treatment effect. J Natl Cancer Inst 2006;98:1331-34.
19. Huang WC ASL, Serio AM, et al. Chronic kidney disease after nephrectomy in patients with renal cortical tumours: A retrospective cohort study. Lancet Oncol 2006;7:735-40.
20. Huang WC EBE, Levey AS, Jang TL, Russo P. Partial nephrectomy versus radical nephrectomy in patients with small renal tumors—is there a difference in mortality and cardiovascular outcomes? J Urol 2009;181:55-62.
21. Weight CJ BTL, Fergany AF, et al. Nephrectomy induced chronic renal insufficiency is associated with increased risk of cardiovascular death and death from any cause in patients with localized cT1b renal masses. J Urol 2010;183:1317-23.
22. Miller DC MS, Litwin MS, Lai J, Saigal CS. Renal and cardiovascular morbidity after partial or radical nephrectomy. Cancer 2008;112:511-20.
23. Lesage K SJ, Fransis K, Van Poppel H. Comparison between open partial and radical nephrectomy for renal tumours: Perioperative outcome and health-related quality of life. Eur Urol 2007;51:614-20.
24. Van Poppel SJ H. How important are surgical margins in nephron-sparing surgery. Eur Urol Suppl 2007;6:533-39.
25. Patard JJ OS, Lam JS, et al. Safety and efficacy of partial nephrectomy for all T1 tumors based on an international multicenter experience. J Urol 2004;171:2181-85.
26. Russo P. Open partial nephrectomy: An essential operation with an expanding role. Curr Opin Urol 2007;17:309-15.
27. Russo P WH. The medical and oncological rationale for partial nephrectomy for the treatment of T1 renal cortical tumors. Urol Clin North Am 2008;35:635-43.
28. Joniau S KVE, Srirangam SJ, Van Poppel H. Outcome of nephron-sparing surgery for T1b renal cell carcinoma. BJU Int 2009;103:1344-48.
29. Patard JJ AJP, Crepel M, et al. Morbidity and clinical outcome of nephron-sparing surgery in relation to tumour size and indication. Eur Urol 2007;52:148-54.
30. Becker F SS, Hack M, Humke U, Ziegler M, Stöckle M. Excellent long-term cancer control with elective nephron-sparing surgery for selected renal cell carcinomas measuring more than 4 cm. Eur Urol 2006;49:1058-64.
31. Antonelli A AC, Nicolai M, et al. Nephron-sparing surgery versus radical nephrectomy in the treatment of intracapsular renal cell carcinoma up to 7 cm. Eur Urol 2008;53:803-09.
32. Peycelon M VH, Comperat E, et al. Long-term outcomes after nephron sparing surgery for renal cell carcinoma larger than 4 cm. J Urol 2009;181:35-41.
33. Thompson RH SS, Lohse CM, Leibovich BC, Russo P, Blute ML. Partial versus radical nephrectomy for 4 to 7 cm renal cortical tumors. J Urol 2009;182:2601-06.
34. Karellas ME MFOB, Jang TL, Bernstein M, Russo P. Partial nephrectomy for selected renal cortical tumours of >/ = 7 cm. BJU Int 2010;106:1484-87.

35. Winfield HN JFD, Godet AS, Clayman RV. Laparoscopic partial nephrectomy: Initial case report for benign disease. J Endourol 1993;7:521-26.
36. Gill IS MGD, Munch LC. Laparoscopic retroperitoneal partial nephrectomy. J Urol 1994;152:1539-42.
37. Lane BR ISG. 5-year outcomes of laparoscopic partial nephrectomy. J Urol 2007;177:70-74.
38. Colombo JR GPH, Aron M, et al. Oncological outcomes of laparoscopic radical nephrectomy for renal cancer. Clinics 2007;62.
39. Aron M GPH, Gill IS. Laparoscopic partial nephrectomy. BJU Int 2007;99:1258-63.
40. Ng CS ISG, Ramani AP, et al. Transperitoneal versus retroperitoneal laparoscopic partial nephrectomy: Patient selection and perioperative outcomes. J Urol 2005;174:846-49.
41. Gill IS LRK, Lane BR, et al. Comparison of 1,800 laparoscopic and open partial nephrectomies for single renal tumors. J Urol 2007;178:41-46.
42. Simmons MN BIC, Gill IS. Perioperative efficacy of laparoscopic partial nephrectomy for tumors larger than 4 cm. Eur Urol 2009;55:199-208.
43. Nguyen MM ISG. Halving ischemia time during laparoscopic partial nephrectomy. J Urol 2008;179.
44. Baumert H AB, Shah N, et al. Reducing warm ischaemia time during laparoscopic partial nephrectomy: A prospective comparison of two renal closure techniques. Eur Urol 2007;52: 1164-69.
45. Bollens R AR, Espinoza BP, et al. Laparoscopic partial nephrectomy with "on-demand" clamping reduces warm ischemia time. Eur Urol 2007;52:804-10.
46. Gill IS MSE, Aron M, et al. "Zero ischemia" partial nephrectomy: Novel laparoscopic and robotic technique. Eur Urol 2011;59: 128-34.
47. Lane BR ISG. 7-year oncological outcomes after laparoscopic and open partial nephrectomy. J Urol 2010;183:473-79.
48. Breda A SVS, Liao J, et al. Positive margins in laparoscopic partial nephrectomy in 855 cases: A multi-institutional survey from the United States and Europe. J Urol 2007;178:47-50.
49. Permpongkosol HSB, Romero FR, et al. Laparoscopic versus open partial nephrectomy for the treatment of pathological T1N0M0 renal cell carcinoma: A 5-year survival rate. J Urol 2006;176:1984-88.
50. Monish Aron G-PH, Gill Inderbir S. Laparoscopic partial nephrectomy: Ready for prime time. Eur Urol 2006;5:968-74.
51. Gill IS MMD, Kaouk JH, et al. Laparoscopic partial nephrectomy for renal tumor: Duplicating open surgical techniques. J Urol 2002;167:469-76.
52. Desai MM ISG, Kaouk JH, Matin SF, Novick AC. Laparoscopic partial nephrectomy with suture repair of the pelvicaliceal system. Urology 2003;61:99-104.
53. Frank I JRCJ, Rubinstein M, Desai M, Kaouk J, Gill IS. Laparoscopic partial nephrectomy for centrally located renal tumors. J Urol 2006;175:849-52.
54. Gill IS JRCJ, Frank I, Moinzadeh A, Kaouk J, Desai M. Laparoscopic partial nephrectomy for hilar tumors. J Urol 2005;174:850-53.
55. Finelli A ISG, Desai MM, et al. Laparoscopic heminephrectomy for tumor. Urology 2005;65:473-78.
56. Gill IS JRCJ, Moinzadeh A, et al. Laparoscopic partial nephrectomy in solitary kidney. J Urol 2006;175:454-58.
57. Steinberg AP SCA, et al. Laparoscopic nephron-sparing surgery in the presence of renal artery disease. Urology 2003;62:935-39.
58. Ramani AP MMD, Steinberg AP, et al. Complications of laparoscopic partial nephrectomy in 200 cases. J Urol 2005;173: 42-47.
59. Turna B RF, Kamoi K, et al. Risk factor analysis of postoperative complications in laparoscopic partial nephrectomy. J Urol 2008;179:1289-95.
60. Haber GP WMW, Crouzet S, et al. Robotic versus laparoscopic partial nephrectomy: Single-surgeon matched cohort study of 150 patients. Urology 2010;76:754-58.
61. Benway BM SBB, Rogers CG, et al. Robot-assisted partial nephrectomy versus laparoscopic partial nephrectomy for renal tumors: A multi-institutional analysis of perioperative outcomes J Urol 2009;182.
62. Mottrie A GDN, Schatteman P, Carpentier P, Sangalli M, Ficarra V. Impact of the learning curve on perioperative outcomes in patients who underwent robotic partial nephrectomy for parenchymal renal tumours. Eur Urol 2010;58:127-33.
63. Volpe A KM, Finelli A, et al. Contemporary results of percutaneous biopsy of 100 small renal masses: A single center experience. J Urol 2008;180:2333-37.
64. Herts BR MEB. The current role of percutaneous biopsy in the evaluation of renal masses. Semin Urol Oncol 1995;13:254-61.

10.5005/jp-journals-10007-1139
REVIEW ARTICLE

The Role of Laparoscopy in the Management of Mirizzi's Syndrome: A Review of Literature

William Wachira Kibe
Senior Registrar, Department of General Surgery, Outspan Hospital, Nyeri, Kenya

ABSTRACT

Minimal access surgery is increasingly becoming the preferred approach to general surgical treatment. Operative experience in the last two decades has established its efficacy and indeed safety in many trials at different centers all over the world.

Laparoscopic cholecystectomy (LC) has therefore become the gold standard of care for patients requiring removal of the gallbladder over this period. In 1992, a National Institute of Health (NIH) consensus development conference concluded that 'laparoscopic cholecystectomy provides a safe and effective treatment for most patients with symptomatic gallstones, laparoscopic cholecystectomy appears to have become the procedure of choice for many of these patients'.

The objective of this study was to review the literature on the use of laparoscopy in the management of Mirizzi's syndrome so as determine its role if any in current and future practice.

Keywords: Laparoscopic management of Mirizzi's syndrome, Cholelithiasis, Choledocholithiasis.

INTRODUCTION

Mirizzi's syndrome is a rare cause of acquired jaundice. It is caused by chronic gallbladder inflammation and large biliary stones resulting in compression of the common hepatic duct. It occurs in approximately 0.1% of patients with gallstone disease and 0.7 to 1.4% of patients undergoing cholecystectomy and it affects male and female equally, but tends to affect older people more often.[1-3] There is no evidence of race having any bearing on the epidemiology. The pathogenesis of this syndrome relates to multiple and large gallstones which can reside chronically in the Hartmann's pouch of the gallbladder, causing undue inflammation, necrosis, scarring and ultimately fistulation into the adjacent common hepatic duct (CHD). As a result, the CHD becomes obstructed by either scar or stone, resulting in obstructive jaundice. MS is therefore attributed to extrinsic compression of the common hepatic duct by gallstones impacted in the cystic duct or the gallbladder neck. Bile duct wall necrosis and subsequent cholecystobiliary fistula caused by chronic inflammation is a rare sequence of the disease.[8]

It can be divided into four types (Fig. 1). There are as follows:

1. Type I: No fistula present
   - Type IA—presence of the cystic duct
   - Type IB—obliteration of the cystic duct
2. Types II-IV: Fistula present
   - Type II—defect smaller than 33% of the CBD diameter
   - Type III—defect 33 to 66% of the CBD diameter
   - Type IV—defect larger than 66% of the CBD diameter.

Mirizzi's syndrome has no consistent or unique clinical features that distinguish it from other more common forms of obstructive jaundice. Symptoms of recurrent cholangitis, jaundice, right upper quadrant pain, generalized body itch, elevated serum bilirubin and serum alkaline phosphatase may or may not be present. Acute presentations of the syndrome may include features of pancreatitis and cholecystitis.

Mirizzi's syndrome is therefore a form of obstructive jaundice caused by a stone impacted in the gallbladder neck or the cystic duct that impinges on the common hepatic duct with or without a cholecystocholedochal fistula. This syndrome is a rare complication of cholelithiasis that accounts for 0.1% of all patients with gallstone disease.[2] Preoperative recognition is necessary to prevent injury to the common duct during surgery.

OBJECTIVES

The objectives of this study were to review the medical literature available on the efficacy and safety of laparoscopic surgery in the management of Mirizzi's syndrome.

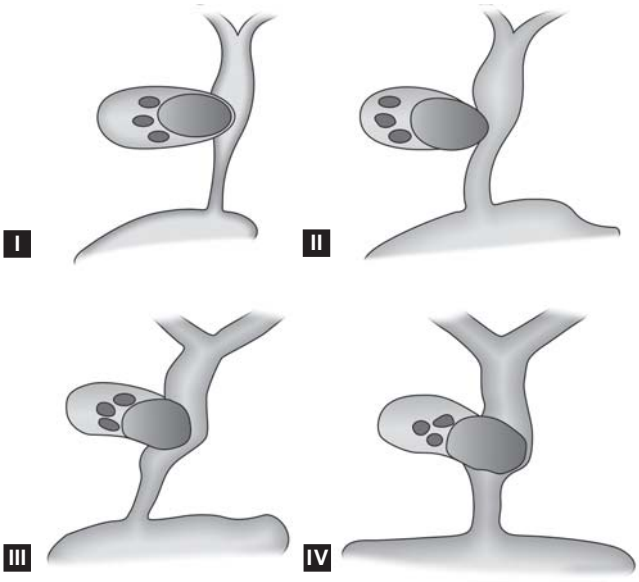


Fig. 1: Schematic representation of Csendes classification for Mirizzi's syndrome[4]

METHODS

Review of literature using the SpringerLink, Google and PubMed searches was performed and in total 148 citations were elicited. Selected papers were screened for further references. Other than papers in English, no other criteria for selection of literature was used due to the small number of articles on the syndrome.

FINDINGS/RESULTS

The difficult surgical management of MS is due to the presence of an intense fibrotic process and/or communication between the gallbladder and the common hepatic duct. Since laparoscopic cholecystectomy became a routine procedure in the early 1990s, only a few studies have been published describing their experience with the laparoscopic technique for the treatment of MS.[9]

M Schafer et al sampled 13,033 patients undergoing LC between 1995 and 1999 and only 39 (0.3%) had MS. A total of 74% had type I MS (24/39) and five had type II MS (5/39). They concluded that MS is rarely encountered and it must be recognized intraoperatively. They noted that it sometimes coexists with carcinoma of the gallbladder (4/39) 11% and overall conversion rates were 74% (24/34) for type I and 100% (5/5) for type II.

Sushil K et al concluded that if not recognized preoperatively, MS can result in significant morbidity and mortality. Preoperative diagnosis may be difficult despite the availability of multiple imaging modalities. Ultrasonography (US), CT, and magnetic resonance cholangiopancreatography (MRCP) are common initial tests for suspected Mirizzi's syndrome (Fig. 2). Typical findings on US suggestive of Mirizzi's syndrome are a shrunken gallbladder, impacted stone(s) in the cystic duct, a dilated intrahepatic tree, and common hepatic duct with a normal-sized common bile duct.[5] The main role of CT is to differentiate Mirizzi's syndrome from a malignancy in the area of porta hepatis or in the liver (Fig. 3). MRI and MRCP are increasingly playing an important role and have the additional advantage of showing the extent of inflammation around the gallbladder that can help in the differentiation of Mirizzi's syndrome from other gallbladder pathologies such as gallbladder malignancy.[7]

In a retrospective analysis of 4800 cholecystectomies, Thegeela et al found Mirizzi's syndrome in 133 (2.8%). Seven (5.3%) patients with Mirizzi's syndrome had associated gallbladder carcinoma (GBC), as compared to only 1% in patients with gallstone disease (GSD). GBC was detected on final histology after cholecystectomy in five patients, and was detected preoperatively and intraoperatively in one patient each. Patients with Mirizzi's syndrome with associated GBC were older (60 *vs* 50 years) and had a longer duration of symptoms as compared to those with Mirizzi's syndrome alone. However, presenting clinical features were not different in these two groups of patients.

They concluded that there was a higher incidence of GBC in patients with Mirizzi's syndrome than in patients with uncomplicated GSD. There were no clinical features to differentiate these patients with GBC from those with Mirizzi's syndrome alone, except that they were a decade older and had a longer duration of symptoms. In the majority, the diagnosis of GBC was made on final histology, after cholecystectomy; hence, this group of patients with GBC are to be treated like any other patients with incidental GBC.

Endoscopic retrograde cholangiopancreatography (ERCP) is the gold standard in the diagnosis of Mirizzi's syndrome. It delineates the cause, level, and extent of biliary obstruction, as well as ductal abnormalities, including fistulation. ERCP also offers a variety of therapeutic options, such as stone extraction and biliary stent placement.

Percutaneous cholangiogram can provide information similar to ERCP; however, ERCP has an additional advantage of identifying a low-lying cystic duct that may be missed on percutaneous cholangiography. Wire-guided intraductal US can provide high-resolution images of the biliary tract and adjacent structures. The diagnosis is difficult and it is more accented in third world countries where access to diagnostic techniques is limited or nonexistent. A preoperative diagnosis is therefore made in 8 to 62.5% of all patients.[6]

Treatment is primarily surgical. Laparoscopic surgery is the standard for MS type I and II and open surgery for managing patients with types III and IV. Good short-and long-term results with low mortality and morbidity have been reported in a number of studies with overall complication rates of about 18% with open surgical management.

Laparoscopic management is contraindicated in many patients because of the increased risk of morbidity and mortality associated with this approach. Endoscopic treatment may serve as an alternative in patients who are poor surgical candidates, such as elderly patients or those with multiple existing

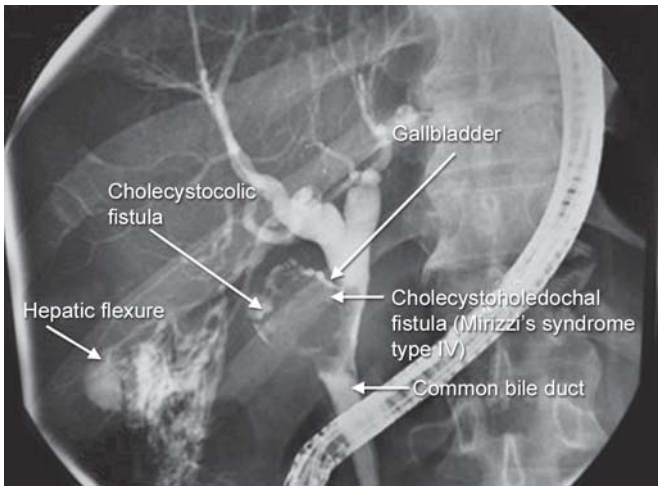


Fig. 2: MRI—T1 and T2-weighed images with iv contrast gadolinium-Bopta, revealing fistulous tract between the right colonic flexure and gallbladder (cholecystocolic fistula) and a large gallstone (2 cm)

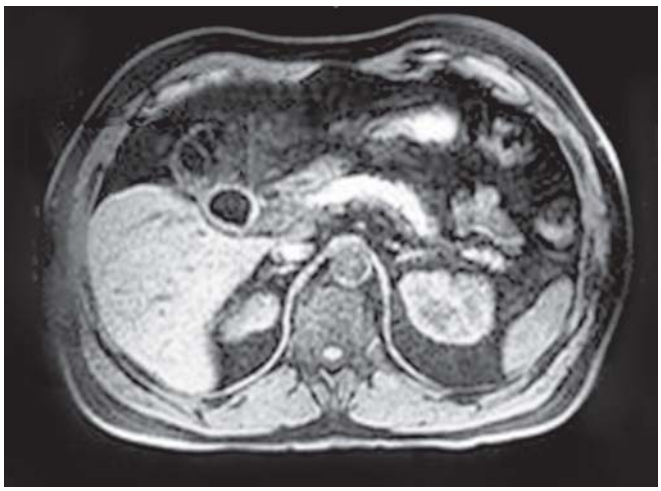


Fig. 3: Spiral CT with evidence of pneumobilia and suspicion of cholecystocolic fistula

comorbidities. Endoscopic treatment also can serve as a temporizing measure to provide biliary drainage in preparation for an elective surgery.

Mirizzi's syndrome is a rare condition, but surgeons must be aware of it. Surgical approach to MS in the 'laparoscopic era' may be complicated by the presence of a cholecystobiliary fistula and in these cases dissection of the Calot's triangle may be difficult or impossible. When an attempt to expose Calot's triangle may lead to severe bile duct injury, such as:

i. Iatrogenic communication between the gallbladder and CBD
ii. Complete transection of CBD after dissection of the gallbladder neck
iii. Tear of CBD.

CONCLUSION

From the literature reviewed, it appears that the outcome of laparoscopic treatment of MS is not inferior to that of open surgery, but it carries a significant conversion rate.[8] If MS types III and IV are suspected, then the 'open' approach is preferable, also for the reconstruction of biliary tree.

Removal of the gallbladder with commencement of dissection at the fundus is well recognized as a safe technique during difficult 'open' cholecystectomy because it minimizes the risks of damage to the structures in or around Calot's triangle[9] and has been recommended by many authors for laparoscopic cholecystectomy for MS types I and II.

The literature reviewed revealed that the papers were all case reports or case series and therefore a randomized controlled study comparing the open with the laparoscopic approach is currently lacking in the surgical literature.[8]

ACKNOWLEDGMENT

I would like to acknowledge the assistance and encouragement I received from Professor RK Mishra who supervised this work. This review and indeed the whole training would not have been possible without him and the magnificent team at World Laparoscopy Hospital.

REFERENCES

1. Soper NJ, Stockmann PT, Dunnegan DL, Ashley SW. Laparoscopic cholecystectomy. The new 'gold standard'? Arch Surg Aug 1992;127(8):917-21; discussion 921-23.
2. Hazzan D, Golijanin D, Reissman P, Adler SN, Shiloni E. Combined endoscopic and surgical management of Mirizzi syndrome. Surgical Endoscopy 1999;13(6):618-20.
3. Ross Jeffrey W, Sudakoff Gary S, Snyder Gregory B, Neela Lamki, Coombs Bernard D, Dachman Abraham H, et al. Mirizzi syndrome. eMedicine. WebMD.
4. Waisberg J, Corona A, de Abreu IW, Farah JF, Lupinacci RA, Goffi FS. Benign obstruction of the common hepatic duct (Mirizzi syndrome): Diagnosis and operative management. Arq Gastroenterology 2005;42:13-18.
5. Ahlawat Sushil K, Singhania Rohit, Firas H. Al-kawas current treatment options in gastroenterology, 2007;10(2):102-10.
6. Caesar A. Mirizzi's syndrome: Diagnosis, treatment and a plea for a simplified classification. Solis-Caxaj World J Surgery 2009;33:1783-84.
7. Harmeet Kaur, Evelyne M Loyer, Chusilp Charnsangavej. Venous embolization of the liver. 2011;2:61-72.
8. Stavros A Antoniou, George A Antoniou, Charalambos Makridis. Laparoscopic treatment of Mirizzi syndrome: A systematic review. Surg Endosc 2010;24:33-39.
9. Martin IG, Dexter SP, Marton J, Gibson J, Asker J, Firullo A, et al. Fundus-first laparoscopic cholecystectomy. Journal of Surgical Endoscopy Feb 1995;9(2):203-06.