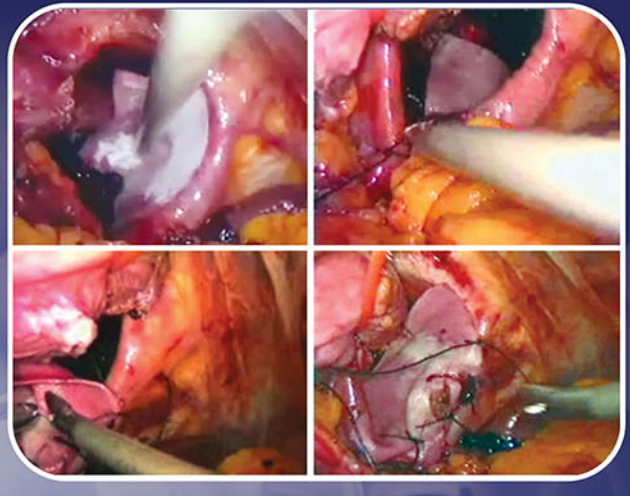
Mastering the Techniques of

LAPAROSCOPIC SUTURING & KNOTTING

RK Mishra



Complimentary Online 26 Videos (Duration approx. 10 hrs)

Foreword
Ray L Green

2nd Edition

JAYPEE

Contents

3A

CHAPTER

Meltzer's knot

INTRODUCTION

Today, endoscopic surgery is rapidly becoming a popular alternative to traditional procedures for a variety of diseases. Most of the endoscopic procedures may require the utilization of laparoscopic suturing at one point or the other. Laparoscopic suturing aids the surgeon in approximating tissues and control of hemostasis. Endoscopic suturing is technically challenging and is a major source of discouragement for many aspiring endoscopic surgeons and even the young endoscopic surgeons. However, it is a popular saying in endoscopic surgery that there is no future without suture. The ability to suture laparoscopically opens the door to perform more complex surgical procedures. The implication is that many operations that have traditionally been performed at laparotomy may now be accomplished laparoscopically.

In the works of Champion et al. and Nduka CC et al., the importance of laparoscopic suturing and the need for the aspiring endoscopic surgeons to appropriately learn the art could not have been more succinctly discussed.

Meltzer's knot is a type of extracorporeal knot which was first described by Meltzer, a prominent endoscopic surgeon in 1991 Tubingen, Germany. It is basically a modification of Roeder's knot; hence, many authorities also refer to Meltzer's knot as a modified Roeder's knot. Meltzer's knot is much stronger than the original Roeder's knot. Meltzer recommended use of polydioxanone suture (PDS) for tying the Meltzer's knot because of the ease with which the knot can be slipped into the body cavity because holding and tensile characteristics of the extracorporeal slip knots depend on the type of ligature material used and the type of knot applied.

In terms of its application and usefulness in extracorporeal suturing, Meltzer's knot has superseded Roeder's knot because it is much stronger than the original Roeder's knot. Meltzer's knot basically has three components:

1. Two hitches
2. Three winds
3. Two half locking hitches. It can be also described as:
   a. Double initial half knot
   b. Three and a half round turns over the limbs of the loop
   c. Double second half knot
   d. Careful stacking of turns between the knots
   e. Sliding in position by push rod

This can readily be remembered by the mnemonic 2:3:2 (compared with 1:3:1 of Roeder's knot). Various techniques and steps of making the Meltzer's knot (and other modifications) and other extracorporeal knots have been described at various points in time. However, the choice will depend on the skill of the surgeon and the clinical situation at hand.

APPLICATION OF MELTZER'S KNOT

Presently, Meltzer's knot is used by many surgeons to tie free structures, especially within the abdominal cavity. For example, Meltzer's knot is quite popular for ligating the base of the vermiform appendix after the mesoappendix has been excised. Meltzer's knot is also very useful in tying the medial end of the cystic duct during cholecystectomy and to fix the cystic duct drainage cannula after transcystic clearance of ductal stones. The Meltzer's knot is also useful in tying vascular pedicles as it can be pushed down unto a pedicle, for example, for suturing uterine artery pedicle and large infundibulopelvic ligament. It can also be used with great advantage for reconstructing the uterus after myomectomy and for colposuspension. In general, extracorporeal knots are preferred during ligature in continuity of large vessels, suturing in areas of limited access where the working space is restricted and in the approximation of edges of defects, where the force required to approximate the edges is substantial.

ADVANTAGES OF MELTZER'S KNOT

- Meltzer's knot gives a much secured knot and thus reduces the chances of risks of slipped ligature compared to Roeder's knot.
- In good hands, it reduces the overall operation time because it obviates the need for complex maneuvers of intracorporeal knots and yet it offers a very stable knot.
- Meltzer's knot can be used with confidence even with slippery material such PDS; because of more hitches, it is more secure.

DISADVANTAGES OF MELTZER'S KNOT

- Meltzer's knot has more hitches and half knots and overload large amount of suture that is pushed through the needle tract.
- Suture can get fractured by some knot pushers.
- It may cause low-volume air leak as the suture passes through the trocar.

- The knot pusher may become dislodged from the suture during transit into the abdominal cavity.
- There has to be a wide range of sutures as some sutures do not slide well.
- It requires close cooperation between the surgeon and assistance and this may lead to a tedious and more time-consuming surgery.
- It is difficult to loosen if the surgeon wants to modify the tension on a ligated tissue.

STEPS OF MELTZER'S KNOT

Method of Making Extracorporeal Meltzer's Pretied Loop for Free Structure Like Appendix

Figures 1 to 10 deal with the abovementioned method as follows.

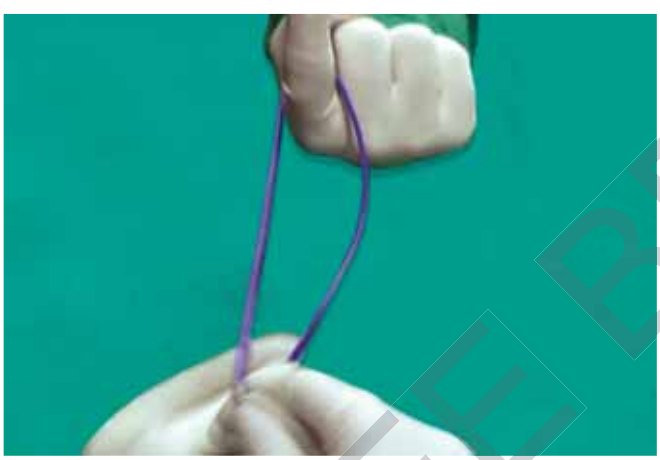


Fig. 1: The shorter limb on the right hand over the longer limb on the left hand of the surgeon.

Method of Making Extracorporeal Meltzer's Knot for Continuous Structure

Intra-abdominal Component of Extracorporeal Meltzer's Knot

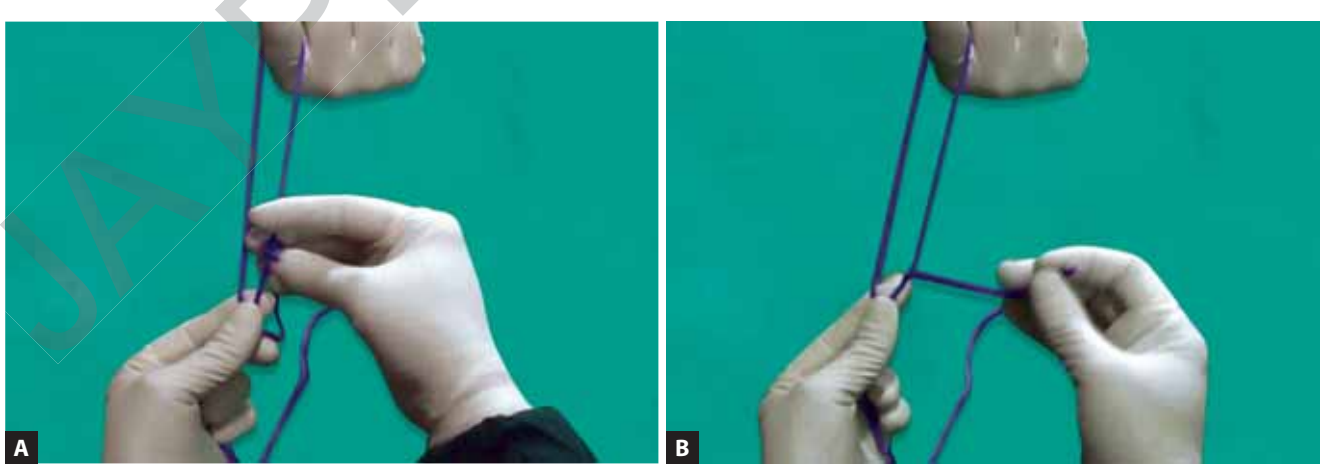
See **Figures 11 to 18**.

CLINICAL APPLICATION

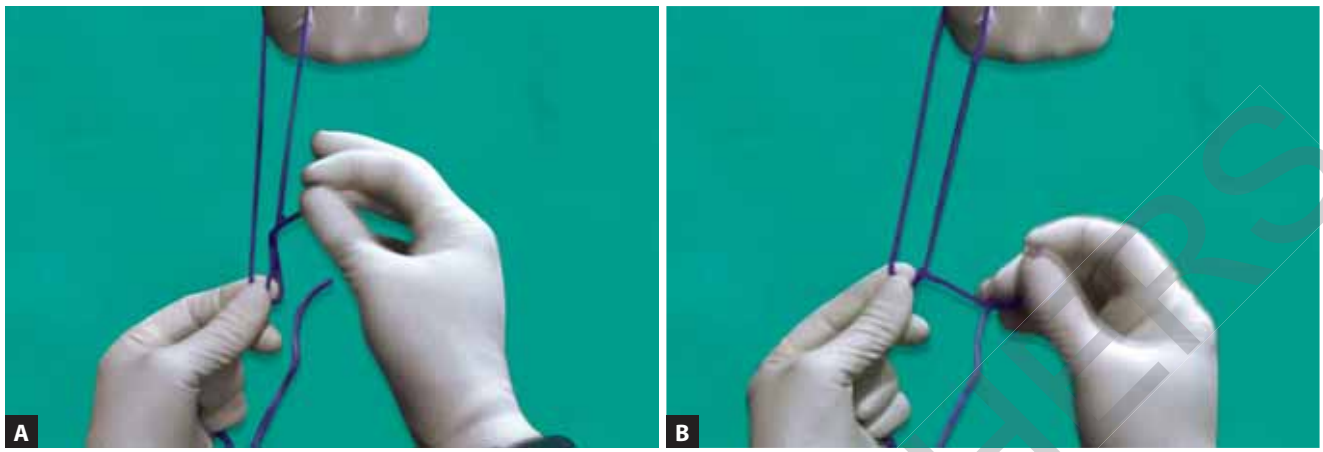
Appendicectomy by Meltzer's knot are described through **Figures 19 and 20**.

TASK ANALYSIS OF EXTRACORPOREAL KNOT FOR CONTINUOUS STRUCTURE

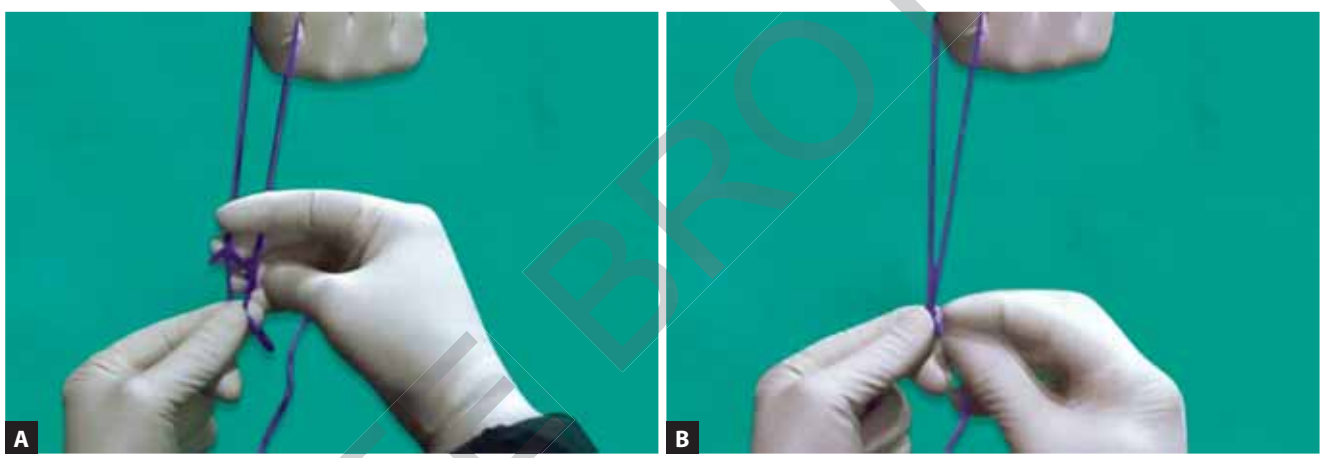
- The length of suture for extracorporeal knot in continuous structures is 90 cm.
- Before commencing the extracorporeal knot for continuous structures, create a surgical window by dissecting the tissue plane at the desired ligation site.
- Secure one end of the 90 cm suture with the Maryland instrument. Feed and conceal one third of the Maryland and suture within the 5 mm reducer. Then, introduce both the Maryland and suture simultaneously through a 10 mm port.
- Introduce an atraumatic grasper through another 5 mm port.
- Guide the suture through the surgical window and have it grasped by the atraumatic grasper.
- The camera operator plays a pivotal role here. Ensure the light cable is directed to the right and illuminates the target area, showcasing the tip of the Maryland instrument to the surgeon.



Figs. 2A and B: The first hitch is being taken on long-standing thread by passing the tail end between the two limbs from below upward.

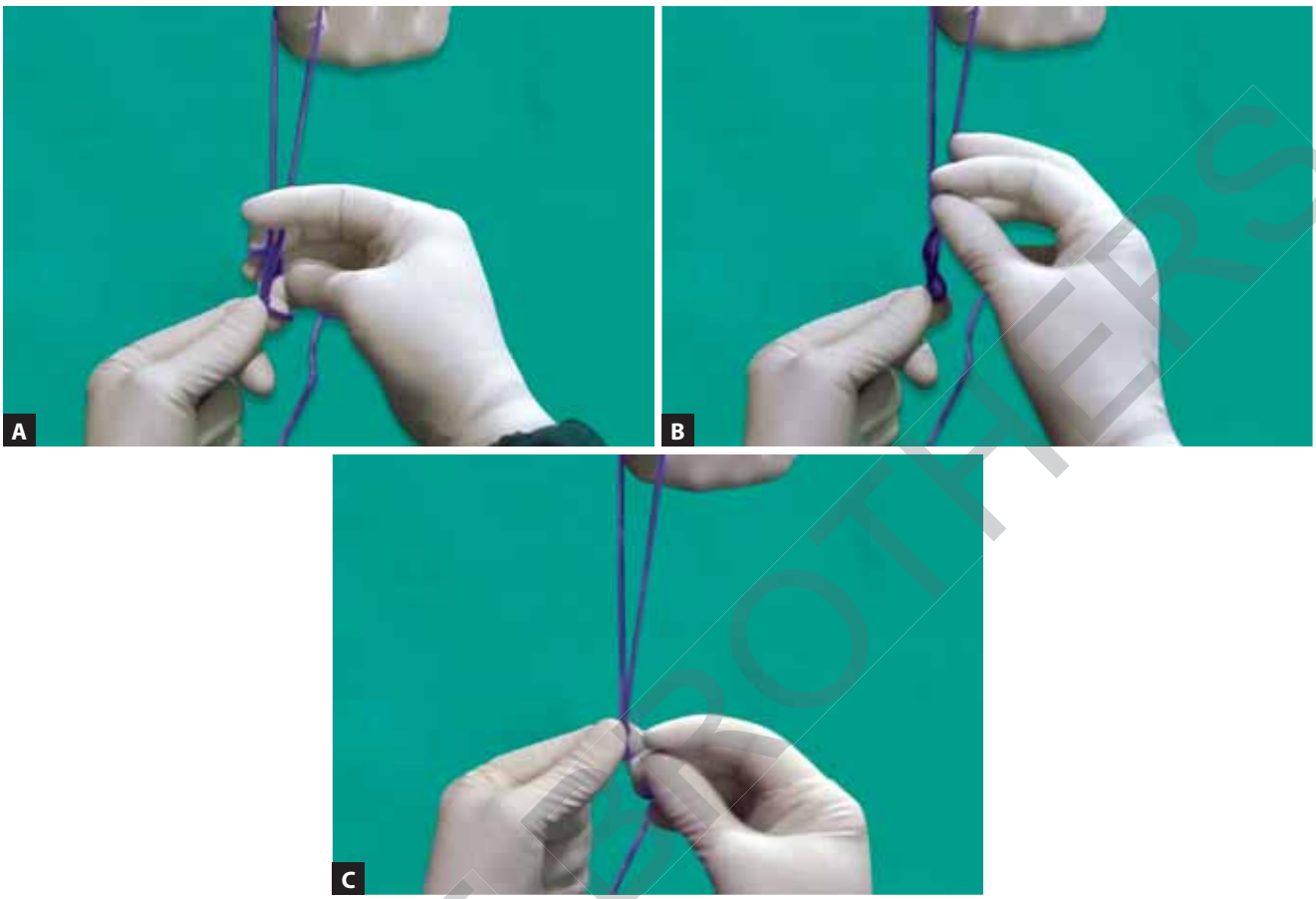


Figs. 3A and B: The second hitch being taken by passing the tail under the right limb and pulling the tail to the right.

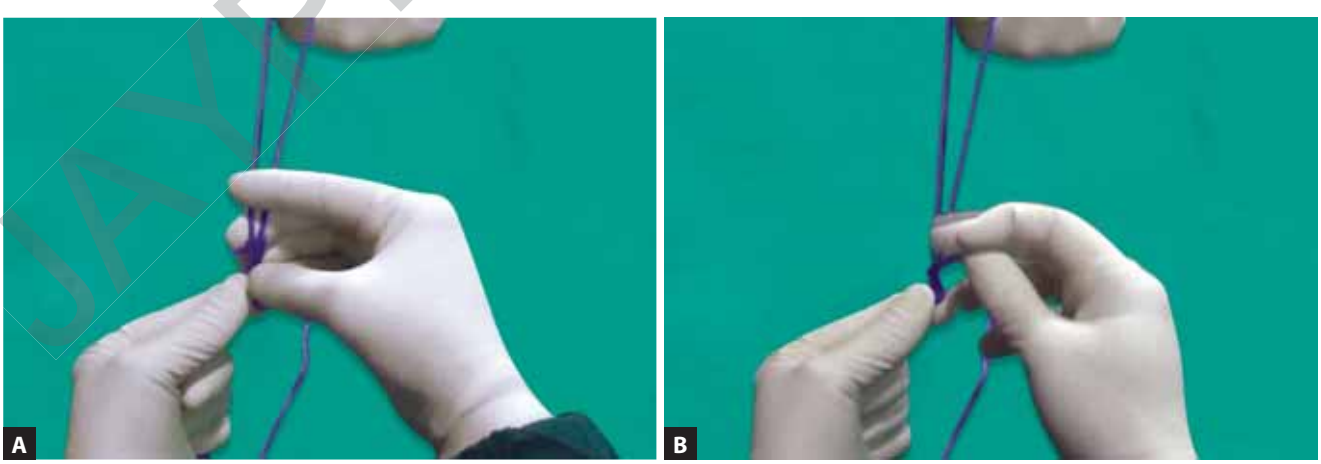


Figs. 4A and B: The first wrap is being taken by passing the tail end beneath both the limbs and the first wrap is being accomplished by turning around both limbs and completed by pulling the tail snug fit.

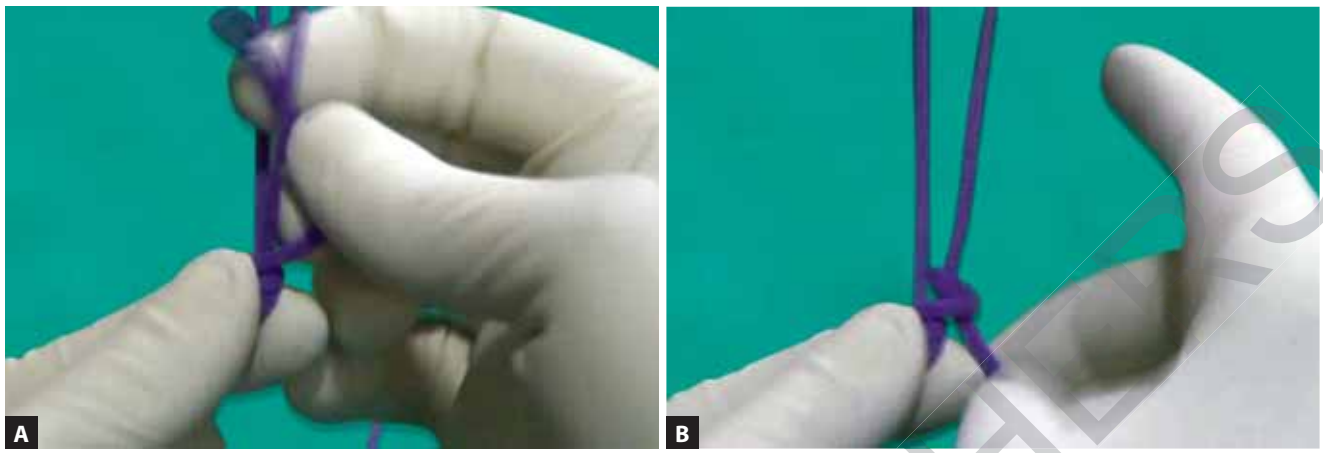
- Transfer the suture from the grasper back to the Maryland instrument.
- Feed the suture inside the abdominal cavity at least four times using the atraumatic grasper, bringing in a total of 20 cm of suture length inside the abdomen.
- Throughout the suture-feeding process, the camera operator should focus the telescope on the tip of the cannula.
- With each feeding, pull a minimum of 5 cm of suture inside.
- Once the suture feeding is complete, reposition the grasper between the suture loop and tissue.
- Use the Maryland instrument to guide the suture out, keeping the grasper in place between the loop and the tissue.
- While extracting the suture, ensure that the grasper remains steady between the suture to prevent tissue damage due to shearing.
- After the tail end of the suture is outside the reducer, instruct the assistant to place their finger on the washer of the reducer, between the two suture ends, to prevent gas leakage.
- Proceed to tie the extracorporeal knot and the assistant's finger should continue to cover the reducer to prevent gas leakage.
- You have the option to use any of the extracorporeal slip knots (Roader's, Meltzer's, or Mishra's knot) based on the diameter of the structure and the quality of your suture material.



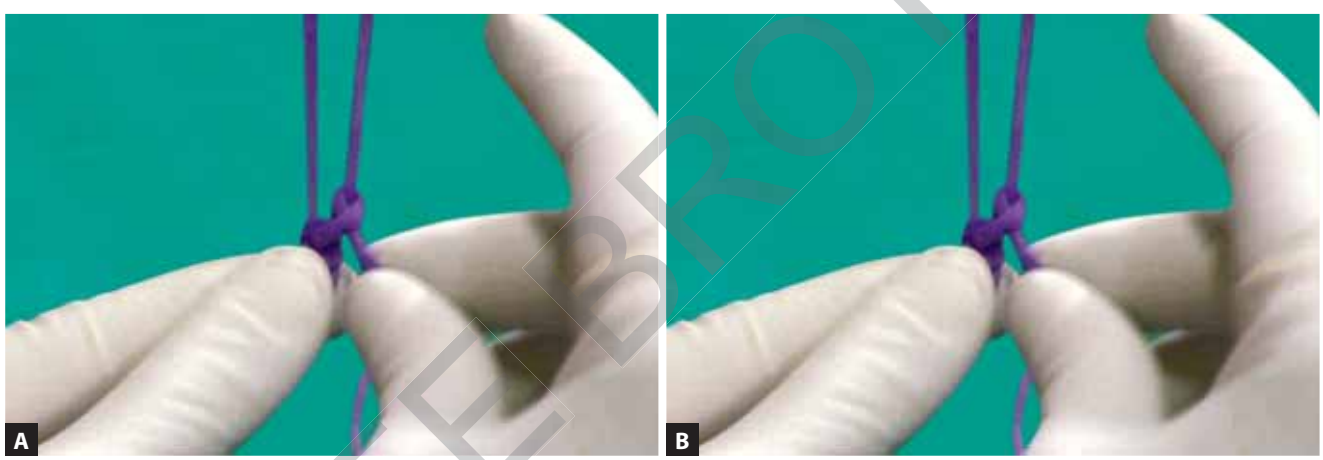
Figs. 5A to C: The second wrap is begun by passing the tail end beneath both limbs, turning around both limbs and then completed by pulling the tail end.



Figs. 6A and B: The third wrap begun by passing the tail end beneath both limbs, turning the tail end around both limbs and then completed by pulling the tail end.



Figs. 7A and B: The first locking half knot is begun by passing the tail beneath the right limb and then passing the tail in a loop formed by the tail against the long limb and it is the then completed by pulling the tail to snugly fit the knot.

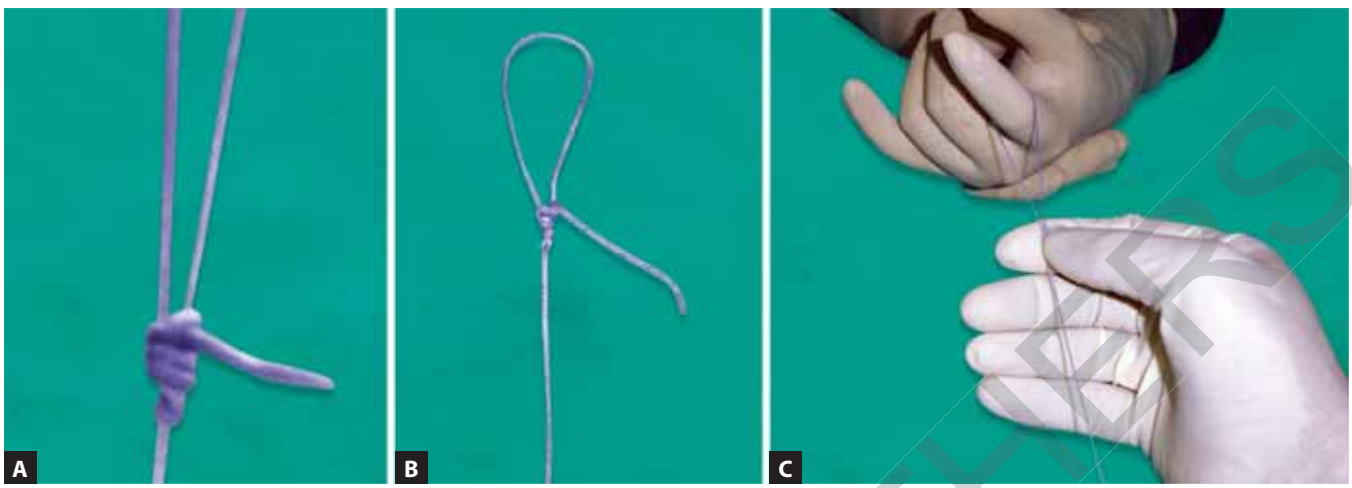


Figs. 8A and B: The second locking half knot is begun by passing the tail beneath the long limb and then passing the tail through the loop formed by the tail against the long limb and then finally completed by pulling the tail to snuggly fit the knot.

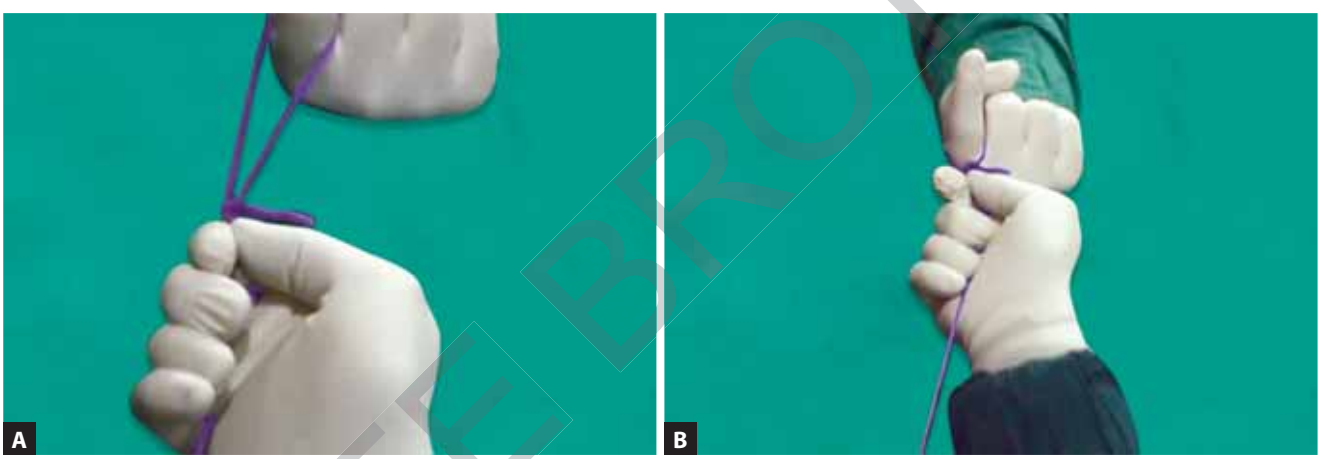
- Feed the suture from the head end of the Bhandarkar knot pusher and pull it out from the tail end of the knot pusher.
- Reverse feed the knot pusher into the 3 mm reducer.
- Introduce the knot pusher and reducer into the 5 mm reducer, having the assistant remove their finger from the reducer. Push the knot pusher into the abdomen under visual guidance.
- Push the knot pusher while pulling the suture to shorten the loop.
- Position the tip of the knot pusher where you intend to tie the knot.
- The knot will naturally slide to the desired location where you want to tie it, aligning with the tip of the knot pusher.
- The pushing of the knot pusher and pulling of the suture should be done delicately to ensure the structure remains unaware of the ligation process.
- After tightening the knot three times consecutively, retract the knot pusher and 3 mm reducer. Introduce hook scissors from the same port and cut the suture, leaving a 1 cm tail.
- Extracorporeal knots are robust, and one knot is adequate for securing continuous structures such as the cystic duct, cystic artery, renal artery, and splenic artery.

DISCUSSION

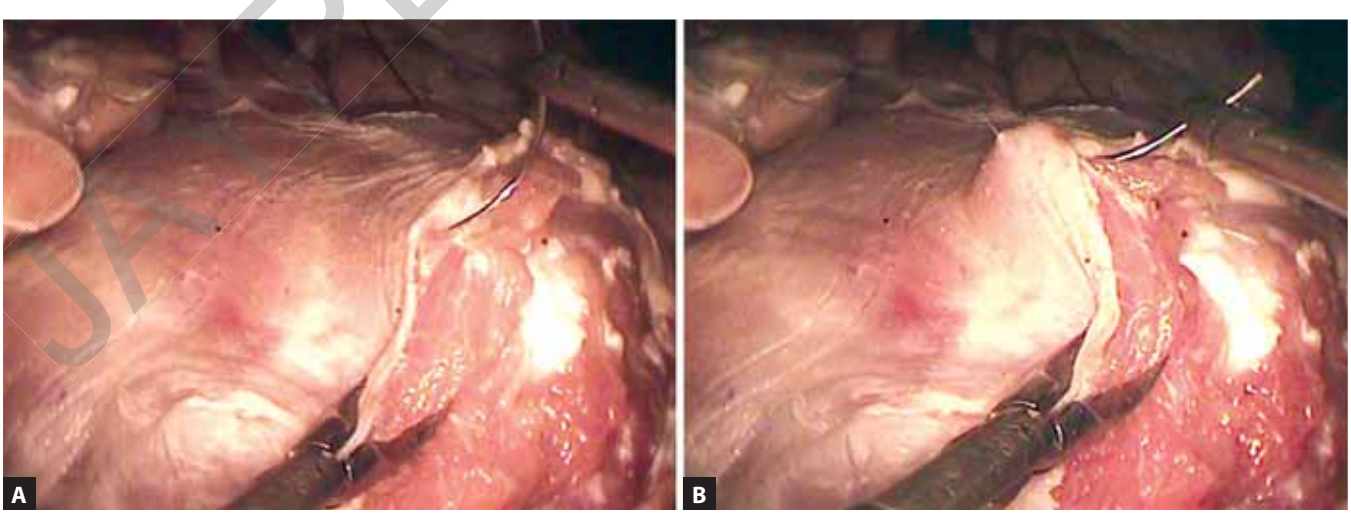
The significance of extracorporeal knots, particularly Meltzer's knot, cannot be overstated. Many complications



Figs. 9A to C: Pretied loop of Meltzer's knot.



Figs. 10A and B: The completed Meltzer's knot is being slipped gently toward the desired point with the help of knot pusher until the knot gets to the point.



Figs. 11A and B: Passing a suture with a needle through the tissue in order to prepare an extracorporeal Meltzer's knot with needle.

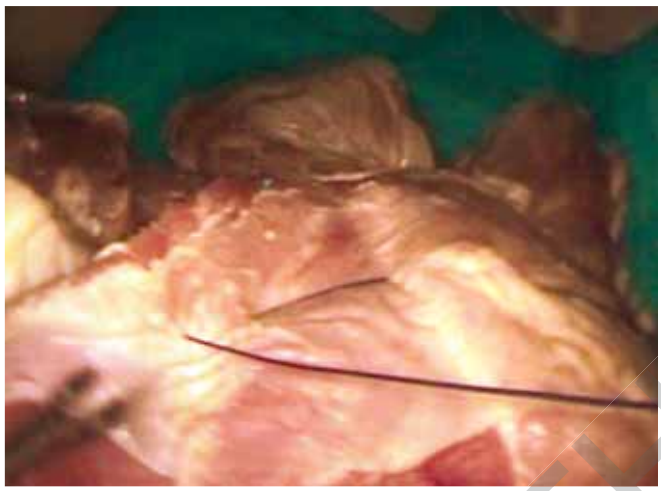
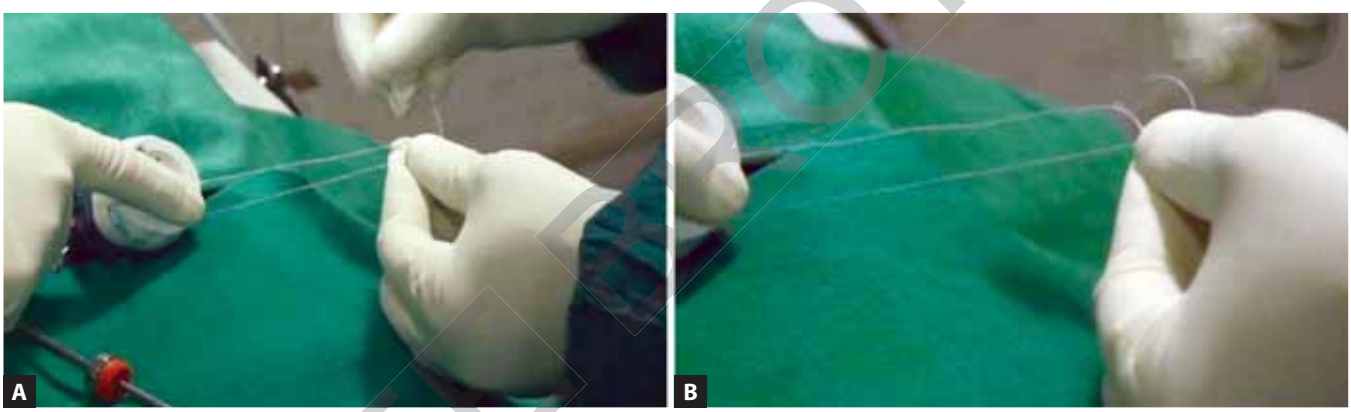


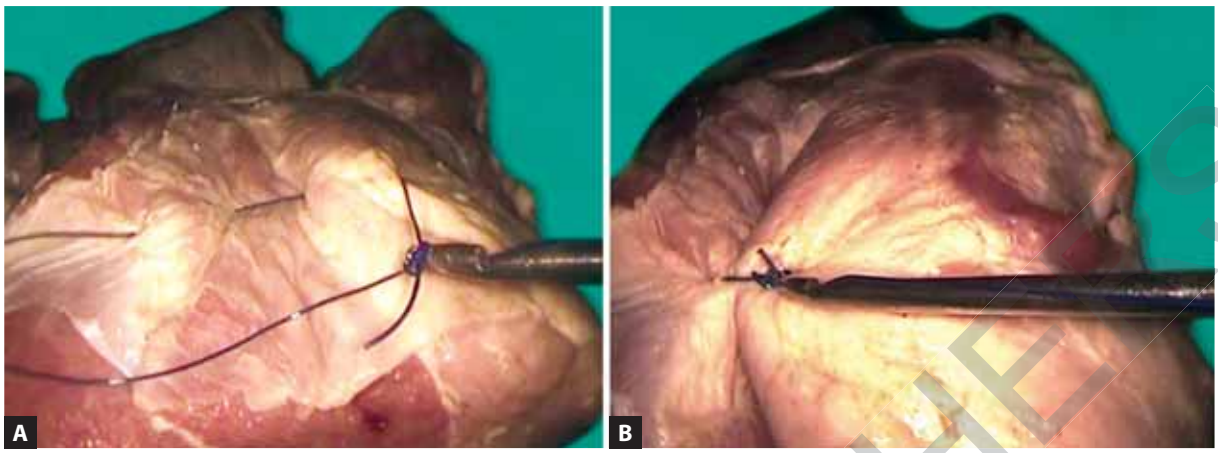
Fig. 12: The suture is being pulled outside the body through cannula in order to prepare the Meltzer's knot.



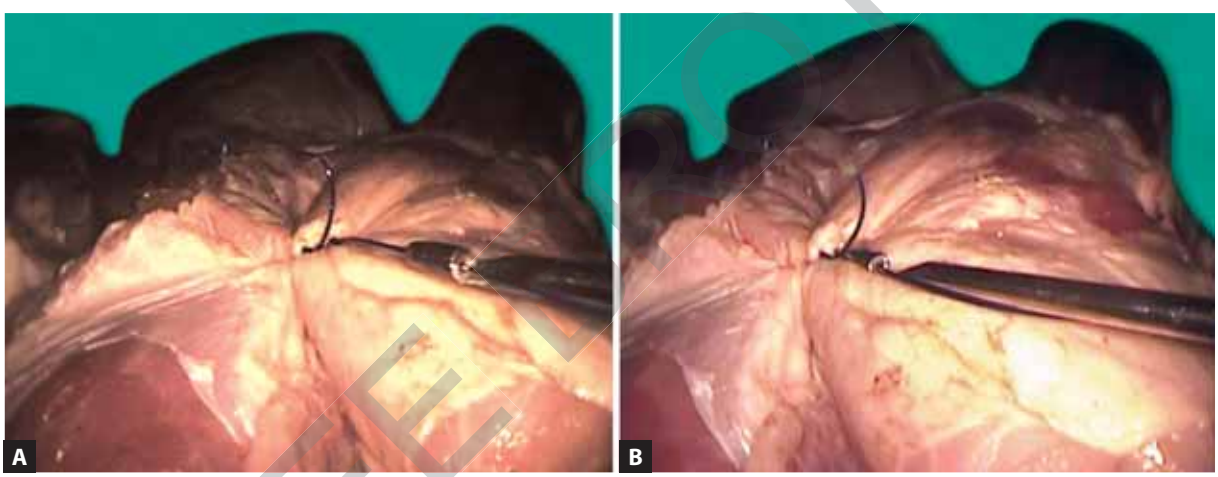
Figs. 13A and B: The assistant finger should be kept in between the thread in such a way the gas should not leak and it should help the surgeon to make the knot and the Meltzer's knot is tied same way as pretied loop.

Fig. 14: Once the Meltzer's knot is ready, the standing end of the suture is reverse loaded over knot pusher.

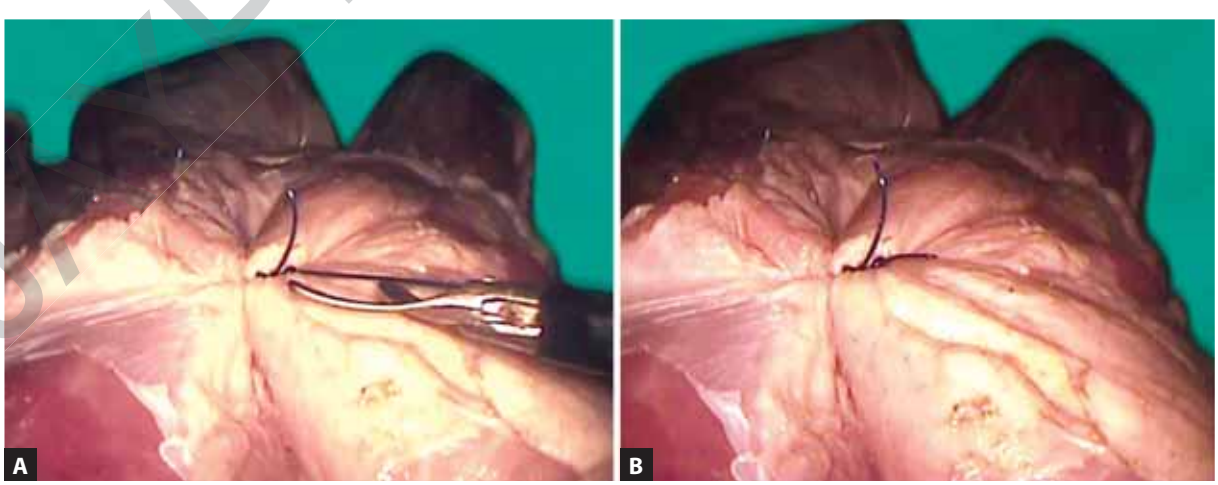
Fig. 15: The knot is pushed inside the abdominal cavity with the help of knot pusher.



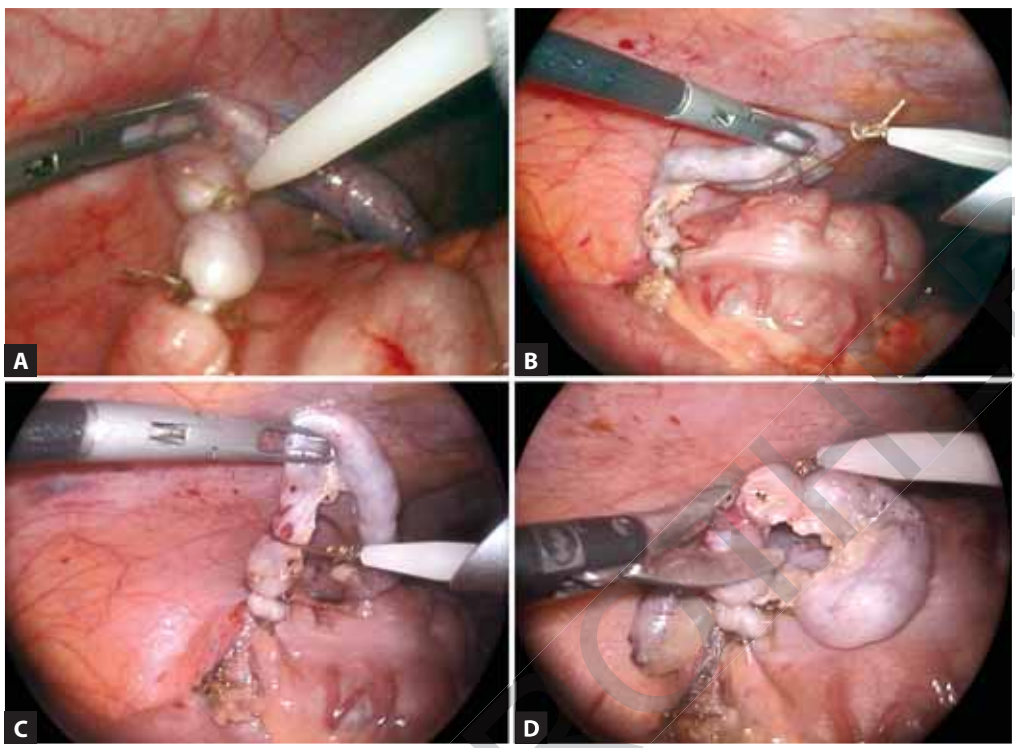
Figs. 16A and B: The suture is being pushed in with the aid of the knot pusher until the knot is applied to the point desired to be sutured or ligated.



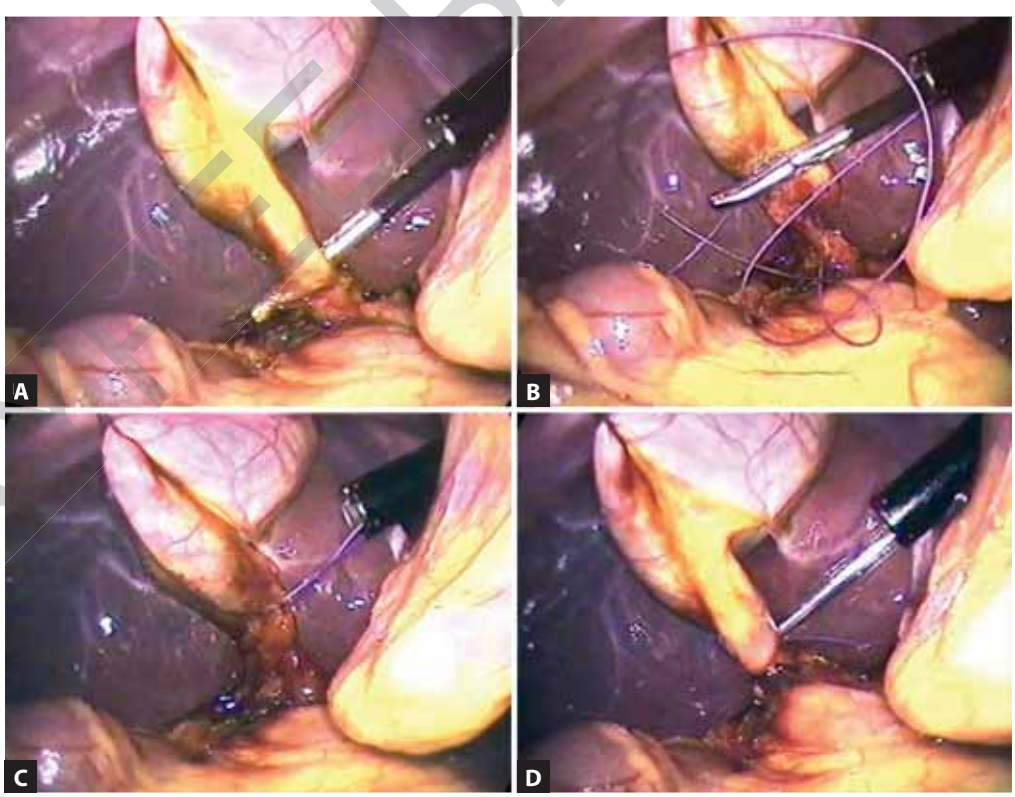
Figs. 17A and B: The knot pusher is being withdrawn slightly and pushed down again in order to tighten the knot. This process is repeated about three to four times until the knot is snugged with the tissue.



Figs. 18A and B: The scissors is introduced from the same port and suture is cut leaving 1-cm long suture.



Figs. 19A to D: Pretied loop of Meltzer's knots used for appendicectomy.



Figs. 20A to D: Extracorporeal Meltzer's knot for continuous structure applied over cystic duct.

in laparoscopic surgery are often linked to inadequate suturing techniques during endoscopic procedures. The adoption of Meltzer's knot has played a vital role in reducing the occurrence of ligature slippage and other associated complications. Meltzer's knot is now generally preferred over the Roeder's knot due to its increased number of wraps and initial and locking hitches. Compared to Roeder's knot, Meltzer's knot offers a more secure tie.

Meltzer's knot, being an extracorporeal knot, is pushed onto the pedicle using a knot pusher, while the remaining suture end is used for countertraction. This method allows the knot to slide down smoothly, reducing the loop around the pedicle as the knot is tightened. During the final tightening phase, the tip of the knot pusher, along with the knot, should be in direct contact with the tissue, while traction is applied to the remaining suture end. These characteristics make Meltzer's knot particularly well-suited for monofilament sutures such as PDS, nylon, or monocryl as they minimize complications such as knot locking.

However, when using braided sutures such as vicryl, this knot may not slide easily and there is a risk of premature knot locking. Additionally, because the slipknot involves the suture passing through the tissue as the knot is pushed toward the pedicle, there is a greater "sawing" effect on the tissue, making premature locking more likely with multifilament sutures compared to monofilament ones.

Meltzer's knot is a highly robust sliding knot that can be mastered with practice. One of its primary advantages is that it requires only one passage of the knot pusher, minimizing issues with potential loss of pneumoperitoneum (the gas used to create a working space during laparoscopic surgery).

Because it can be pushed onto a pedicle, Meltzer's knot is suitable for tying vascular pedicles, making it the preferred choice for securing uterine artery pedicles and large infundibulopelvic ligaments. It is also valuable for reconstituting the uterus after myomectomy. However, due to its strength, it can be challenging to loosen if tension modification is necessary, as in colposuspension.

Given the security of Meltzer's knot, it finds relevance in various procedures such as appendicectomy, cholecystectomy, splenectomy, etc. Therefore, aspiring laparoscopic surgeons should receive thorough training in laparoscopic suturing techniques. The use of extracorporeal knots offers numerous advantages over intracorporeal techniques. Training programs should emphasize extracorporeal suturing techniques early in laparoscopic surgical training, allowing surgeons to develop this skill over time. Various objective assessment programs can help surgeons gauge their proficiency in endoscopic suturing techniques. Institutions should also have regular evaluation and appraisal programs to enhance the performance of laparoscopic surgeons.

RECOMMENDATIONS

- Implement an objective structured training program to train and assess laparoscopic surgeons, ensuring they meet specific criteria for laparoscopic suturing techniques before performing complex procedures.
- Establish programs for continuous training and retraining of laparoscopic surgeons to enhance their skills.
- Emphasize the use of endotrainers for skill development.
- Encourage participation in workshops, conferences, and seminars to learn new suturing techniques and improve practice.
- Younger surgeons should seek opportunities for attachments and postings with senior colleagues and regularly update their libraries with modern books on laparoscopic surgery.

CONCLUSION

The skilled laparoscopic surgeon should be proficient in laparoscopic suturing and knotting, as it is crucial for performing advanced, complex procedures with precision and safety while minimizing complications. Proficiency in endosuturing provides confidence in reconstructing vital organs, repairing inadvertent injuries, or controlling bleeding when other methods are not suitable. Therefore, it is essential for laparoscopic surgeons to receive adequate training in the art of laparoscopic suturing techniques, including Meltzer's extracorporeal knot. This will significantly enhance the overall performance of laparoscopic surgeons and contribute to the reduction of morbidity and mortality associated with laparoscopic surgery.

BIBLIOGRAPHY

1. Al Falloiji M. Making loops in laparoscopic surgery state of the art. Surg Laparosc Endosc. 1993;3:477-81.
2. Bhatia P, John SJ, Deed JPS (Eds). Step by Step Art of Endosuturing. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2007. pp. 109-40.
3. Champion JK, Hunter J, Trus T, Laycock W. Teaching basic video skills as an aid in laparoscopic suturing. Surg Endosc. 1996;10:23-35.
4. Chen MH, Khalil H (Eds). Laparoscopic Suturing Techniques for Surgeons. Oxford: Oxford University Press; 2022.

5. Choi E, Kim DY. The Use of Biodegradable Sutures in Laparoscopic Surgery. J Biomed Mat. 2024;15(3):438-45.
6. Chou D, Elkington N, Shukla-Kulkarni A, Hashim E. Sliding knots. In: Jain N (Ed). State of the Art Atlas and Textbook of Laparoscopic Suturing. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2006. pp. 45-53.
7. Chua HB. A tripod device for an extracorporeal slip knot (Roeder's knot). J R Coll Surg Edin. 1997;42:403-6.
8. Dunsmore RC. Laparoscopic intracorporeal square-to-slip knot. J Am Coll Surg. 1995;180:689-99.
9. Fernandez R, Martin CJ. Ergonomics in Laparoscopic Suturing: Minimizing Surgeon Fatigue. J Ergonomics Surg. 2023;17(3):145-54.
10. Gomez R, Lee T. Evolution of Suturing Techniques in Laparoscopic Surgery. J Minim Invasive Sur. 2021;28(2):123-32.
11. Gupta S, Mehra R. Barriers to Learning Laparoscopic Suturing: A Survey of Surgical Residents. Education Surg. 2023;47(1):55-62.
12. Harper D, Lombardi A. Adapting Traditional Suturing Techniques for Laparoscopic Applications. Surg Techniques Rev. 2021;35(4):320-8.
13. Karabacak RO, Shabgahi B, Biberoglu KO. A new practical knot technique for use in laparoscopic endoscopy. Endoscopy. 1992;24:805-8.
14. Kumar V, Saxena AK (Eds). Advanced Techniques in Laparoscopic Surgery. Berlin: Springer; 2020.
15. Lavelle JF, Sinclair MF. Automated Suturing Devices in Laparoscopic Surgery: A Comparative Analysis. Technol Surg. 2020;22(6):789-98.
16. Lee J, Kim S. Innovations in Laparoscopic Suturing Instruments. Int J Med Robot. 2022;18(1):e2210.
17. Luks FI, Deprest J, Brosens I, Lerut T. Extracorporeal surgical knot. J Am Coll Surg. 1994;179(2):220-2.
18. Meltzer A, Schurr MO, Lirici MM, Klemm B, Stockel D, Buess G. Future trends in endoscopic surgery. Endosc Surg Allied Technol. 1994;2:76-82.
19. Mendez C, Gupta A. Laparoscopic Suturing: Mastery Through Technique and Practice. London: Elsevier Health Sciences; 2023.
20. Mishra RK (Ed). Textbook of Practical Laparoscopic Surgery. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2008.
21. Mishra RK (Ed). Two Port Technique for Laparoscopic Cholecystectomy. India: The Hindu, Online edition of India's National Newspaper; 2006.
22. Mishra RK, (2007). Textbook of Practical Laparoscopic Surgery. Jaypee Brothers Medical Publishers, New Delhi, pp. 104-23.
23. Morrison T, Jacobs LR. Teaching Laparoscopic Suturing: The Role of Simulation in Medical Schools. Med Teacher. 2021;43(7):778-84.
24. Mishra RK (Ed). Textbook of Laparoscopy for Surgeons and Gynecologists, 4th edition. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2021. pp. 900.
25. Nathanson LK. Laparoscopic appendicectomy. Hosp Update. 1992;18:580-5.
26. Nduka CC, Darzi A. Teaching laparoscopic surgery: Training courses are popular and valuable (letter). Br Med J. 1994;308:1435.
27. Nguyen L, Ho CP. Impact of Suture Materials on Laparoscopic Knot Reliability. Mat Surg. 2024;9(2):200-10.
28. Novira Y, Horchani A. The pre-looped intracorporeal knot: a new technique for knot tying in laparoscopic surgery. J Urol. 2001;166;195-7.
29. O'Reilly MP, Saunders BH. Virtual Reality Training for Laparoscopic Surgery. Cambridge: Cambridge University Press; 2022.
30. Palanivelu C (Ed). Textbook of Surgical Laparoscopy. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2002.
31. Palanivelu C (Ed). The Art of Laparoscopic Surgery. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2007.
32. Patel R, Thompson J. The Role of Simulation in Learning Laparoscopic Suturing and Knotting. Med Education Online. 2021;26:1857289.
33. Rodriguez A, Davis SS. Robotic-Assisted Laparoscopic Knot Tying: Methods and Efficiency. Surg Innov. 2019;26(4):459-66.
34. Sharp HT, Dorsey JH, Chovan JD, Holtz PM. A simple modification to add strength to the Roeder knot. J Am Asssoc Gynecol Laparosc. 1996;3:305-7.
35. Sharp HT, Dorsey JH, Chovan JD, Holtz PM. The effect of knot geometry on the strength of laparoscopic slip knots. Obstet Gynecol. 1996;88:408-11.
36. Shimi SM, Lirici MM, Vander Velpen G, Cuschieri A. Comparative study of holding strength of slipknot using absorbable and nonabsorbable ligature materials. Surg Endosc. 1994;11:1285-91.
37. Smith JA, Patel VR (Eds). Principles of Laparoscopic Suturing and Knotting. New York: Springer; 2023.
38. Soper NJ, Hunter JG. Suturing and knot tying in laparoscopic surgery. Surg Clin N Am. 1992;72:1139-52.
39. Surgical Knots and Suturing Techniques. (2024). Available from https://en.wikipedia.org/wiki/Surgical_knot.
40. Trimbos JB, Van Aissel EJC, Klooper PJ. Performance of sliding knots in monofilament and multifilament suture materials. Obstet Gynecol. 1986;68:425-30.
41. Trimbos JB. Security of various knots commonly used in surgical practice. Obstet Gynecol. 1984;64:274-80.
42. Wang Y, Thompson C. Innovations in Knot Tying Techniques for Minimally Invasive Surgery. Innov Surg. 2022;18(4):250-60.
43. Williams NE, Tan JL. Comparative Study of Knot Security in Laparoscopic Surgery. J Surg Res. 2020;245:217-23.
44. Zimmerman KA, Patel ND. Laparoscopic Knotting: A Visual Guide for Surgeons. Philadelphia: Lippincott Williams & Wilkins; 2022.

Mastering the Techniques of
LAPAROSCOPIC SUTURING & KNOTTING

Salient Features

- ***Comprehensive Techniques Coverage:*** The textbook offers a detailed and comprehensive overview of various suturing and knotting techniques specific to laparoscopic surgery. It covers fundamental skills as well as advanced techniques, ensuring that both novice and experienced surgeons can benefit from its content
- ***Step-by-Step Illustrations:*** Each technique is accompanied by step-by-step illustrations and high-quality images, making it easier to understand and replicate the procedures. These visual aids are crucial for grasping the intricate movements required in laparoscopic suturing and knotting
- ***Practical Tips and Tricks:*** The book includes practical tips and tricks from experienced surgeons, providing insights into overcoming common challenges and improving efficiency. These pearls of wisdom are invaluable for enhancing one's surgical skills and achieving better outcomes
- ***Focus on Ergonomics and Instrument Handling:*** Emphasis is placed on the ergonomics of laparoscopic suturing and the proper handling of instruments. This focus helps surgeons reduce fatigue and improve precision during lengthy procedures, which is essential for maintaining high standards of patient care
- ***Case-based Learning:*** The textbook incorporates case studies and real-life scenarios to illustrate the application of various suturing and knotting techniques in different surgical contexts. This approach aids in bridging the gap between theoretical knowledge and practical application, making it a valuable resource for surgical education and training.

Here are five important points about Dr RK Mishra

Renowned Expertise in Minimal Access Surgery: RK Mishra is a highly respected figure in the field of minimal access surgery, known for his extensive expertise and contributions to laparoscopic and robotic surgery. His work has significantly influenced the practice and teaching of these advanced surgical techniques.

Founder and Director of World Laparoscopy Hospital: He is the founder and director of the World Laparoscopy Hospital in Gurugram, Haryana, India. This institution is a leading center for training, research, and clinical practice in minimally invasive surgery, attracting surgeons from around the world.

Prolific Educator and Trainer: He is dedicated to surgical education and training. He has trained thousands of surgeons in laparoscopic and robotic surgery through workshops, courses, and fellowships. His commitment to teaching has helped disseminate advanced surgical skills globally.

Author of Widely Acclaimed Textbooks: Dr Mishra has authored several authoritative textbooks on laparoscopic and robotic surgery. His books, including Textbook of Practical Laparoscopic Surgery, Book of Laparoscopic Hernia Repair, and Textbook of Laparoscopic Suturing and Knotting", are widely used by surgical trainees and practitioners to enhance their understanding and proficiency in minimally invasive techniques.

Pioneer in Surgical Techniques and Innovation: He has been at the forefront of developing and refining new surgical techniques. His innovative approaches and contributions to the field have earned him numerous accolades and recognition, solidifying his reputation as a pioneer in minimally invasive surgery.

Printed in India

Available at all medical bookstores or buy online at www.ejaypee.com

JAYPEE BROTHERS
Medical Publishers (P) Ltd.
EMCA House, 23/23-B, Ansari Road,
Daryaganj, New Delhi - 110 002, INDIA
www.jaypeebrothers.com

Join us on facebook.com/JaypeeMedicalPublishers
Follow us on instagram.com/JaypeeMedicalPublishers

Shelving Recommendation
SURGERY

ISBN 978-93-5696-716-8