

Role of Mishra's Knots in Various Surgeries in Laparoscopy

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ABSTRACT

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

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

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

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

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

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

Keywords: Extracorporeal sutures, Mishra's Knot, Sliding knot.

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INTRODUCTION

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

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

A good knot must fulfill the two basic qualities:

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

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

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

DEFINITIONS

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

Wrapping limb: The free portion of the suture limb that wraps around the postlimb.

Effective knot: Possesses the attributes of both knot security and loop security.

Knot security: The effectiveness of a knot to resist slippage when load is applied.

Loop security: The ability of a knot to maintain a tight suture loop as a knot is tied.^{3,7,8}

TECHNIQUE

More than one turn of the wrapping limb around the post (i.e., any sliding knot other than a half hitch) is there for

compound sliding knots. They can be used in situations where the suture slides smoothly and freely through the tissue and anchoring device. They are advantageous since compound sliding knots can be made to slide down the postlimb without unraveling or jamming prematurely. Theoretical disadvantages include abrasion of suture against the anchor eyelet, and suture cutting through tissue as it slides.^{4,9,10}

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

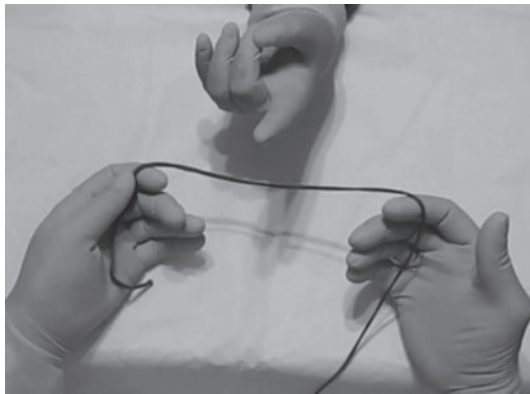


Fig. 1: Use assistants finger to form a knot

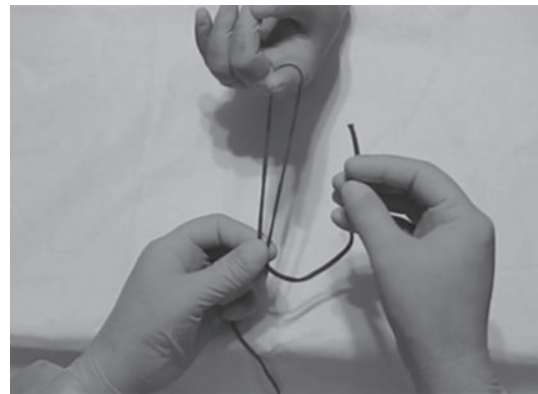


Fig. 2: Shorter hand to be placed over longer hand



Fig. 3: Take half hitch on the right side



Fig. 4: Take one wind

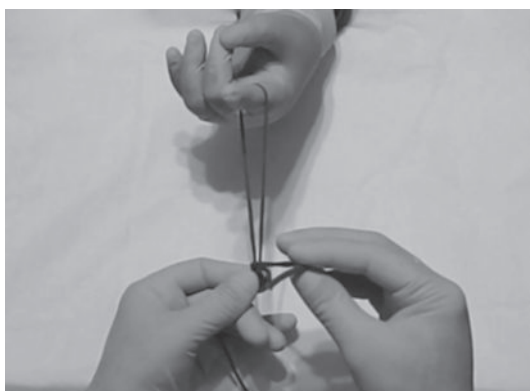


Fig. 5: Complete the wind



Fig. 6: Take second half lock

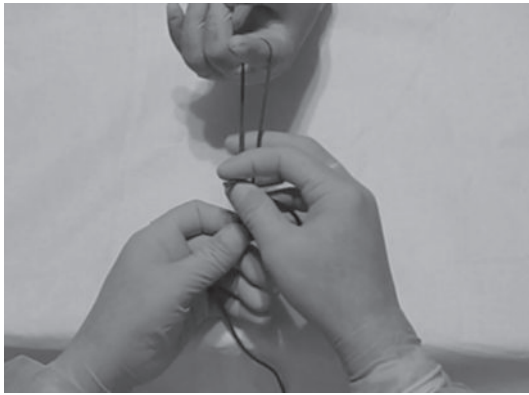


Fig. 7: Complete the second wind

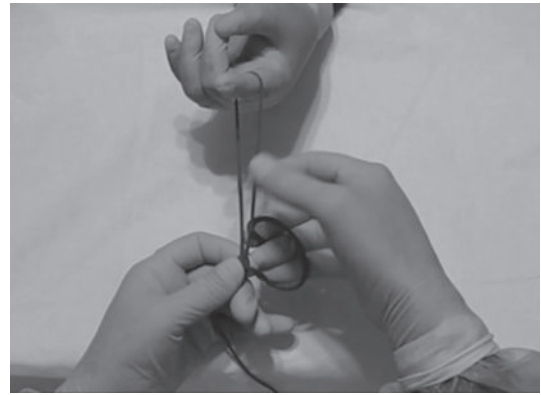


Fig. 8: Complete the third lock

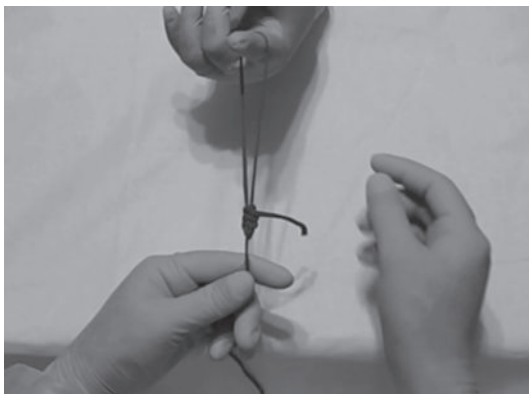


Fig. 9: Make the knot and slide it up



Fig. 10: Knot complete

DISCUSSION

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

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

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

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

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

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

RESULTS

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

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

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

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

CONCLUSION

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

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