Operative Techniques

Single instrument intracorporeal knot tying during single port laparoscopic hernia repair in children: A new simplified technique

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A R T I C L E   I N F O

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A B S T R A C T

Background: With the increasing number of open surgical procedures shifting to laparoscopy, laparoscopic suturing and knot tying are becoming integral parts of the skills that any laparoscopist must acquire. It is the most difficult step in laparoscopic surgery, especially in single incision pediatric endosurgery (SIPES). It needs special laparoscopic skills and very long learning curve. The aim of this study is to introduce a new simplified technique for single instrument intracorporeal suture tying during single incision laparoscopic hernia repair (SILHR).

Patients and methods: This study was conducted at Al-Azhar University Hospitals between June 2008 and June 2010. Three-hundred and eighty three patients with 402 congenital inguinal hernias were subjected to SILHR using percutaneous insertion of purse string suture by Reverdin Needle (RN) with single instrument intracorporeal suture knot tie.

Description of the technique: Under general endotracheal tube anesthesia, a 0.8-1.2-cm. longitudinal transumilical skin incision was done for insertion of the umbilical port and a 3-mm Maryland forceps. RN was used for insertion of a purse string suture with single instrument intracorporeal suture tie around internal inguinal ring (IIR). The purse-string knot airtightness was stress-tested by raising the intraabdominal CO₂ pressure to 16–24 mm Hg for about 30 seconds.

Results: A total of 383 patients with 402 congenital inguinal hernias were subjected to SILHR. They were 304 males and 79 females with a mean age of 2.2 ± 2.25 years. A single instrument technique was used for intracorporeal suture knot tie and all cases were completed laparoscopically without conversion. The mean operative time was 12.5 ± 3.3 minutes for unilateral hernia repair and 17 ± 4.37 for bilateral cases. All patients achieved full recovery without intraoperative or postoperative complications.

Conclusion: Single instrument intracorporeal suture tie is feasible, simple, and rapid as it resulted in marked decrease of operative time. It is of low cost, secure and gives great help during SIPES surgery without struggling. It is a good alternative option to extra corporeal knot tying.

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In laparoscopic surgery, intracorporeal suturing is one of the most important and difficult technique. Each laparoscopic surgeon trains alone to improve his technique of suturing. However for most average surgeons the technique of tying a knot is still a difficult procedure in laparoscopic surgery [1].

Recently, laparoscopic surgery has progressed rapidly especially in single incision pediatric endosurgery (SIPES). This newer procedure has the potential to provide a better and more desirable cosmetic outcome in addition to less postoperative pain and decreased recovery time which ultimately leads to earlier patient discharge from the hospital [2,3]. However a single port laparoscopic surgery requires a substantial amount of time to get used to the technique and practice since surgical space is not enough and the angle between the instruments is extremely narrow to handle the instruments freely when compared to conventional laparoscopic surgery [4].

Intracorporeal suturing and knot tying during SIPES remain some of the most challenging tasks and ligation of suture is considered as a difficult and complicated process. The crux of the problem is that laparoscopic knot tying can lead to increased operation times [5].

Technologic advances have resulted in the development of staplers and suturing devices, clip application, endoscopic-loop tie, to aid in tissue approximation during laparoscopy [6]. However, all these modalities are expensive, and not suitable for children owing to larger sizes.

Over the last few years, SIPES is increasingly used for a variety of procedures; SILHR is perhaps its common applications [2]. Reconstructive pediatric procedures like hernia repair, pyeloplasty and Nissen fundoplication through SIPES technique require suturing and knot tying, which is particularly challenging. It is very difficult to utilize two instruments for knot tying as they lie almost parallel. Herein in this study, we introduce a new simplified technique for
single instrument intracorporeal suture knot tying using single instrument suture knot tie without any undue tension on the tissues. It makes the ligation a lot easier, secure and fast after suturing in both SIPS and conventional laparoscopic surgery. We call it Shalaby-Ismail Tie, which was imagined by Dr. Shalaby and Dr. Ismail during SILHR.

1. Patients and methods

This study was conducted at Pediatric Surgery Unit, Al-Azhar University Hospitals, Cairo, Egypt between June 2008 and June 2010. A total of 402 inguinal hernias were repaired laparoscopically in 383 children. All children were subjected to full history taking, thorough clinical examination, and routine laboratory investigations (CBC, BT, CT, FBS, liver and renal profile). The main outcome measurements of this study included feasibility of the technique, tightness of the suture tie, operative time, development of hydrocele and hernia recurrence. Ethical committee of our hospital approved the study protocol and a written informed parental consent was obtained.

1.1. Description of the technique

Patients were placed supine in the Trendelenburg’s position with tilting to the opposite side of the hernia. General endotracheal tube anesthesia was used in all cases. A 0.8–1.2-cm longitudinal transmucosal skin incision was done with elevation of skin flaps and a 5-mm umbilical port was inserted into the abdomen (Fig. 1A–C).

Creation of pneumoperitoneum to a pressure of 8–12 mm Hg and a telescope 5-mm, 30 degree was used. A 3-mm Maryland forceps, holding the tip of a braided polyester 2–0 thread, was inserted into the abdomen without trocar just behind the umbilical port but in a separate fascial opening.

Laparoscopy was started by inspection of the pelvis and both IIRs. Saline was injected into the extraperitoneal space around the IIR to separate the spermatic vessels and vas deference. Reverdin Needle (RN) (Martin Medizin-Technik, D-78501, Tuttlingen, Germany) is used for insertion of a purse string suture with single instrument intracorporeal suture tie around internal inguinal ring (IIR). A stab incision of the skin is done 2 cm above and lateral to the IIR on the right side and 2 cm above and medial to the IIR on the left side and RN is inserted into the peritoneal cavity. The needle is manipulated to pierce the peritoneum at 3 O’clock on the margin of IIR and is advanced along the inferior margin of IIR under the peritoneum and in front of the spermatic vessels and vas deference to pierce the peritoneum at 9 O’clock on the margin of IIR. Then, the side of the hole of RN is opened for insertion of the thread and the needle is withdrawn backward in the same path to the starting point at 3 O’clock. Again, RN is reinserted at 3 O’clock and is advanced along the superior margin of the IIR beneath the peritoneum and fascia transversalis to come out from the same opening at 9 O’clock. The short end of the thread is withdrawn out from RN and pulled slightly to establish a length of about 10-cm. Once the suture passed around the IIR completely without any skip area, the long end of the thread is hold outside of the abdomen by the surgeon’s left hand. The tip of the short end of the thread is grasped by Maryland and is rotated for 360 degree either under or above the long limb of the thread forming a loop and is passed through that loop, which is already made by rotation, and circulates twice around the long limb to make a surgeon’s knot. Then, the Maryland releases the short end of the thread to rehold it again from outside the loop. The long end of thread is pulled slightly by the left hand while the short end of thread is pushed further by a Maryland. To make the knot firmly tightened, the short end of the thread is held 0.5-cm close to the peritoneum and is pushed in a downward and medial direction to the pelvic cavity while the long end of thread is pulled upward (Fig. 2). The procedure is repeated again as above for 2–3 times, but the short end of thread circulates once only around the long limb in an alternated manner (if the tip of the short limb passed below the long limb the opposite will be done in the following turn to form a locking knot) (Figs. 3 and 4).

The purse-string knot airtightness was stress-tested by raising the intraperitoneal pressure to 16–24 mm Hg. The increase in pressure was sustained for about 30 seconds. The patient was monitored carefully during the whole procedure for arrhythmia, change in blood pressure or decreased oxygen saturation. The airtightness was confirmed by the absence of hernial sac enlargement with the intraperitoneal pressure increase. In case of escape of gas into the hernial sac, a second suture was inserted around IIR

2. Results

A total of 402 inguinal hernias were repaired laparoscopically in 383 children. The reports of these patients were collected and analyzed. They were 304 males and 79 females with a mean age of 2.2 ± 2.25 years (range = 0.58–10.00 years). The demographic data of all patients are shown in Table 1. A single instrument technique has been used for intracorporeal knot tie and all cases were completed laparoscopically without conversion. The mean operating time for saline injection, insertion of purse string around IIR and single instrument intracorporeal suture tie and stress testing the knot was 7.5 ± 2.32 minutes for unilateral cases and 15 ± 4.37 minutes for bilateral cases. The overall mean operative time from skin to skin was 12.5 ± 3.3 minutes for unilateral hernia repair and 17 ± 4.37 for bilateral cases. All patients achieved full recovery without intraoperative or postoperative complications. In 1 case, stress-test resulted in escape of gas into the hernial sac and a second suture was inserted again around IIR. Most children went home at the same day. The mean hospital stay was 7.79 ± 1.28 hours (range, 5–19 hours). There were 3 recurrences (3/402) (0.75%) and 5 cases of hydrocele (5/402) (1.24%). The cosmetic results are excellent (Fig. 1D).

3. Discussion

The challenge of intracorporeal suturing and knot tying, at awkward angles and with limited visibility and depth perception, has long been recognized as a significant barrier to the advancement of minimally invasive surgery. The crux of the problem is that knot tying using laparoscopic tools can lead to increased operation times. Sutures remain the ‘gold standard’ of fixation for many surgical procedures [5].
Suturing and knot tying have been the most difficult challenges for surgeons using SIPES [7]. Instrument triangulation facilitates intracorporeal knot tying in conventional laparoscopy, but there is no simple method for suturing and tying in SIPES. To obviate this step, some practitioners replace suturing with staples or clips [8,9] and others place a small accessory port to allow triangulation [10]. To minimize instrument clashing and partly restore conventional techniques, we introduced a new simplified technique for single instrument intracorporeal suture knot tie during SILHR. The initial experience suggested that it improved 3 limitations of SIPES: triangulation, limited visual axis and field, and ergonomics. However, no comparative studies have investigated the workload of suturing between our technique and conventional suturing during SIPES and further studies are needed for its validation.

Many laparoscopic techniques for the treatment of pediatric inguinal hernia have mushroomed in the past two decades. These techniques vary considerably in their approaches to the internal ring (intraperitoneal or extraperitoneal), use of ports (three, two, or one), endoscopic instruments (two, one, or none), sutures (absorbable or nonabsorbable), and techniques of knotting (intracorporeal or extracorporeal) [11].

Subcutaneous endoscopic assisted ligation (SEAL) of the hernial sac and other similar extraperitoneal techniques resulted in marked reduction of operative time when compared to the transperitoneal purse string suture using standard 3-port technique [11]. However, SEAL is associated with a high recurrence rate and development of granuloma, infection, and skin puckering at the site of a subcutaneously placed knot [12]. These drawbacks of SEAL and other similar techniques were avoided by the use of RN technique where the suture is tied intracorporeal and not subcutaneously.

Different extracorporeal techniques of suture tie have been devised to assist in fashioning the knot. These extracorporeal techniques are easy to perform and are usually created by multiple throws that are advanced intracorporeally with a knot pusher. However, extracorporeal techniques have several disadvantages as they may result into undue tissue trauma, and excessive tension on tissues while pushing the knot into position and loss of focus on operative field during creation of knot [13]. Most importantly, sequential throw formation in opposite directions is technically demanding, resulting in an unsecured sliding sequence instead of a square knot [6,14–16].

Many laparoscopic surgeons use slip knots because they can be performed quickly and more easily than square knots. Several extracorporeal variations have been described such as the Roeder, Weston, and Duncan knots; however, all slip knots are significantly weaker than properly formed square knots. Similarly, an intracorporeal slip knot may be formed using our simplified technique. However, this type of knot is not as secure as the square knot [17].
Tying a basic square knot or surgeon’s knot laparoscopically and intracorporeally, however, presents unusual challenges for the otherwise accomplished surgeon because of lack of manual dexterity posed by 2 rigid instruments proscribing an acute angle, the long manipulation distance from the operator’s hands, exaggeration of fine movements owing to the fulcrum effect, and 2-dimensional visualization. Laparoscopist should develop the same level of proficiency in suturing and tying a knot intracorporeally [18].

The flat square knot remains the most familiar and generally reliable knot in laparoscopic surgery [14,17,19]. When properly formed, it has comparable strength to conventional open square knots [20,21]. However, it needs 2 instruments for its construction and it is very difficult in cases of SIPES. We find our technique of knotting produces the facility to make double or triple knot followed by any number of hitches in a very short time using the same instrument. In addition, our knot can be manipulated in smaller spaces. In our long laparoscopic experience, we find that the extracorporeal knotting requires long time and manipulation of the knot and the pusher can be cumbersome and less reliable.

Table 1
Demographic data of all patients.

<table>
<thead>
<tr>
<th>Demographic data</th>
<th>No. of patients</th>
<th>%</th>
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<tbody>
<tr>
<td>Sex</td>
<td></td>
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<tr>
<td>Male</td>
<td>304</td>
<td>79.37%</td>
</tr>
<tr>
<td>Female</td>
<td>79</td>
<td>20.62%</td>
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<tr>
<td>Age per months</td>
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<td></td>
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<tr>
<td>1–12</td>
<td>24</td>
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<tr>
<td>13–24</td>
<td>197</td>
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<tr>
<td>25–36</td>
<td>139</td>
<td>36.29%</td>
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<tr>
<td>&gt;36</td>
<td>23</td>
<td>6%</td>
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<tr>
<td>Presentations</td>
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<tr>
<td>Right inguinal hernia</td>
<td>263</td>
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<tr>
<td>Left inguinal hernia</td>
<td>93</td>
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<td>Bilateral inguinal hernia</td>
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<tr>
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</tr>
<tr>
<td>Rec. left inguinal hernia</td>
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</table>

In our Pediatric Surgery Unit, Al-Azhar University Hospitals, laparoscopy is used routinely for repair of congenital inguinal hernia in children. The majority of cases are closed by percutaneous insertion of purse-string suture encircling its whole circumference without any skip area by RN technique [11]. We have routinely used single instrument intracorporeal suture tying technique to advance and secure knots in SILHR. Recently it has been used in 383 cases with 402 inguinal hernias. Although an initial surgeon’s knot can be used in many situations, our new simplified technique has several advantages. First, it provides a very secure knot as the traditional knotting method. Second, it can be done by conventional laparoscopic instruments without extra skills. Third, it is performed completely within the body as extracorporeal knots are often more complex and time consuming, require the use of a knot pusher, and decrease the ability to gauge the appropriate tension. Fourth, this technique shortens the operative time. Fifth, it can be used simply in both SIPES and conventional laparoscopic surgeries. We usually test the suture tie security by raising the intraperitoneal CO₂ pressure to 16–24 mm Hg. The airtightness is confirmed by the absence of hernia sac enlargement with the increased intraperitoneal pressure. In case of escape of gas into the hernia sac, a second suture is inserted around IIR.

We introduced an easy, safe, simple and rapid technique for repair of CIH using percutaneous insertion of purse string suture by RN and single instrument intracorporeal knot tying which is less time consuming and more secure. Both, the operative time and the recurrence rate in our series are lower than that reported in the literature because LIHR was started after gaining good experiences in different laparoscopic procedures. Also, we followed many technical refinements such as injecting normal saline into the extraperitoneal space at IIR, including subperitoneal tissue all around IIR without any skip area, reducing tension on the knot of purse string suture by deflation of the abdomen and squeezing the scrotum to empty the hernial sac and the use of nonabsorbable suture. These latest technical refinements and modifications of the techniques resulted in marked reduction of development of postoperative hydrocele, lowering the recurrence of hernia to 0.78% and reduced operative time. Some of the
above mentioned technical refinements have been described before by Chan and others [21–23].

4. Conclusion

Our new simplified technique for intracorporeal knot tie is applicable, safe, shortens the operative time and is suitable for all types of laparoscopic surgeries including SIPES. It is a good alternative option to extra corporeal knot tying.

References