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Operative Techniques

One trocar needlescopic assisted inguinal hernia repair in children: a novel technique

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ABSTRACT

Background: Inguinal hernia repair using a percutaneous internal ring suturing technique is an effective alternative technique to conventional laparoscopic hernia repair. It is one of the most commonly used approaches for laparoscopic hernia repair in children. However, most percutaneous techniques have utilized extracorporeal knotting of the suture and burying the knot subcutaneously. This approach has several drawbacks. The aim of this study is to present a modified technique for single cannula needlescopic assisted hernia repair in children.
Patients and methods: Three-hundred and fifty-seven patients with 397 indirect inguinal hernias underwent a one port needlescopic assisted inguinal hernia repair. The open internal inguinal ring [IIR] was closed using an 18-gauge epidural needle [EN], a 14-gauge venous access cannula [VAC], and a homemade suture device. Saline was injected extraperitoneally around the IIR for hydrodissection. The main outcome measurements were: feasibility, safety of the technique, operative time, recurrence rate, and cosmetic results.
Results: This prospective study was conducted on 357 patients at Al-Azhar, Alexandria, and Mansoura University Hospitals during the period from June 2012 to October 2015. There were 286 males and 71 females. The mean age was 2.6 ± 1.3 years (range = 4 months to 6 years). One-hundred and ninety-eight patients presented with a right-sided inguinal hernia, 119 patients with a left-sided hernia, and 40 patients with bilateral inguinal hernia. The mean operative time was 12.6 ± 1.7 min (range = 8–15 min) for unilateral cases and 18.6 ± 1.7 min (range = 14–20 min) for the bilateral repairs. No wound complications or umbilical hernias developed. The mean follow-up period was 18.6 ± 1.2 months (range = 11–36 months). During the follow-up period, no recurrence was detected, and the scars were nearly invisible.
Conclusion: This preliminary study shows that a single port needlescopic assisted hernia repair in infants and children is a very promising technique to achieve nearly scarless surgery. The procedure is very safe, rapid, easy to learn, and reproducible.

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Congenital inguinal hernia is a common pediatric surgical condition, and herniotomy has become the standard treatment. The three-port laparoscopic inguinal hernia repair is associated with increased operative time, cost, and postoperative pain [1]. Recently, several authors have reported changing from 3 to 2 ports, and subsequently to a single-incision technique with a trend toward increasing the use of extracorporeal knotting [2–4]. Single-incision pediatric endoscopic surgery (SIPES) hernia repair is thought to provide a better and more desirable cosmetic outcome in addition to less postoperative pain and decreased recovery time which leads to earlier patient discharge [5]. However, SIPES requires a long learning curve to get familiar with the technique since intra-abdominal space is not enough and the angle between the instruments is extremely narrow to maneuver the instruments freely [6–8].

Indirect inguinal hernia repair using the percutaneous internal ring suturing technique is thought to be an effective alternative approach to laparoscopic inguinal hernia repair [LIHR] with intracorporeal suturing. Most described techniques use extracorporeal knot-tying and burying the knot subcutaneously. This may result in stitch sinus, infection, granuloma, and puckering of the skin. Furthermore, the inclusion of muscular tissues with the suture may lead to an increased rate of recurrence owing to loosening of the suture and cutting through the muscular tissues [4,9–11]. All these drawbacks can be avoided by applying extracorporeal fashioning of the knot and sliding it to be tightened and placed completely intraperitoneal rather than subcutaneous [12–14].

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In this study, we describe a modified technique for one trocar needlescopic assisted inguinal hernia repair in children, using, epidural needle [EN], [venous access cannula [VAC], and two homemade Suture Retrieval Devices [Loop suture retrieval (LSR) and hook suture retrieval (HSR)] [Fig. 1A and B].

Only one 5-mm umbilical port and 2-skin punctures [1-mm and 1.2-mm] are needed to perform the procedure. The main concept with this technique is the percutaneous insertion of a purse string suture around the internal inguinal ring [IIR] with extracorporeal tying of the suture and intra-abdominal burying of the knot. To the best of our knowledge, this technique has not been reported in the English literature. We refer to this technique as Shalaby-II as it was developed by our first author.

1. Patients and methods

Three hundred and fifty-seven patients with 397 indirect inguinal hernia defects underwent one cannula needlescopic assisted inguinal hernia repair [single port hernia repair - SPHR] during the period from June 2012 to October 2015. The main outcome measurements were: feasibility of the technique, safety of the technique, operative time, recurrence rate, and cosmetic results. Patient inclusion criteria were: bilateral IHR, unilateral IHR with questionable other side, patients needing IHR associated with umbilical hernia, and parental request. Exclusion criteria were: recurrent cases, incarcerated cases, wide diameter of IIR [more than 2-cm], inguinal hernia with undescended testis, morbidly obese patient with thick anterior abdominal wall, parental refusal, and contraindications for laparoscopy for major lower abdominal surgery.

The protocol was discussed and approved for clinical study by the Ethical Research Committees of Al-Azhar University, Alexandria University Hospital, and Mansoura University Hospital. The procedures and the aim of the study were clearly explained to the parents and the family. A written informed consent was obtained before enrollment of the patients into the study.

1.1. Preoperative preparation

All children underwent a complete history and examination, and routine laboratory investigations. Preoperative ultrasound to measure the diameter of IIR was done in 75 cases in whom clinical evaluation was not conclusive, and the patient was eligible for study enrollment if the IIR diameter was more than 5-mm. All patients received one dose of preoperative antibiotic prophylaxis in the form of Ceftriaxone 50 mg/kg one hour before surgery.

1.2. Description of the technique

The patient is placed supine in the Trendelenburg position. General endotracheal tube anesthesia is used in all patients. A 5-mm vertical transumbilical skin incision is created within the umbilical cicatrix, and a 5-mm port is inserted into the abdomen through which a 5-mm, 30-degree telescope is introduced. Creation of pneumoperitoneum to a pressure of 8 to 12 mm-Hg is accomplished. A venous access cannula [VAC] [Plusflon; Mediplus Limited, Bahadurgah, India] is introduced under vision through the anterior abdominal wall [AAW] in the midline, 2-finger breadths above the symphysis pubis.

VAC is used as a mini-port for insertion of EN to measure the diameter of the IIR, insertion of a blunt probe to assist purse string suturing of IIR in some cases with redundancy of the peritoneum, and withdrawal of both ends of the thread and for passage of the constructed knot inside the abdomen after extraperitoneal closure of the hernia [Fig. 2].

Laparoscopy is initiated by inspection of the pelvis and both IIRs. The diameter of the IIR is measured intra-operatively by noting the number of marks on the EN. The length of each mark on the EN is measured before the operation [1-cm each] [Fig. 3]. Cases with IIR diameter wider than 2-cm were excluded from the study because there may be a redundancy of the peritoneum at its neck which may slip during insertion of the purse string suture and it will be very difficult to ensure complete encirclement of IIR by this technique. Also, it may need to be narrowed by suturing the muscular arch to the iliopubic tract [15,16].

In both males and females, hydrodissection is applied as described by Tatekawa and Muensterer [17,18]. A 10-ml syringe fixed to 22-gauge needle is inserted percutaneously over the IIR at the 12 o'clock position, and saline is injected into the preperitoneal plane circumferentially to dissect the peritoneum off the vas deferens and testicular vessels [Fig. 4A].

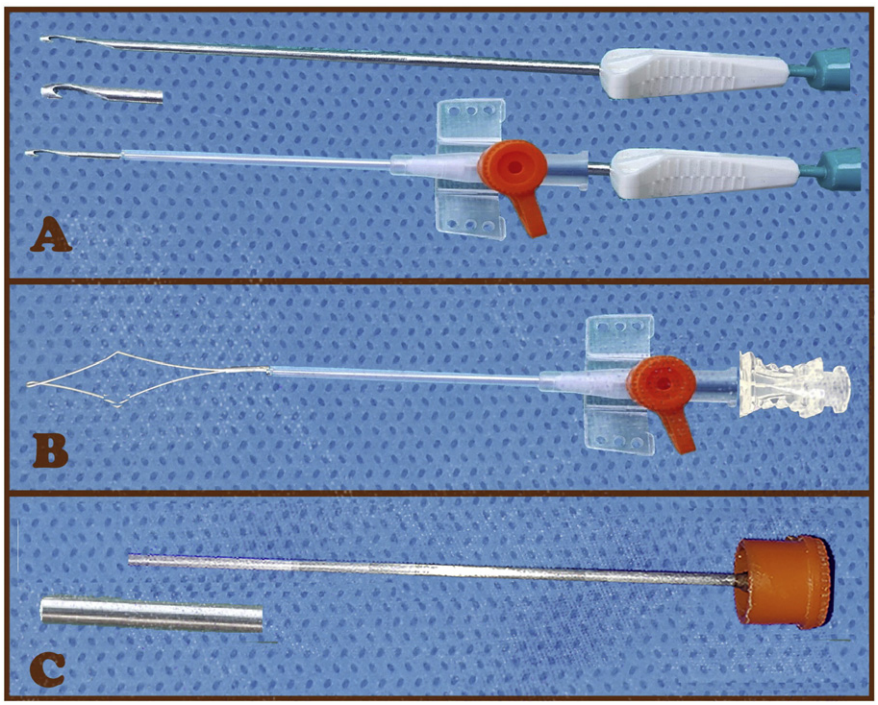

Fig. 1. Showing homemade suture retrieval with 14 gauge VAC. (A, Homemade hook SR; B, Loop SR; C, Homemade blunt probe).

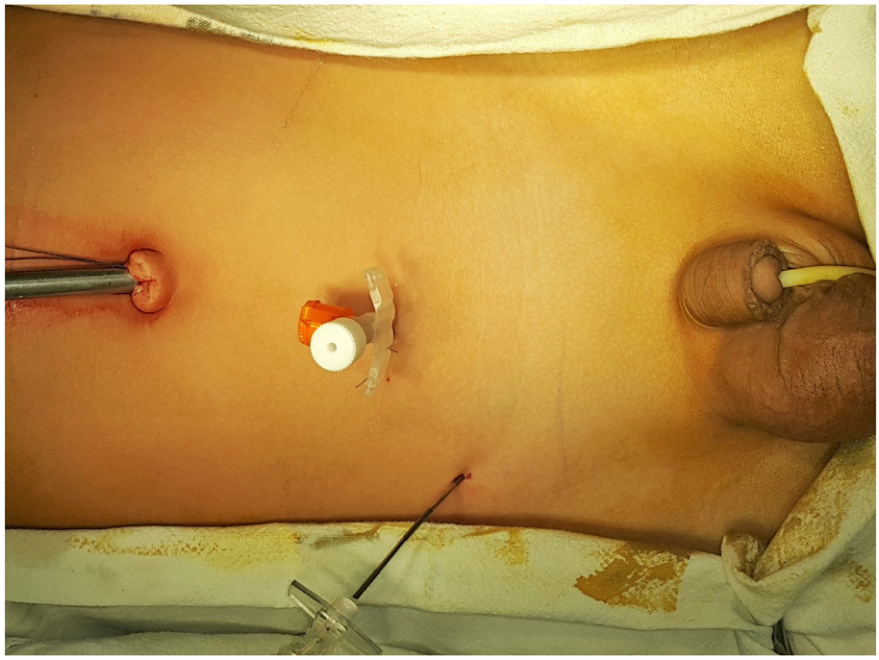

Fig. 2. Insertion of umbilical port, VAC and EN is seen.

Under laparoscopic visualization, an 18-G epidural needle [EN] is inserted through a tiny stab skin incision directly over the IIR and passed medially around IIR in the preperitoneal space created by the hydrodissection. When it is over the vas deferens and testicular vessels, or under the round ligament, it is advanced laterally to penetrate into the peritoneal cavity. A polypropylene 2–0 suture is passed through the EN into the peritoneal cavity where it is grasped and pulled to the outside of the abdomen by the homemade loop suture retrieval [LSR] device introduced through the VAC, leaving the other end of the thread inside the EN [Fig. 4B–F]. The EN is then withdrawn gradually through the preperitoneal space to the starting point at the roof of the IIR [at 12 o'clock] [Fig. 4A]. The EN is then advanced along the lateral aspect of the IIR to exit through the same peritoneal perforation lateral to the testicular vessels where the thread is picked out of the EN by the HSR, and brought through the VAC to the outside of the abdomen [Fig. 4B–D]. The homemade hook retrieval device is created by thinning the stylet of an Endoclose (Covidien, Mansfield, MA) after detaching it from the needle [Fig. 1B]. The insertion of a thin homemade blunt probe [Fig. 1C] through the VAC was needed in 4 male patients with redundancy of the peritoneum at the IIR to stretch the peritoneum around IIR during insertion of purse string suture.

The 2–0 polypropylene thread is now encircling the IIR completely without any skip areas, and both ends are outside the abdomen through the VAC [Figs. 5F] and [6A].

The knot is fashioned extracorporeally using a French Sliding Knot [Fig. 6A–B] and one end of the thread is pulled to slide through the VAC where it is tightened around the IIR by pulling on the other end. The knot is buried intraperitoneally rather than subcutaneously [Fig. 6C–D]. [The French Sliding Knot was developed by Dr. Jeff Valla, with personal communication during the 6th annual meeting of ESPES-Madrid 2016].

For more safety and security of the knot, a second and third half hitches, are constructed extracorporeally, and pushed through the site of VAC using either a blunt EN or a fine home-made tie pusher through the site of VAC as seen in Figs. 7A–D and 8A. While the suture is being tightened, the distal hernia sac is being squeezed extracorporeally to expel CO2. The tightness of the purse-string knot is tested as previously described [8]. Finally, both ends of the 2–0 polypropylene thread outside the abdomen are pulled tightly and cut flush with the AAW, leaving two short ends to retract inside the abdomen [Fig. 6F]. (For more details, see the accompanying videos). The abdomen is de-sufflated, the umbilical port is removed, and the umbilical fascia is closed with an absorbable suture. No stitches are required for the small stab incisions.

The patients can eat after four hours, and they are discharged on the evening of the same day or the next morning. All patients were instructed to follow up in clinic at one week, two weeks, one month, six months, and three years.

1.3. Statistical analysis

Data were analyzed using the SPSS software package version 18. For continuous variables, data were expressed as mean ± SD or median [IQR]. Categorical variables were expressed as frequency number and percent.

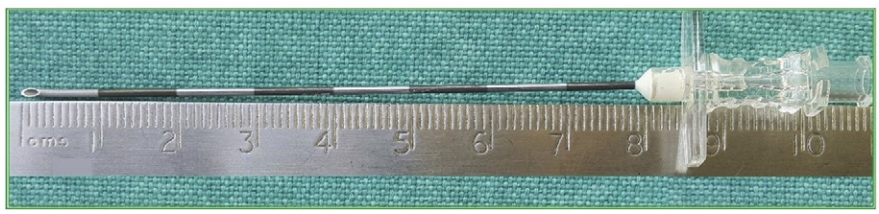

Fig. 3. Measurement of epidural needle [Each mark = 1 cm.] for estimation of the diameter of IIR.

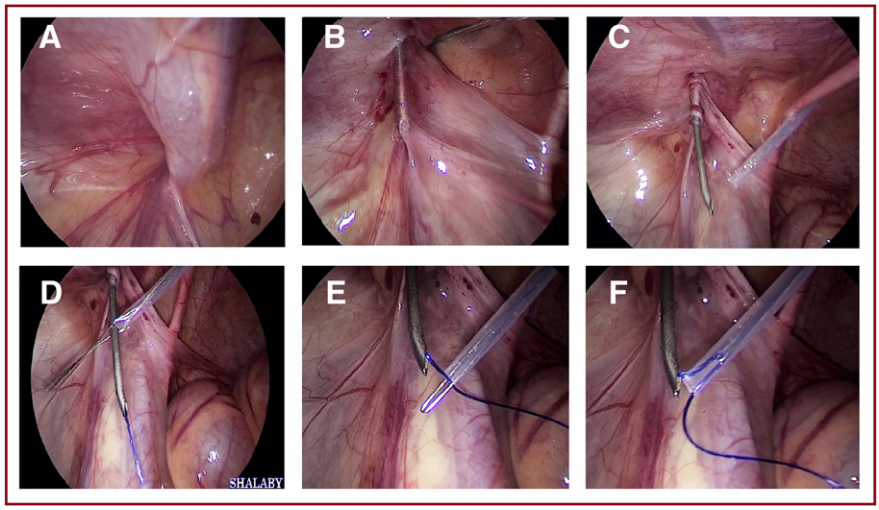

Fig. 4. Showing injection of saline into the preperitoneal plane circumferentially for hydro-dissecting the peritoneum off the vas deferens and testicular vessels [A]. EN is inserted over the IIR and passed medially around IIR in the preperitoneal space created by hydro dissection. Once over the vas deferens and testicular vessels, or under the round ligament it is advanced laterally to penetrate into the peritoneal cavity. [B, C]. Picking of the thread by a home-made LSR through VAC and withdrawal of EN to the starting point.

2. Results

A total of 397 inguinal hernia repairs were successfully performed at the three centers by one port needlescopic-assisted hernia repair in 357 children during the period from June 2012 to October 2015. They were 286 males and 71 females. Their mean age was 2.6 ± 1.3 years [range = 4 months and six years]. The mean operating time for unilateral and bilateral inguinal hernia repairs was 12.6 ± 1.7 min (range = 8–15 min) and 18.6 ± 1.7 min (range = 14–20 min), respectively. All cases were completed laparoscopically without conversion.

In three patients, a hematoma developed owing to the inadvertent injury of the inferior epigastric vessels. This was managed by deflation of the abdomen and by applying continuous pressure on the AAW at the region of the IIR for 5 min. In four patients, there was a significant skip area during insertion of purse string suture that necessitated re-insertion of a second purse string suture around the IIR. No wound complications or umbilical hernias occurred.

The mean follow-up period was 18.6 ± 1.2 months (range = 11–36 months) and all patients were available for follow-up at 1 week, 2 weeks and 1 month, while 90% of them were available at 6 months [either by attendance in the clinic or by telephone questionnaire] but only 10% at 3 years. We believe that our follow-up is good because we were very anxious to follow all patients to look for the results of this new technique (Telephone contact, internet questioner, e-mails and even home visits). No recurrences have been found in follow-up and the resulting tiny suprapubic incisions are barely visible.

3. Discussion

Inguinal hernia is one of the most common surgical conditions in infants and children. Traditionally, inguinal exploration with high ligation of the hernia sac has been the standard treatment. However, potential complications include trauma to the vas and vessels with the risk of injury, a relatively large inguinal incision, especially in the obese child, technical difficulties in small babies, and the inability to assess the contralateral side for a PPV, unless laparoscopy is performed through the known hernia sac. Laparoscopic herniorrhaphy has advantages related to the evaluation for a contralateral PPV and avoidance of dissecting the spermatic vessels and vas deferens. Recently, the literature has contained an increasing number of reports on laparoscopic hernia repair in children, highlighting an increase not only in the number of cases that

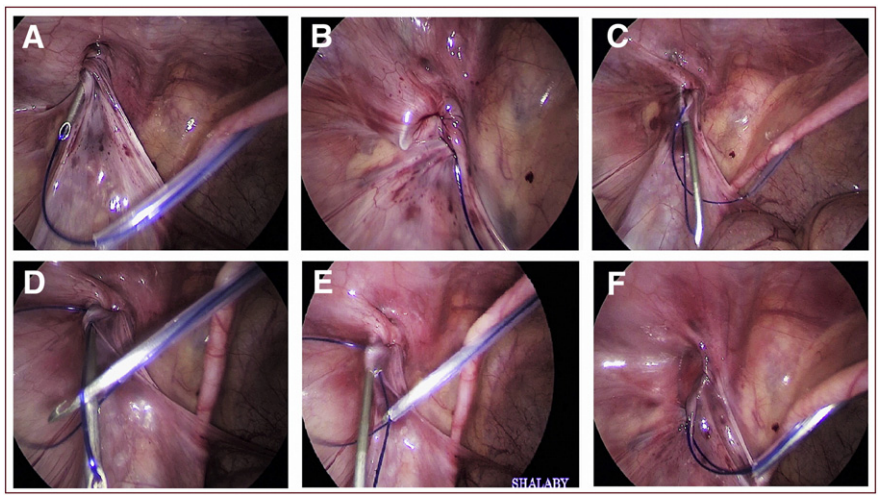

Fig. 5. Showing withdrawal of EN to the starting point at the roof of IIR (A). Reinsertion of EN along the lateral margin of the IIR (B) to exit through the same peritoneal puncture lateral to testicular vessels where the thread was picked out EN by a homemade HSR through VAC to the outside of the abdomen (C-E). Prolene thread is encircling the IIR completely and both ends are outside the abdomen through the barrel of VAC (F).

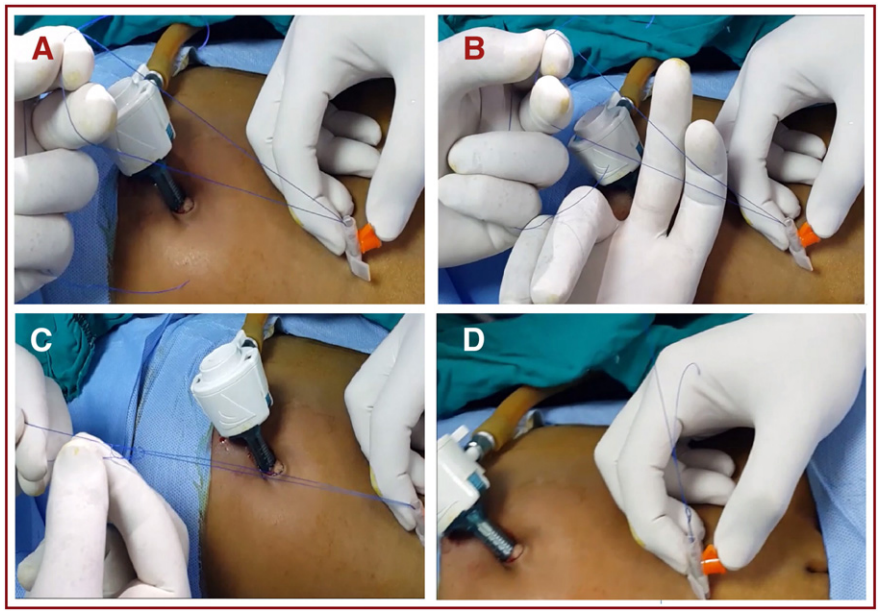

Fig. 6. Showing a case of right hernia of canal of Núck where Prolene thread is encircling the IIR completely and both ends are outside the abdomen through the barrel of VAC [A]. The suture is then tied extracorporeally using French Sliding Knot and pulled to slide through the VAC [B–D].

have been managed but also in the number of modifications and technical refinements in the procedure itself [19,20].

The desire of pediatric surgeons to reduce the morbidity and scars has stimulated them to apply less invasive techniques. Single-incision laparoscopic hernia repair is an evolving technique that reduces the multiple skin incisions used in conventional laparoscopic surgery and improves cosmesis. However, it is very challenging, especially during suturing and knot-tying [2,3,21,22].

Inguinal hernia repair using the percutaneous internal ring suturing technique has been widely used, and numerous techniques have been described [8,10] However, most of the described techniques have used extracorporeal tying of the suture with burying the knot subcutaneously. We have sought to develop a technique that is free from any drawbacks like stitch sinus, infection, granuloma, puckering of the skin, and recurrence. Moreover, including tissues in the ligature is concerning for causing eventual loosening of the knot when the extra tissues cut through, leading to recurrence [9–11]. All these drawbacks can be avoided by applying extracorporeal fashioning of the knot and sliding it to be tightened, and placed completely intraperitoneal rather than subcutaneous [12–14,23].

In this study, we introduced a modification of our previously published technique (5) in the form of replacing the Reverdin Needle (RN) and Maryland clamp with EN, VAC, suture retrieval (SR) device and one 5-mm port. We noticed that the diameter of RN used in our previous technique is thick [reaching 3-mm at its proximal end and is not available all the time in addition to its high cost]. The idea behind this technique is to use locally available equipment (VAC, EN) and homemade SR [either HSR or LSR [Fig. 5A–B] which are available anytime,

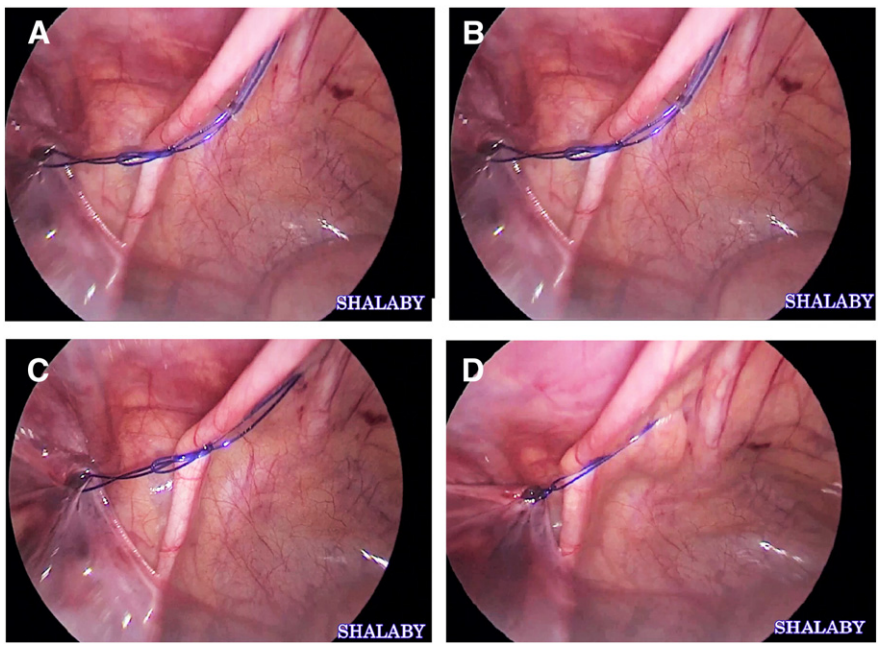

Fig. 7. Showing the steps of tightening the suture around IIR and placing the knot intracorporeally by pulling the outside ends of the thread [A–D].

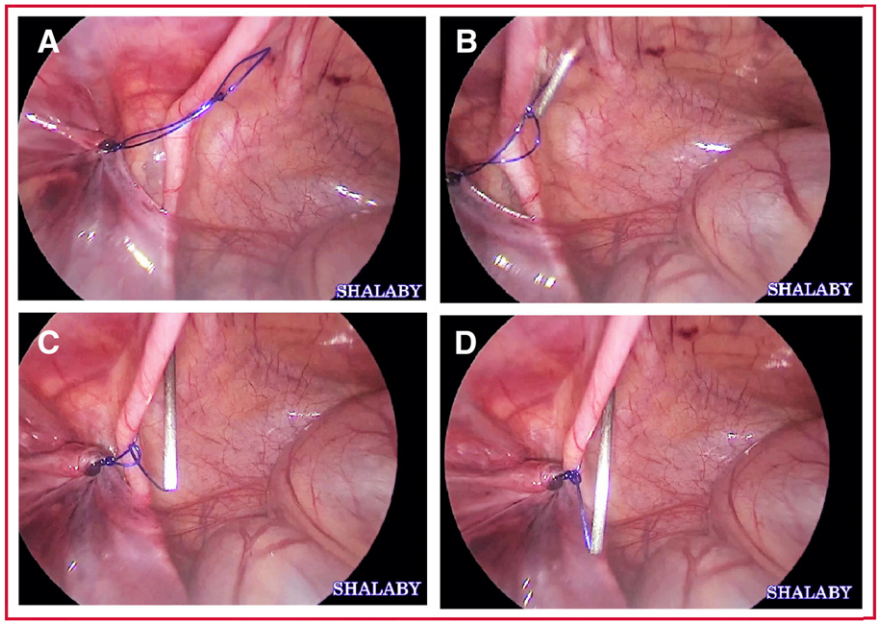

Fig. 8. Showing a second half hitch constructed extracorporeally and pushed into the peritoneal cavity [A]. Pushing the knot for tightening around IIR by a blunt EN as a tie pusher. [C-D].

and inexpensive. The Endo Close™ suturing device has a spring-loaded blunt stylet mechanism. The stylet retracts as the needle is pushed through the abdominal wall and automatically advances once the peritoneum is penetrated. The stylet has a notched end which is used to capture and hold the suture. It is recommended to use Prolene suture sizes 2–0 or 0. Our homemade hook SR device [Fig. 5A] was made by thinning out the stylet of an Endo Close after detaching it from the needle so that it can pass easily through the VAC to pick the polypropylene suture out the EN. The use of VAC ensures the passage of the 2-ends of the thread in the same track to avoid inclusion of muscle and subcutaneous tissue within the suture during tying which may later cause the loosening of the suture and predispose to recurrence. Also, we used the French knot invented by Dr. Jef Valla which is characterized by its ability to slide when pulling on one end of the thread, and is locked after reaching its destination by pulling of the other end. It does not need a tie pusher as ordinary extracorporeal knot.

We feel that this new technique has several advantages. First, it provides a very secure knot, not like the traditional knotting method. Second, it is cost effective as it is performed by inexpensive readily available equipment and only one 5-mm port. There is no need for a tie pusher or laparoscopic instruments. Third, it avoids the complications of burying the knot subcutaneously.

The concept of hydrodissection during laparoscopic inguinal hernia repair has been previously described [11,13]. Chan et al. employed extraperitoneal hydrodissection during laparoscopic hernia repair in children and found that the recurrence rate decreased from 4.88% to 0.4% [10]. We have used extraperitoneal hydrodissection during our one cannula technique which helps separate the vas and testicular vessels from the peritoneum at the IIR, allowing a completely enclosing suture around the hernia defect without any gaps. Also, hydrodissection is useful in providing additional space for negotiating the working instruments, keeping the EN just under the peritoneum, ensuring that we do not include any muscular or subcutaneous tissue.

As there is only one 5-mm transumbilical incision for the telescope and two small punctures, for EN and VAC, the cosmetic outcomes of our approach are very good [Fig. 9]. Our parents have been very satisfied with the scarless results in post-operative follow-up.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpedsurg.2017.08.020.

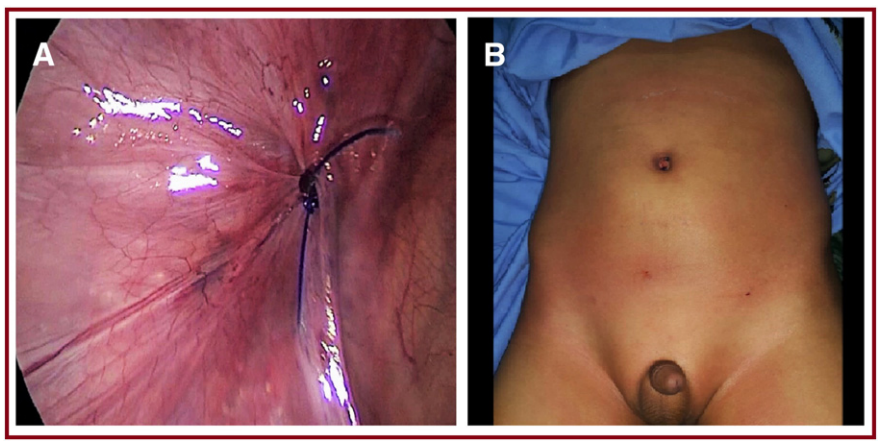

Fig. 9. Showing snugly closed IIR [A] and immediate post-operative sites of umbilical port and needles punctures [B].

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