RESEARCH ARTICLE

Needlescopic primary paediatric inguinal hernia repair by hernia sac disconnection and peritoneal closure

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Abstract

Objective: To evaluate the short-term outcome of the needlescopic hernia sac disconnection and peritoneal closure in the treatment of primary paediatric inguinal hernia.

Method: The prospective study was conducted from April 2019 to April 2021 at the Paediatric Surgery Unit of the General Surgery Department at Kafrelsheikh University Hospital, Egypt, and comprised patients aged 6-144 months having uncomplicated paediatric inguinal hernia. The patients were subjected to needlescopic hernia sac disconnection and peritoneal closure. The follow-up protocol included outpatient visits at 1 week and at 1, 3 and 6 months postoperatively to check for recurrence and other complications. Data was analysed using SPSS 24.

Results: Of the 50 patients with 65 hernias, 37(74%) were males and 13(26%) were females. The overall mean age was 50.78± 31.74 months (range: 9-120 months) and mean internal ring diameter was 11.90±3.518mm (range: 8-20mm). The mean operative time was 20.66±2.94 minutes for unilateral cases and 30.60±5.15 minutes for bilateral cases. There was no conversion to conventional laparoscopy or to open herniotomy. All cases were followed up for a mean of 11.56± 3.99 months. No recurrence was encountered in any case and the scars were invisible in 40(80%) cases 6 months postoperatively.

Conclusion: Needlescopic hernia sac disconnection and peritoneal closure was found to be feasible, safe and effective in the treatment of primary paediatric inguinal hernia.

Keywords: Inguinal, Hernia, Cicatrix, Laparoscopy, Sutures, Paediatric, Mediflex. **DOI: 10.47391/JPMA.EGY-S4-14**

Introduction

Inguinal hernia affects 1-5% of mature infants and up to 30% of premature babies.[1] Open herniotomy stands for decades as the gold standard treatment for paediatric inguinal hernia (PIH).[2]

Laparoscopic inguinal hernia repair (LIHR) has challenged conventional surgery over the past 20 years in terms of better cosmetic results, decreased postoperative pain, reduced or comparable operative time (OT), and ability to evaluate and manage latent contralateral hernias, if found, but the main concern was always the high recurrence rates.[3, 4]

LIHR can be classified into two broad categories based on the approach of internal inguinal ring (IIR) repair; intraperitoneal or extraperitoneal with insufficient proof about the ideal technique between them.[3] However, laparoscopic hernia sac disconnection and peritoneal closure replicate all steps of open repair and were found superior to other techniques, with a reported recurrence of 0.3% to 1.2%.[2, 5, 6]

Several laparoscopic studies described changing from 5mm to 2mm ports, and subsequently to a single-incision technique utilising variable instruments and needles.[7-9]

To the best of the current authors' knowledge, all needlescopic procedures for LIHR were limited to peritoneal closure without hernia sac disconnection except for 3 studies.[6, 10, 11] However, the main cause responsible for recurrence was believed to be the non-division of the hernia sac.[5]

Recently, Shalaby et al. reported a needlescopic technique where they utilised only needles and small instruments to perform hernia sac disconnection and peritoneal closure with combined extra and intracorporeal knotting.[11]

The current study was planned to evaluate the short-term outcome of needlescopic hernia sac disconnection and peritoneal closure in the treatment of primary PIH.

Patients and Methods

The prospective study was conducted from April 2019 to April 2021 at the Paediatric Surgery Unit of the General Surgery Department at Kafrelsheikh University Hospital, Egypt. After approval from the institutional ethics review committee, the sample was raised using consecutive non-probability sampling technique from among the patients attending the outpatient clinic. Those included were

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patients with uncomplicated PIH aged 6-144 months. Patients with complicated or recurrent PIH, those with hydrocoele or undescended testis, major anomalies or chronic comorbidities, such as congenital heart disease and severe chest problems, were excluded.

After taking informed consent from all the patients' parents (all patients were children and can not give consent alone), they were subjected to inguinoscrotal ultrasound (U/S) to measure the internal ring diameter (IRD) and to check for contralateral latent hernias in unilateral cases.

The procedure was done using a suture grasper device (SGD) (Mediflex Company, Islandia, New York, USA), an isolated homemade diathermy probe (DP) devised by the 2nd author, an 18-G epidural needle (EN), and an ordinary diathermy handle (DH).

Four port sites were used. These included an umbilical port for the insertion of 5mm telescope; Point A in the midline (midway between umbilicus and symphysis pubis or slightly lower in older children) for the insertion of SGD in right-sided hernias, or DP/EN for left-sided hernias; Point B at McBurney's point for insertion of DP or EN in right-sided hernias; and Point C at the corresponding McBurney's point on the left side of the abdomen for the insertion of SGD in left-sided hernias.

The patient was placed supine. General anaesthesia with endotracheal intubation was used for all patients. Port and needle sites were infiltrated with a mixture of lignocaine 2% (3mg/kg) plus bupivacaine 0.25% (2mg/kg). A 5mm, 30-degree telescope was inserted through a 5mm umbilical port with an open technique. Pneumoperitoneum was established with carbon dioxide (CO_2) at a 2 L/min flow rate and 10-15mmHg pressure depending on the patient's size and age. Laparoscopic exploration was done with the evaluation of both IIR.

For the right-sided hernia, SGD was inserted at point A, and DP was connected to a conventional DH at point B. For the left-sided hernia, SGD was inserted at point C and DP at point B. Thus, SGD was a left-sided instrument, and DP or EN were right-sided instruments in all cases (Figure 1).

The IRD was measured intraoperatively by using the marks on EN as a reference (Each mark=1cm).[9]

The vas and vessels were bluntly separated in males using traction and counter-traction by DP in the right hand, and SGD in the left hand holding the peritoneum, while the round ligament was disconnected in females. Then, circumferential peritoneal disconnection was performed using careful sharp dissection by DP in high-voltage cutting mode to avoid collateral heat (Figure 2A-C).

EN was then inserted at point B in right-sided hernias, or point A in left-sided hernias to pass through the lower edge of the disconnected peritoneum in a purse-string manner. Then, a non-absorbable 2-0 suture (Prolene®) was threaded into the EN till it appeared intraperitoneally after which it was brought outside the abdomen by the SGD in the left hand (Figure 2D).

The EN was then retracted backward with the suture thread inside and passed through the upper peritoneal leaflet to complete a purse-string around IIR, and then the second limb of the thread was withdrawn outside by the SGD again (Figure 2E).

The SGD was then inserted through the same point to withdraw both limbs together outside the abdomen. A French sliding knot was then made extracorporeally to close the peritoneal defect, followed by two intracorporeal single-instrument Shalaby-Ismail Knots[12] (Figures 2F-H).

The abdomen was then deflated, the umbilical port was removed, and 2-0 or 3-0 absorbable sutures (Vicryl®) were used to close the umbilical fascia, while other skin punctures were closed by steristrips®.

OT was estimated from skin incision to skin closure, including the time needed for port insertion and port site closure. Oral paracetamol and/or per-rectal diclofenac were given postoperatively as dose/weight. Oral fluids were allowed 2 hours postoperatively and the patients were discharged after tolerating oral feeding. Early and late postoperative complications were recorded.

The routine follow-up protocol included outpatient visits at 1 week, and at 1, 3 and 6 months postoperatively to check for recurrence and other complications. After that, patients' follow-up was done in the outpatient clinic on non-regular bases and also by phone calls for those who were unable to show up. The cosmetic outcome was evaluated by asking the patients' parents to judge the operative scars' appearance 6 months postoperatively. The scars were rated as invisible, barely visible, clearly visible and scarred, and aesthetically disturbing, according to a scale developed by Geiger et al.[13]

Data was analysed using SPSS 24. Data were expressed as mean ± standard deviation (SD) for continuous variables. Categorical variables were expressed as frequencies and percentages.

Results

Of the 50 patients with 65 hernias, 37(74%) were males and 13(26%) were females. There were 32(64%) patients with right-sided hernias, 10(20%) were left-sided and 8(16%) were bilateral. The overall mean age of the patients was

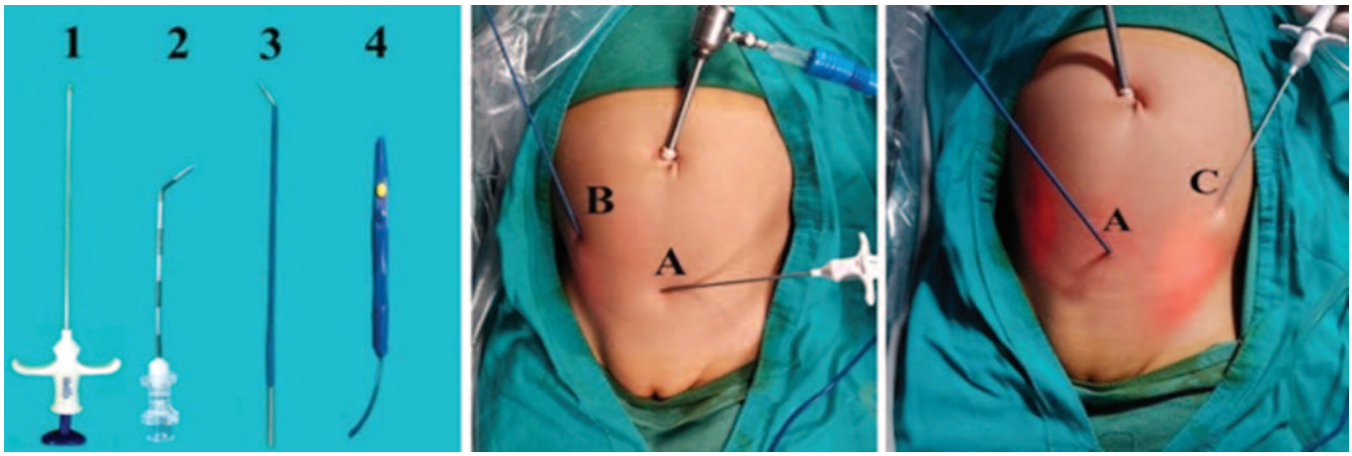

Figure 1: Figure 1: The needles used and port positions in right-sided and left-sided hernias.
1: SGD (Suture grasper device, **2**: EN (Epidural needle), **3:** DP (Diathermy probe), **4:** DH (Diathermy handle). **A:** Site of insertion of SGD in right-sided hernias or DP and EN in left-sided hernias, **B:** Site of insertion of DP and EN in right-sided hernias, C: Site of insertion of SGD in left-sided hernias.

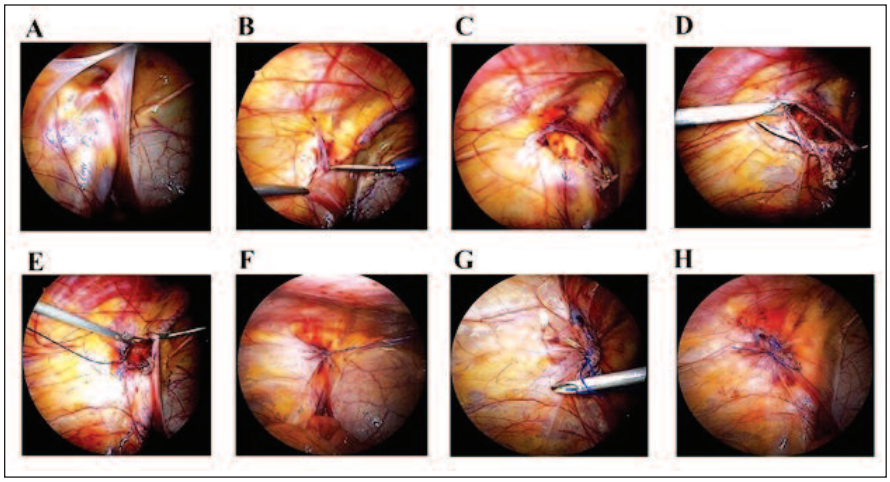

Figure 2: Figure 2: Needlescopic hernia sac disconnection and peritoneal closure in left-sided hernia in a female child.
A: Left inguinal hernia, **B:** Starting disconnection of the medial half of internal inguinal ring (IIR), **C:** Completion of disconnection of IIR, **D:** Epidural needle (EN) threading lower half of the peritoneal defect, **E:** EN threading the remaining upper half of the peritoneal defect, **F:** French knot sliding to close the defect, **G:** Addition of intracorporeal single instrument knot, **H:** Final view of the closed IIR

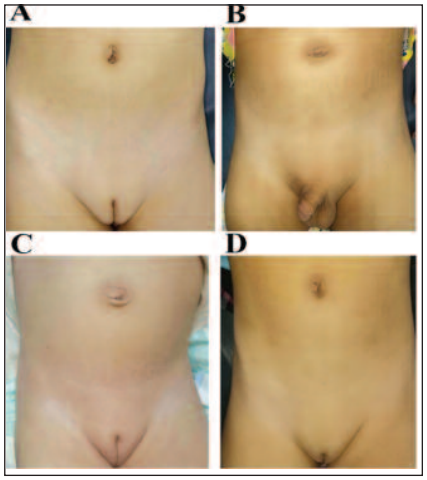

Figure 3: Late postoperative cosmetic results of 4 different cases.

50.78± 31.74 months (range: 9-120 months). Preoperative U/S examination detected 7(14%) cases to have latent subclinical hernias; 2/65 hernias(3.08%) right-sided and 5/65 hernias (7.69%) left-sided. The mean IRD, as measured by preoperative U/S, was 9.98±2.83 (range: 7.50-17.00mm).

Mean OT was 20.66±2.94 minutes (range: 14-25 minutes) for unilateral cases and 30.60±5.15 minutes (range: 22-38 minutes) for bilateral cases. There was no conversion to conventional laparoscopy or to open herniotomy. The mean IRD measured intraoperatively was 11.90±3.52mm (range: 8-20mm), which was larger than the size assessed by preoperative U/S. Also, 7(10.77%) we calculate hernias not cases so 7 hernias out of total 65 hernias, latent contralateral hernias identified by preoperative U/S were positive intraoperatively. No major intraoperative haemorrhage, no structural vessel or vascular injuries, and no other intraoperative complications were noted.

All patients tolerated oral feeding 2-4 hours postoperatively and were discharged 4-8 hours postoperatively. All cases were followed up for a mean period of 11.56±3.99 months (range: 6-18 months). No recurrences or port-site infection or port-site hernias were reported during the follow-up. Transient scrotal oedema was encountered in 2(4%) cases; both were males and stabilised with conservative management. The operative scars were evaluated by the patients' parents as invisible in 40(80%) cases, barely visible in 9(18%), and clearly visible in 1(2%) case (Figure 3).

Discussion

Minimally invasive surgery has completely altered PIH management in the last two decades. The laparoscopic approach has been the subject of most studies published during this period.[14]

Variable surgical techniques have been used for laparoscopic PIH repair in the past 20 years with the emergence of needlescopic techniques, making this type of surgery less invasive and more feasible.[15]

However, most of these needlescopic techniques include extracorporeal suture knotting and subcutaneous knot burial without peritoneal disconnection. This can have several disadvantages, including suture granulomas and an increased recurrence rate due to non-division of peritoneum or the suture material becoming loose or getting broken.[11]

Hernia sac disconnection and peritoneal closure reproduce all steps of the classic open herniotomy; dissection, division and suture closure of the peritoneal defect. These steps result in peritoneal trauma and adhesions which are believed to be the main factors responsible for durable healing and low recurrence.[5,16]

To our knowledge, there are only 3 studies that described the usage of needles in hernia sac disconnection and peritoneal closure, utilising 1.6mm Mediflex needles, as was the case in the current study, but peritoneal closure differed in the 2 recent reports[10, 11] from the older one.[6]

The age of patients in the current study ranged between 9-120 months, which was in line with literature.[8,10,14,17-19]

Patients aged <6 months were excluded to avoid structural injuries caused by operating in a narrow space, and because of the weak peritoneum, which would not have been suitable for closure with the 18G EN.

The current study had male predominance, which goes with the well-known male predominance in PIH.[17]

Most of the cases were right-sided hernias, which is similar to an earlier study.[20]

In the current study, mean OT was 20.66 for unilateral and 30.6 minutes for bilateral cases. This was compared to the only 3 needlescopic reports performing hernia sac disconnection and peritoneal closure.[6,10,11] The 1st study[6] disconnected the sac and utilised the sewing machine principle for peritoneal closure and reported only the time needed for suturing (4.83, 6.72 min for unilateral and bilateral cases, respectively) without mentioning the whole OT. The more recent study[11] performed the original procedure adopted in our study and reported mean OT to be 14.28 and 23.3 minutes for unilateral and bilateral cases, respectively. Marey et al.[10] evaluated a similar technique, but they used a venous access cannula (VAC) to act as a port for non-insulated DP and reported a mean OT of 25±1.80 and 39.58±3.61 minutes for unilateral and bilateral cases, respectively.[10] The current study used an insulated homemade DP to fit the ordinary DH to omit the need for VAC.

Many laparoscopic studies adopted the disconnection closure principle and reported mean OT ranging from 27.68 to 48.5 minutes for unilateral cases, and from 32 to 65 minutes for bilateral cases.[14,15,20] Accordingly, the needlescopic technique in the study consumed comparable or even less OT if compared to them which can be explained by the fact that laparoscopic intracorporeal suturing is technically demanding, particularly in the narrow pelvis of younger children.[11] The study used EN percutaneously to thread the peritoneal leaflets and closed them by a French sliding knot constructed extracorporeally without the need for advanced intracorporeal suturing skills.

The mean IRD intraoperatively was larger than the U/S measurement preoperatively. This can be explained by the fact that the insufflation pressure may render the IRD bigger.

All hernias in the current study were operated upon with only disconnection and peritoneal closure with no need for muscular arch repair regardless of the IRD.

Shehata et al. suggested using a muscular arch repair for defects >25mm, peritoneal closure alone for defects <15mm, and peritoneal disconnection and closure for moderate defects 15-25mm.[21] Others recommended peritoneal disconnection and closure for IRD >10mm and a simple disconnection for IRD <10mm[14, 22] while Libri et al. recommended a muscular arch repair for all hernias with IRD >10mm.[23]

No major intraoperative complications were encountered in the current study, which was similar to literature.[14,15,19,22,24] This can be explained by the better laparoscopic visualisation and magnification, and easier dissection of the vas and gonadal vessels off the peritoneum, minimising their injury.

Performing the original procedure evaluated by this study, Shalaby et al. reported iatrogenic inferior epigastric vascular injury in 2(0.5%) patients. They completed the procedure without conversion by deflating the CO_2 and applying external abdominal wall compression for 5 minutes.[11]

All cases in this study were completed laparoscopically without conversion to open surgery. Many studies have reported 0% conversion rate.[8, 11, 12, 15]. On the contrary, conversions have also been reported.[5,24]

The hospital stay ranged 4-8 hours and all cases were discharged after tolerating oral feeding on the operative day itself, which is in line with earlier studies.[4,11,15], while Elbatarny et al. opted to discharge all patients in the morning after the surgery due to lower age of their patients' and the rural residence of some patients.[14]

Incomplete disconnection, keeping a peritoneal gap over the vas and vessels in males, loose or broken knots, and large hernia defects without muscular arch repair are all possible reasons for recurrence after laparoscopic PIH repair. However, the non-division of the hernia sac remains the most important factor causing recurrence.[20]

No recurrences were reported in the current study which had a mean follow-up of 11.56 months. This matches the results by Shalaby et al. and Marey et al., who performed the same needlescopic technique, and reported no recurrences after a mean follow-up of 19.6 and 9 months, respectively.[10, 11] No recurrence was also encountered in different series performing laparoscopic hernia sac disconnection and peritoneal closure.[5, 14, 15]

However, other studies reported variable recurrence rates as they only disconnected the peritoneum without closure or ligated the peritoneum without disconnection. Elbatarny et al. reported a 15% recurrence rate in the disconnection-only group, with no recurrence in the disconnection and closure group.[14] Similarly, García-Hernández et al., who performed disconnection without closure, reported a 0.53% recurrence rate.[19] Takehara et al. performed peritoneal closure without disconnection and reported a 0.73% recurrence rate.[25] Abd-Alrazek et al. recommended disconnection and closure rather than closure alone as he encountered a 2.6% recurrence rate in the closure-only group with no recurrence in the disconnection and closure group.[20] Also, Almetaher et al. operated on 33 cases with bilateral PIH where they closed one side and disconnected and closed the other side. They reported a 2% recurrence rate in the closure-only sides with no recurrence in the disconnection and closure sides.[4]

The cosmetic outcome is a crucial aspect of parent satisfaction. The scars of the conventional laparoscopic working ports are small, but visible on the anterior abdominal wall if compared to the nearly hidden inguinal crease incision of the open repair.[11]

In this study, the parents rated the wound cosmesis at 6 months postoperatively as invisible in 80%, barely visible in 18%, and clearly visible in 2% cases.

The excellent cosmetic outcome matched earlier results.[10,11]

This can be explained by the fact that conventional laparoscopic working ports were replaced by 1.6mm needle punctures that became nearly unnoticeable after 6 months. The camera port scar was hidden inside the umbilicus by using a vertical 5mm transumbilical incision instead of the usual transverse supraumbilical incision.

In terms of limitations, the current study had a relatively small sample with no comparative group. Besides, the sample size was not calculated, and the cosmetic outcome assessment was essentially subjective.

Conclusion

Needlescopic division of the hernia sac at IIR and suture closure of the peritoneal defect together comprised a feasible, safe, effective and reproducible technique for PIH repair, obviating the need for advanced laparoscopic intracorporeal suturing skills.

Acknowledgment: The study is dedicated to the soul of the late Professor Rafik Shalaby, who devised the technique, taught the authors, and shared some of his cases with them.

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References

1. Esposito C, Gargiulo F, Farina A, Del Conte F, Cortese G, Servillo G, et al. Laparoscopic Treatment of Inguinal Ovarian Hernia in Female Infants and Children: Standardizing the Technique. J Laparoendosc Adv Surg Tech A 2019;29:568-72. doi: 10.1089/lap.2018.0630.
2. Wang D, Yang P, Yang L, Jin S, Yang P, Chen Q, et al. Comparison of laparoscopic percutaneous extraperitoneal closure and laparoscopic intracorporeal suture in pediatric hernia repair. J Pediatr Surg 2021;56:1894-9. doi: 10.1016/j.jpedsurg.2020.11.022.
3. Saranga Bharathi R, Arora M, Baskaran V. Minimal access surgery of pediatric inguinal hernias: a review. Surg Endosc 2008;22:1751-62. doi: 10.1007/s00464-008-9846-7.
4. Almetaher HA, Hassan HS, Effat A, Elhalaby EA. Laparoscopic repair of congenital inguinal hernia: a comparative study between purse–string suture and peritoneal disconnection with ligation techniques in bilateral cases. J Ped Endosc Surg 2020;2:83-9. Doi: 10.1007/s42804-020-00052-y.
5. Becmeur F, Philippe P, Lemandat-Schultz A, Moog R, Grandadam S, Lieber A, et al. A continuous series of 96 laparoscopic inguinal hernia repairs in children by a new technique. Surg Endosc 2004;18:1738-41. doi: 10.1007/s00464-004-9008-5.
6. Shalaby R, Abdalrazek M, Hamed A, Elhady S, Ibrahim R, Shahin M, et al. Novel application of the sewing machine principle; a new simplified intracorporeal suturing technique for pediatric inguinal hernia. J Pediatr Surg 2019;54:1505-9. doi: 10.1016/j.jpedsurg.2019.01.054.

7. Ozgediz D, Roayaie K, Lee H, Nobuhara KK, Farmer DL, Bratton B, et al. Subcutaneous endoscopically assisted ligation (SEAL) of the internal ring for repair of inguinal hernias in children: report of a new technique and early results. Surg Endosc 2007;21:1327-31. doi: 10.1007/s00464-007-9202-3.
8. Patkowski D, Czernik J, Chrzan R, Jaworski W, Apoznański W. Percutaneous internal ring suturing: a simple minimally invasive technique for inguinal hernia repair in children. J Laparoendosc Adv Surg Tech A 2006;16:513-7. doi: 10.1089/lap.2006.16.513.
9. Shalaby R, Elsayaad I, Alsamahy O, Ibrahem R, El-Saied A, Ismail M, et al. One trocar needlescopic assisted inguinal hernia repair in children: a novel technique. J Pediatr Surg 2017. doi: 10.1016/j.jpedsurg.2017.08.020. [ahead of print].
10. Marey MA, Elshimy KM, Hashish MS, Elsawaf MI. Evaluation of One Trocar Needlescopic Assisted Peritoneal Disconnection and Closure in Pediatric Inguinal Hernia Repair. Asian Journal of Research in Surgery(AJRS) 2021;6:5-11.
11. Shalaby R, Negm M, El-Sawaf M, Elsaied A, Shehata S, Hamed A, et al. Needlescopic Disconnection and Peritoneal Closure for Pediatric Inguinal Hernia Repair: A Novel Technique. Surg Laparosc Endosc Percutan Tech 2021;32:272-8. doi: 10.1097/SLE.0000000000001001.
12. Ismail M, Shalaby R. Single instrument intracorporeal knot tying during single port laparoscopic hernia repair in children: a new simplified technique. J Pediatr Surg 2014;49:1044-8. doi: 10.1016/j.jpedsurg.2014.02.082.
13. Geiger S, Bobylev A, Schädelin S, Mayr J, Holland-Cunz S, Zimmermann P. Single-center, retrospective study of the outcome of laparoscopic inguinal herniorrhaphy in children. Medicine (Baltimore) 2017;96:e9486. doi: 10.1097/MD.0000000000009486.
14. Elbatarny AM, Khairallah MG, Elsayed MM, Hashish AA. Laparoscopic Repair of Pediatric Inguinal Hernia: Disconnection of the Hernial Sac Versus Disconnection and Peritoneal Closure. J Laparoendosc Adv Surg Tech A 2020;30:927-34. doi: 10.1089/lap.2018.0679.
15. Wheeler AA, Matz ST, Schmidt S, Pimpalwar A. Laparoscopic inguinal hernia repair in children with transperitoneal division of the hernia sac and proximal purse string closure of peritoneum: our modified new approach. Eur J Pediatr Surg 2011;21:381-5. doi: 10.1055/s-0031-1291181.
16. Blatnik JA, Harth KC, Krpata DM, Kelly KB, Schomisch SJ, Ponsky TA. Stitch versus scar--evaluation of laparoscopic pediatric inguinal hernia repair: a pilot study in a rabbit model. J Laparoendosc Adv Surg Tech A 2012;22:848-51. doi: 10.1089/lap.2012.0137.
17. Shehata SM, El Attar AA, Attia MA, Hassan AM. Laparoscopic herniotomy in children: prospective assessment of tertiary center experience in a developing country. Hernia 2013;17:229-34. doi: 10.1007/s10029-012-1031-1.
18. Schier F. Laparoscopic surgery of inguinal hernias in children--initial experience. J Pediatr Surg 2000;35:1331-5. doi: 10.1053/jpsu.2000.9326.
19. García-Hernández C, Carvajal-Figueroa L, Suarez-Gutiérrez R, Landa-Juárez S. Laparoscopic approach for inguinal hernia in children: resection without suture. J Pediatr Surg 2012;47:2093-5. doi: 10.1016/j.jpedsurg.2012.06.026.
20. Abd-Alrazek M, Alsherbiny H, Mahfouz M, Alsamahy O, Shalaby R, Shams A, et al. Laparoscopic pediatric inguinal hernia repair: a controlled randomized study. J Pediatr Surg 2017;52:1539-44. doi: 10.1016/j.jpedsurg.2017.07.003.
21. Shehata SM, Attia MA, Attar AAE, Ebid AE, Shalaby MM, ElBatarny AM. Algorithm of Laparoscopic Technique in Pediatric Inguinal Hernia: Results from Experience of 10 Years. J Laparoendosc Adv Surg Tech A 2018;28:755-9. doi: 10.1089/lap.2017.0273.
22. Riquelme M, Aranda A, Riquelme-Q M. Laparoscopic pediatric inguinal hernia repair: no ligation, just resection. J Laparoendosc Adv Surg Tech A 2010;20:77-80. doi: 10.1089/lap.2008.0329.
23. Libri M, Destro F, Cantone N, Pavia S, Lima M. "Double N": Evolution of the Surgical Technique for Laparoscopic Herniorrhaphy After 10-Year Experience in a Single Center. J Laparoendosc Adv Surg Tech A 2015;25:684-8. doi: 10.1089/lap.2014.0410.
24. Van Batavia JP, Tong C, Chu DI, Kawal T, Srinivasan AK. Laparoscopic inguinal hernia repair by modified peritoneal leaflet closure: Description and initial results in children. J Pediatr Urol 2018;14:272.e1-e6. doi: 10.1016/j.jpurol.2018.02.015.
25. Takehara H, Yakabe S, Kameoka K. Laparoscopic percutaneous extraperitoneal closure for inguinal hernia in children: clinical outcome of 972 repairs done in 3 pediatric surgical institutions. J Pediatr Surg 2006;41:1999-2003. doi: 10.1016/j.jpedsurg.2006.08.032.