

Review Article

Surgical Repair of Pediatric Indirect Inguinal Hernia: Great Waves of Change from Open to Laparoscopic Approach

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- Open technique
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Abstract

This paper reviewed the current procedures for surgical repair of indirect inguinal hernias, highlighting the move from traditional open herniorrhaphy to laparoscopic repair, focusing on the appeal and success of laparoscopic approaches compared to open techniques, and surveyed which method is likely to survive as the gold standard in the future.

Integrated comparisons did not favor the laparoscopic approach over open repair, because the wide varieties of laparoscopic approaches were associated with varying results. A recent questionnaire administered to 187 attendees of European Pediatric Surgeons' Association – British Association of Pediatric Surgeons (EUPSA-BAPS) meeting from 46 countries revealed that most pediatric surgeons still favor open techniques and a laparoscopic approach has yet to be accepted.

Analysis of individualized techniques and outcomes in various morbidities, however, revealed the superiority of laparoscopic techniques over open techniques with regard to greater operative ease, fewer complications, and lower recurrence rates, especially in incarcerated/sliding hernias and recurrent hernias.

Although laparoscopic hernia repair has not been established long enough to fully consider the risks posed by late complications, growing experience, wider adoption, a decreased prevalence of complications and increasing advantages favor the emergence of the laparoscopic approach as the gold standard in the future.

INTRODUCTION

Inguinal hernia has affected human kind since humans first achieved bipedal walking. More than one hundred years after modern concepts were introduced for the repair of hernias, general surgeons, including pediatric surgeons, have addressed this concern in daily practice. Despite the vast accumulation of anatomical and physiological knowledge, as well as technical improvements, unresolved problems remain, such as recurrence, metachronous contralateral inguinal hernia (MCIH), and reproductive system complications, among others. Therefore, many reports have raised the need for improving surgical outcomes via new techniques that minimize invasiveness, diminish complications, save time in the operation room, reduce hospital costs and improve cosmesis, including critical appraisals [1].

In the current state of pediatric inguinal hernia repair, the high ligation of the patent processus vaginalis (PPV) at the internal inguinal ring (IIR) via a groin incision has been

established as a proven procedure with a high success rate and a low rate of complications [2]. With the advent of the laparoscopic era, however, a trend toward the application of laparoscopic techniques for pediatric herniorrhaphy has begun, and this trend seems to be accelerating recently. The aim of the current review was to focus on the appeal and success of laparoscopic approaches compared to open techniques and to survey which method is likely to survive as the gold standard in the future.

A history of the open technique

Inguinal hernia has been treated via surgery since the 5th century. The rapid evolution of medicine and surgery, including antisepsis and anesthetic procedures, during the early 19th century, supported the practice of hernia surgery [3]. Advances in anatomical knowledge led to the concept that indirect inguinal hernias are the result of a combination of two factors: the presence of a potential space within the processus vaginalis and the concomitant weakening of the transversalis fascia crura surrounding the IIR [4]. Several techniques following this

concept, including high ligation of the hernia sac and narrowing of the IIR, resulted in hernia recurrence in all patients [3].

Bassini introduced a breakthrough in hernia treatment in 1887. His procedures, which intended the complete reconstruction of the inguinal canal, were widely performed for indirect and direct inguinal hernias. All subsequent techniques were variants of Bassini's concept until the introduction of artificial materials [3]. In 1991, Nyhus, Klein and Rogers wrote a textbook with the goal of reviewing the vast literature related to inguinal hernia [4]. This book clarified the complete anatomical relationship of the laminar structure of the inguinal region, which works as a shutter and sphincter mechanism. Understanding the anatomical relationship helped to decrease the incidence of recurrent hernias, which plagued the surgical world at that time. Bassini's technique, when applied to Type I and II hernias, was considered as misguided, because it destroyed the normal inguinal floor, resulting in recurrence. The recommended repair was individualized to the type of hernia: Type I, high ligation of the sac, no repair; Type II, high ligation of the sac, transversalis fascia repair of IIR (plastic repair); Type III B, ilio pubic tract repair with or without mesh [4].

In the field of pediatric surgery, in 1899, Ferguson proposed hernia repair via exposure, dissection, simple high ligation and removal of the hernial sac; Potts et al., successfully applied this technique to the pediatric population [5]. The textbook "Pediatric Surgery", published in 1979 [6], provided a detailed explanation of surgical techniques for boys and girls, recommending a lowest crease incision instead of the oblique incision used in adults, which was fundamentally incorporated in the textbook published in 1986 [2]. Interesting differences in the practice recommended in different generations include mandatory complete removal of the distal sac because incomplete removal of the sac resulted in recurrence according to the former textbook, whereas it was not necessary in the latter textbook; alternatively, a dilated IIR with a large hernia might need to be narrowed by suturing the edges of the transversalis fascia.

Numerous reports have appeared over the last two decades regarding topics such as the optimal timing of an operation [7], minimization of the skin incision [8], and techniques for large hernias in infants and older children [9-11]. Thus, the peripheral portions of the procedures have been altered because of evolving techniques and the analysis of outcomes; however, the fundamental concepts of Ferguson and Potts have remained as the gold standard for the repair of indirect hernia in infants and children [12].

Emergence of laparoscopic approach

In the 1950s, routine contra lateral inguinal exploration was thought to decrease the overall incidence of hernias in adults because of the 60% incidence of positive exploration [13,14]. A questionnaire completed by 40 senior pediatric surgeons in North America in 1981 revealed that 80% of the responders routinely explored the opposite side in boys, and 90% did so in girls [15]. However, the incidence of MCIH after the repair of unilateral hernia was much lower than the positive rate of contralateral PPV (cPPV) [16,17]. Since then, controversy has existed as to whether the asymptomatic contralateral side should be explored or observed.

The laparoscopic approach was first used to resolve this problem in 1992 [18]. Initially, diagnostic laparoscopy was performed through the ipsilateral hernial sac during open herniorrhaphy for unilateral inguinal hernia and a positive cPPV was closed using the open approach [19-22]. Technical modifications followed to decrease false-negative cases and to increase accuracy; e.g., a silver probe inserted through the abdominal wall to manipulate the doubtful IIR [23], and laparoscopy conducted through the umbilicus to enable a direct field of view [24]. Trans inguinal laparoscopy with a large angle or flexible scope, the trans umbilical approach, low-intra-abdominal pressure during laparoscopy, and broad cPPV definitions were recommended to reduce the occurrence of MCIHs [25,26]. A meta-analysis brought this controversy to an end, surpassing previously developed diagnostic tools such as the "silk glove sign", herniography, preoperative sonography, and intra operative diagnostic pneumo peritoneum, revealing sensitivity and specificity values of 99.4% and 99.5%, respectively [27].

Diagnostic laparoscopy through the umbilicus created the potential to repair a cPPV during the same session without the addition of a crease incision. El-Gohary first conducted a procedure with loop ligation of the hernial sac during diagnostic laparoscopy among girls in 1997 [28]. Laparoscopic hernia repairs based on the Ferguson and Potts principle (i.e., simple high ligation of the PPV at the IIR) was initially practiced only in girls [29,30] but was then extended to boys [31,32]. Over the last two decades, numerous techniques to address inguinal hernias have emerged. These techniques are primarily divided into two groups based on their approach to repairing the IIR, i.e., either intra peritoneally or extra peritoneally. Bharathi et al., comprehensively reviewed the articles addressing laparoscopic hernia repair [33].

Intraperitoneal approach

This approach arose from the natural extension of applying the usual laparoscopic procedures to the abdomen. These techniques involved the intracorporeal looping of inverted hernial sac without knotting, which can only apply to girls [28], the intracorporeal placement of sutures in a Z, W or purse-string figure, including only the peritoneum or some underlying connective tissue, at the orifice of the PPV and with either intracorporeal knotting (Figures 1,2) or intracorporeal ligation using a knot pusher as a method applicable to both sexes [34-36]. However, these techniques were associated with higher rates of recurrence, likely due to the tension at the closure of the internal opening, breakage of the peritoneum by the purse-string thread, or the sutures apart from the medial margin of the IIR that were in front of the vas and vessels.

Subsequently, improved techniques to minimize the recurrence were developed, including a W-shaped suture of the IIR with a previous incision to the lateral wall of the sac [37], IIR closure with a purse-string suture covered by secondarily sutured umbilical ligament [38,39], laparoscopic iliopubic tract repair [31,40] and the circumferential division of the PPV at the level of the IIR followed by sutures in a lying 8 or purse-string figure, reproducing all of the steps of open repair except groin incision (Figure 3) [41-45].

These techniques decreased the recurrence rate, although the technique requires mastery in intracorporeal suturing and

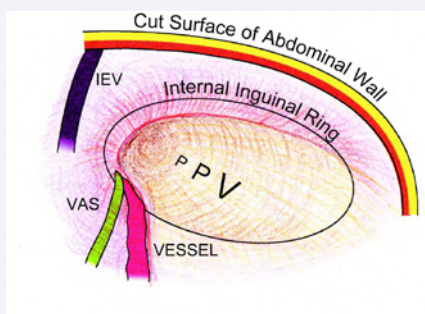


Figure 1 Schematic drawing of right internal inguinal ring with PPV. Abbreviations: IEV: Inferior Epigastric Vessels; PPV: Patent Processus Vaginalis; VAS: Vas Deference; VESSEL: Testicular Vessels

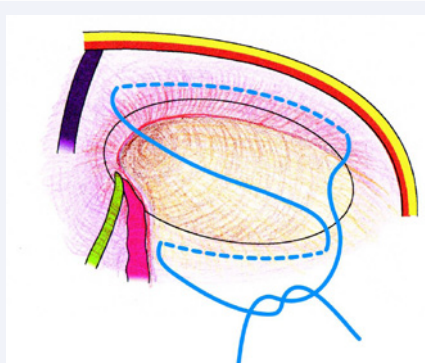


Figure 2 Intraoperative approach with placement of a suture in a figure of Z at the orifice of PPV and intraoperative knotting. Dotted lines indicate a suture running through the extraperitoneal space.

technical expertise to avoid jeopardizing the vas and vessels [33]. Another technique aimed to functionally close the IIR with a peritoneal flap made of a detached wall of the sac flipped over medially to cover the hernia site to form a one-way peritoneal valve [46]. However, this elegant technique lacked reproducibility and was associated with high intraoperative complications and recurrence rates [47].

Extraperitoneal approach

This approach was generated from a totally different concept by which to overcome the need for intracorporeal suturing and knotting. This concept basically consists of the extraperitoneal encircling of the IIR with a suture introduced percutaneously and extracorporeal tying. A suture held on the tip of a sharp instrument is introduced percutaneously and advanced along the medial or lateral hemi-circumference of the IIR extra peritoneally, in sequence, to place a suture around the IIR circumferentially, which is finally taken out at the puncture site where the suture was initially introduced. Both ends of the suture are tied extracorporeally and the knot is buried beneath the puncture site.

At the medial aspect of the IIR, the suture is advanced through a plane between the peritoneum and the vas and vessel structures or passed intraperitoneally just enough to bypass these structures and then reintroduced into the extraperitoneal plane (either skipped or jumped over; Figure 4,5).

These techniques are far simpler and technically easier than intracorporeal suturing and tying. The instruments used for this aim were a maxillary steel awl [48], a swaged-on needle and a Tuohy needle [49], a large suture needle [50,51], an injection needle [52], a specially devised needle such as the "Reverdin needle" [53], "Lapaherclosure" [54] or the "Endoneedle Kit" [55].

The open approach vs the laparoscopic approach

Overview: Several review articles regarding pediatric inguinal hernia have discussed the trend toward the laparoscopic

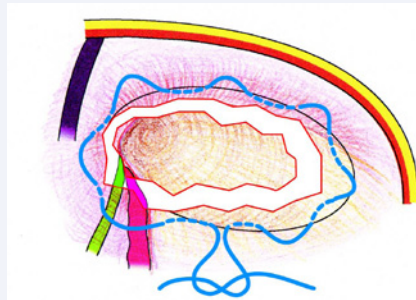


Figure 3 Intraoperative approach with circumferential division of the PPV at the level of the IIR followed by sutures in a purse-string fashion, reproducing all the steps of open repair except for groin incision.

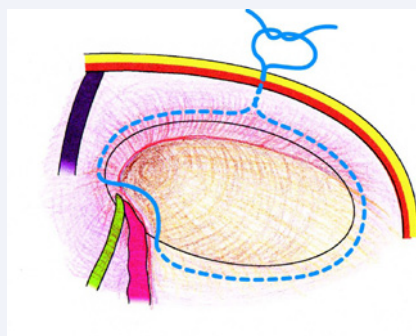


Figure 4 Extraperitoneal approach with extraperitoneal encircling of the IIR with a suture introduced percutaneously and extracorporeal knotting. The knot is buried beneath the puncture site. The suture jumps over the vas and vessels to avoid involvement in the ligation.

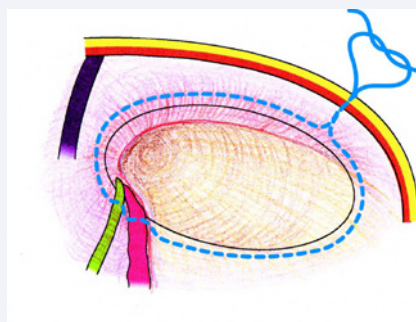


Figure 5 Extraperitoneal approach with completely extraperitoneal encircling of the IIR. The suture is advanced through a plane between the peritoneum and the vas and vessels, leaving them outside of the ligature.

approach. Brandt (2008) suggested avoiding the open exploration of the contralateral side because of the potential risk of infertility. The contralateral side can be explored via laparoscopy or left alone, and the high ligation of the hernial sac can be performed using open or laparoscopic techniques [56]. In his critical appraisal, Rosenberg (2008) reported that the use of laparoscopy was increasing for pediatric herniorrhaphy. However, it was still not evident whether pediatric hernia repair should be performed laparoscopically or as an open operation [1]. Lao et al. (2012) stated that most laparoscopic series to date have been associated with an increased recurrence rate compared with open repair; with increasing experience, however, the recurrence rate has approached that of open repair in some series [57].

One interesting report suggested conservatism among surgeons. An analysis of the EUPSA-BAPS 2012 questionnaire among 187 participants across 46 countries revealed that 79% of respondents practiced laparoscopic surgery for pediatric surgical conditions; however, only 22% routinely performed laparoscopic inguinal hernia repair [58]. Only 15% of respondents performed laparoscopy after incarceration, although this approach has been recommended in the case of incarcerated/sliding inguinal hernias [59,60]. The open approach was preferred by 83% of responders for its considerable advantages with respect to less risk of recurrence, less abdominal organ injury, less vas/vessel injury, and the short operation time [58].

Comparative study: Electronic searches in PubMed database restricted to comparative study between laparoscopic herniorrhaphy (LH) and open herniorrhaphy (OH) included the following types of studies: two retrospective comparative studies [47,61], four prospective comparative studies (of which two studies compared a LH group and an OH group allocated by patient/parent preference with informed consent [55,62], and two used randomized comparisons [63,64] and one meta-analysis [65]. In the comparative studies in which the grouping was performed with parental choice, the majority of parents preferred LH based on its postoperative cosmetic superiority, bilateral IIR inspection and simultaneous repair of an unattractive umbilicus [55,62]. In these studies, the results varied widely based on the methods of LH. Laparoscopic flip-flap repair showed unsatisfactory outcomes with a high incidence of intraoperative complications (LH: vas injury 7%, technical failure 20% vs. OH: 0%) and recurrence (27% vs. 0%, respectively) [47].

With an intraperitoneal approach with a purse-string suture of the IIR (with or without division of the PPV), the LH group experienced less pain, and their recovery and wound cosmesis were more satisfactory than those of the OH group. The mean operation time was longer in the LH group for unilateral repair but equal for bilateral repair between both groups. Differences in the recurrence rates between LH and OH groups were not significant (LH: 0.8%, 3.3%, and 0% vs. OH: 1.7%, 6.0%, and 0%, respectively) [62-64].

Using the extraperitoneal approach with a simple encircling and ligation of a PPV at the IIR, LH was superior to OH with regard to technical simplicity with a short operation time, and the reproductive systems remained intact. The mean operation time was shorter in the LH group for bilateral repair, although it was the same for unilateral repair between the two groups.

The differences in recurrence rates between LH and OH were not significant (LH: 0.2%, and 0.9% vs. OH: 0.7%, and 0%, respectively) [55,61].

A significant difference was observed with regard to the incidence of MCIH for both intraperitoneal and extraperitoneal approaches compared with OH (LH: 0.8%, 0%, 0%, 0%, and 0% vs. OH: 1.7%, 2.2%, 9.7%, 11.9%, and 6.0%, respectively) [55,61-64]. In a meta-analysis, Yang et al., (2011) favorably evaluated laparoscopic repair because it is superior to open herniorrhaphy in the repair of bilateral hernias with short operative times and lower rates of MCIH [65]. Chan et al., emphasized the superiority of laparoscopic repair because of the reduced pain, faster recovery and better cosmesis [63].

Comparisons of individual morbidity

Incarcerated/sliding hernia: Unlike typical elective open herniorrhaphies, hernias containing incarcerated and/or sliding viscera are much more difficult and troublesome, with high rates of postoperative complications [66-68]. The literature produced during the OH era reported a 12% incidence of incarceration/strangulation among 2,764 paediatric hernias at admission [66]. Operations for incarcerated hernias in infants are particularly difficult because the sac is edematous and easily torn, rendering the testicular vessels and the vas vulnerable to trauma [2]. Furthermore, inspecting the contents of the hernial sac is extremely difficult after reduction [67,69]. The overall complication rate after elective hernia repair was approximately 2%; this figure rose from 19% to 31% following operations for incarcerated hernias [66,68,70]. Reported complications include infarction or atrophy of the testis or ovary, acquired undescended testis, vas transaction, bowel obstruction, intestinal necrosis, wound infection, and recurrent hernia [70,71].

A laparoscopic approach to the incarcerated hernia has been attempted both intraperitoneally [69-72] and extraperitoneally [60]. Nah et al. [71] emphasized the superiority of the intraperitoneal approach in his comparative study with regard to operative complications, stating that LH presented a lower complication rate (4%; 1 recurrence) than OH (14%; 1 vas transaction, 1 testicular ascend, 2 testicular atrophies, and 1 recurrence); however, the operation took more time in the LH group. Endo et al. [60] completed repairs in all patients using the extraperitoneal approach without conversions, serious complications or recurrence. The mean operation time in the LH group was shorter than that in the OH group, indicating the technical ease of LH [60]. The advantages of the laparoscopic approach are a lower incidence of complications, technical ease, the surgical bypass of all oedematous tissue, leaving the cord structures untouched, reduction under direct visual control, inspection of the incarcerated organ at the end of the procedure, and simultaneous repair of the cPPV, if present [69,71]. The advantages of LH were highlighted in female infants with sliding or incarcerated ovary/adnexa. To treat ovary/adnexa incarceration/sliding, including uterine sliding by LH, the IIR can be encircled with a suture proximal to the IIR level after reducing the prolapsing organs, placing all of the surrounding viscera out of the IIR, without any special resources, unlike with OH [60].

In traditional open repair of incarcerated/sliding hernias,

preoperative diagnostic imaging, such as ultrasound and computed tomography, are recommended for differentiating the hernial content [73-75]. The laparoscopic approach can free patients from these preoperative examinations because intraperitoneal inspections resolve every ambiguity near the IIR and in the hernial sac [60].

Neonates and premature infants: Substantial debate exists regarding performing repairs on premature infants with an inguinal hernia. In the 1980s, many pediatric surgeons have been reluctant to operate on premature infants with reducible hernias because of the surgical difficulties due to their fragile hernia sacs and spermatic cords, postoperative apnea and bradycardia requiring ventilatory support [76]. In accordance with the development of contemporary neonatal intensive care, a trend toward earlier repair (before discharge from the neonatal intensive care unit [NICU]) has emerged to prevent the risk of incarceration and its associated complications [76-79]. In a survey of the members of the American Academy of Pediatrics, Section on Surgery in 2005, 63% of the respondents indicated that they would perform inguinal herniorrhaphies just prior to discharge from the NICU [80]. Early surgical interventions might avoid operative difficulties due to long-standing hernias and the gonadal ischemia caused by incarceration [79,81]. Contralateral groin exploration was performed 96% of the time, because of high association with cPPV was found in 85% of the cases [77].

Certain surgeons have recommended repair as an elective procedure in a later stage or individually timing the repair to minimize anesthetic and technical risks because herniorrhaphy prior to discharge from the NICU is associated with a prolonged hospital stay, and early repair does not prevent incarceration [82,83]. Furthermore, premature infants have higher complication rates than term infants [84]. Toki et al. emphasized that most preterm neonates with PPV regress spontaneously and should be observed until at least 9 months old without attempting hernia repair [85].

Reports of numerous extraperitoneally repaired patients involved premature infants who were treated on demand even in the NICU without intraoperative complications or recurrence [54,55]. However, because these procedures require a high level of technical skill because of the narrow working space and larger proportion of bowel loops in the peritoneal space, reports of small infants with inguinal hernias are scarce. Two papers describing the intraperitoneal approach among small infants weighing less than 3 kg or 5 kg, including premature infants, reported preferable outcomes without major intraoperative complications and recurrence rates ranging from 0% to 4.4% [86,87] compared with overall complication rates of 2% to 8% and recurrence of 1% to 3% [78]. In general, anesthesiology considerations and infant size favor OH among premature infants with inguinal hernias [88].

Recurrent hernia: Reoperations for recurrent hernias that developed after open herniorrhaphy can be extremely difficult because of the dense fibrous tissue in the operative field resulting from the previous operation [89]. Careless dissection of inguinal structures with altered anatomy can increase testicular atrophy rates [90]. Laparoscopic approaches that can close the reopened IIR, maintaining distance from a fibrotic inguinal canal, might be

more advantageous than an open approach. In an extraperitoneal repair series involving recurrent hernias, the reopened IIR was closed without paying particular attention to the inguinal structures [91]. A study that compared operation times, success rates and complications associated with secondary laparoscopic repair (with intraperitoneal purse-string sutures) for recurrent hernias after primary open repair with previously collected data from primary laparoscopic repairs, did not show any significant differences [92]. A study comparing laparoscopic repairs with open repair in recurrent hernias revealed that the operation time was much shorter in the laparoscopic repair group than in the open repair group [90]. All recurrent hernias after previous laparoscopic repairs were repaired using laparoscopic approach again without additional recurrence [37,44,45,53,91,93]. Laparoscopic repair is the preferred operation for recurrent indirect inguinal hernia after open repair [92].

Complications

Postoperative hernia recurrence: It is difficult to eradicate postoperative recurrence as an outcome of herniorrhaphy. The reported recurrence rates after conventional open herniorrhaphy among children range from 0.8% to 3.8% [94]. The technical errors that affect recurrence are, (1) failure to find the hernial sac, (2) insufficient low-level ligation of the sac, (3) injury to the floor of the inguinal canal due to operative trauma, (4) failure to close the internal ring in girls, and (5) postoperative wound infection and hematoma [94,95]. The laparoscopic technique can avoid all of these possible causes of recurrence [63].

Despite the fact that the laparoscopic approach theoretically provides high ligation of the PPV more proximally than does open repair, higher rates of recurrence have been reported using this approach. In a recent review of the recurrences after laparoscopic hernia repair, the most common site of recurrence occurred along the medial internal ring at the site of passage of the cord structures [96]. The exclusion of the cord structures from the repair leads to an inherent weakness at this location (specifically when the peritoneum is traversed to safely avoid these structures). Another consideration is that the peritoneum-to-peritoneum approximation might be inadequate to affect proper scar formation and healing [50]. Intraperitoneal approaches with simple Z-type or purse-string sutures are associated with recurrence rates ranging from 3.1% to 4.4% [34,40,93].

Another procedure with an extraperitoneally placed circuit suture that jumped over the vas and vessels reported recurrence rates ranging from 0% to 4.3%, which were lower than those associated with intraperitoneal closures [48,50-52,54]. In methods that allow complete encircling of the IIR, the suture is passed between the peritoneum and the vas and vessel structures to avoid skipping any areas; alternatively, a laparoscopic technique involving complete division and then stitching of the PPV at the IIR achieved the lowest recurrence rates ranging from 0 to 1.3% [41-43,55].

Injury to the reproductive system: The drawbacks associated with the reproductive system are a hidden but not negligible. Childhood inguinal herniorrhaphy is one of the most frequent causes of infertility [97]. Testicular atrophy and injury to the vas are complications with far-reaching consequences in

open herniotomy [33]. One report suggested that either the vas deferens or epididymis was found in 0.53% of all hernial sacs removed during open herniorrhaphy [98]. The incidence of vasal injury during inguinal herniorrhaphy has been estimated at 0.5% [99].

Theoretically, the incidence of testicular atrophy is rare in LH because of the multiple collateral circulations of the testis, which makes dissection at the internal ring level extremely safe [100]. The reported incidence of postoperative testicular atrophy is 0% to 0.4% using the open approach [9,11,55,62,68], 0% to 0.2% using the laparoscopic intraperitoneal approach [34,38,40,42,45,93] and 0% using the laparoscopic extraperitoneal approach [50,54,55,61].

Fallopian tube obstruction or the displacement of the ovary and Fallopian tube in the retroperitoneal space in women with histories of childhood inguinal herniorrhaphy has been reported as a cause of infertility [101-104]. Open repair requires the traction of the round ligament from the outside to obtain an acceptable visual field and achieve high ligation [105], leaving the remainder of the U-turned Fallopian tube in the hernial sac, which acts as a sliding component after reducing the ovary. The round ligament is shortened, and the ovarian suspensory ligament is ventrally dislocated, especially in female infants with sliding/incarcerated hernias [106]. Careless handling of the neck of the hernial sac can induce cutting or the ligation of the Fallopian tube. These complications have been observed much less frequently using laparoscopic approach, perhaps because of the more precise dissection and recognition of the organs enabled by magnification [33].

Academic aspect: A rich store of knowledge has been obtained based on the enormous accumulation of empirical evidence during laparoscopic surgeries. Some of these discoveries have led to resolutions of concerns regarding LH, such as the use of a simple closure without the division of the hernial sac with evidence of a completely closed IIR without adhesion, which protects against future recurrence [105]. MCIH after the closure of a symptomatic unilateral hernia might occur because of the morphological changes to the cPPV that result from closing the symptomatic IIR [107]. Features of the PPV were investigated in conjunction with clinicopathology and embryology [108]. Laparoscopic investigations have added more accurate and useful information in terms of the morphologic spectrum of the IIR between clinical hernia and recurrence, cPPV, hydrocele and maldescended testis [109,110]. Laparoscopic inspections for suspected recurrent pediatric hernias have detected the existence of recurrence as direct, femoral or pantaloon-type hernias, which are extremely rare in infants and children [111]. Furthermore, the laparoscopic closure of the IIR may be applied for orchiopexy in a variable type of maldescended testes that plays a role in changing the operative method of orchiopexy thoroughly [112]. All of these achievements could not have developed from open herniorrhaphy.

CONCLUSION

A recent questionnaire revealed that most pediatric surgeons still favor open unilateral inguinal hernia repair and LH has yet to be accepted even amongst experts in pediatric laparoscopy

[58]. Although integrated comparisons did not favor the laparoscopic approach over open repair because of the wide variety of laparoscopic approaches with varying results, the laparoscopic approach has established supremacy with regard to individual morbidity, except among neonates and preterm infants. Along with experience-related advances in techniques and patient feedback provided to family doctors, the incidence of LH has markedly increased, and the procedure has become the first choice for herniorrhaphy in hospitals [55]. These emerging techniques have led to an increased use of extracorporeal knotting and diminished use of working ports and endoscopic instruments [33].

Laparoscopic hernia repair is not sufficiently established to fully consider the risks posed by late complications; however, growing experience, wider adoption, decreased complications, and increasing advantages favor the emergence of the laparoscopic approach as the gold standard to treat pediatric inguinal hernia in the future.

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