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Current Trends in the Management of Inguinal Hernia in Children

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Abstract

Inguinal hernia repairs in one of the most common surgical procedures in the pediatric population. Its diagnosis is made easily and the repair is usually performed by open surgery and with low complications rates. However, a substantial number of topics concerning anesthetic management, the precise time of operation especially in premature and high-risk infants, and the need of contralateral exploration have not yet been resolved. Recently, the introduction of laparoscopic repair seems to play a significant role regarding the safety, the examination and possible simultaneously repair of the contralateral groin, and the better cosmetic results. In this review, the current trends of the above mentioned topics will be discussed.

Keywords

Inguinal Hernia, Children, Management

1. Introduction

Inguinal hernia (IH) in children is a congenital lesion resulting from a persistent patent processus vaginalis (PPV) [1]. The reported incidence of IH varies from 3% to 5% in full-term newborns, 13% among newborns born of less than 33 weeks of gestational age [2], and 30% in infants of less than 1000 g birth weight [3]. Males have a much more incidence to develop IH with a male/female ratio of 3:1 and 10:1 [4].

IH has a higher familiar incidence [5] and it has been observed with increasing frequency in twins and siblings of patients [6]. A number of associate Zd disorders including undescended testis, cystic fibrosis, bladder

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extrophy, increased abdominal pressure (meconium ileus, necrotizing enterocolitis gastroschisis/omphalocele), increased peritoneal fluid (ascites, peritoneal dialysis and the presence of a ventriculo-peritoneal shunt) and connective tissue disorders (Ehlers-Danlos syndrome, Hunter-Hurler syndrome, Marfan syndrome and mucopolysaccharidosis) may contribute in the presence of an IH [7].

Although there are not definite data, IH is commonly repaired shortly after diagnosis has been established because of the high risk of incarceration particularly in young infants [8]. The standard treatment of choice is still the open herniotomy and is credited with being easy to perform, having a high success rate and low rate of complications [9]. However, the introduction of laparoscopy has gained popularity and a variety of laparoscopic techniques for IH repair in children have been reported in the literature [10]-[14]. In this article, anesthetic considerations, timing of surgery, and the role of laparoscopy in IH repair and contralateral exploration, are discussed.

2. Anesthetic Considerations

Traditionally, the majority of children with IH are treated under general anesthesia either with mask, laryngeal mask or endotracheal intubation [15]. However, in the cases of premature infants and high-risk infants requiring surgery, complications are common even for minor surgical procedures [16]-[19].

2.1. Anesthesia in the Preterm Infant with IH

Infants with gestational age ≤ 37 weeks undergoing IH repair under general anesthesia are susceptible to display respiratory and cardiovascular complications, most commonly apnea [16], with a rate of about 10% to 30% [20]. The pathogenesis of apnea in preterm infants is multifactorial and involves a number of causes including airway obstruction, anemia, immature respiratory drive, hypothermia, diaphragmatic fatigue and anesthetic drugs [16]-[18] [20]. Steward [16] suggested that the depressant effect of anesthetic drugs, and an increase of muscle fatigue, may contribute to a subsequent episode of apnea. Allen *et al.* [21] reported an association with the use of intraoperative narcotics and muscle relaxants and the incidence of postoperative apnea-bradycardia in expremature infants with a post-conceptual (gestational age in weeks plus chronologic age in weeks) age of <41 weeks corrected gestational age compared with 47 weeks corrected gestational age. In line, Liu *et al.* [19] reported that infants < 46 weeks of post-conceptual age were at risk to develop postoperative apnea. The anesthetic risk of apnea in former premature infants it seems to relate with the corrected gestational age [22], with a peak at 41 weeks of post-conceptual age [17]. Furthermore, Vaos *et al.* [23] reported that preterm infants undergoing IH repair within 1 week of diagnosis, experienced a significant greater risk of apnea compared to those undergoing operation later. However, there are not accurate data to correlate the minimum post-conceptual age and the chance of postoperative anesthetic complication. Warther-Larsen *et al.* [24] suggested a 12 h postoperative monitoring for former preterm infants of <46 weeks post-conceptual age, and 12 h monitoring for infants between 46 - 60 weeks and a history of anemia, neurological diseases, chronic lung diseases and episodes of apnea at home, while in a healthy child a post-anesthetic monitoring of 6 h.

To avoid the risk of postoperative complications in high risk infants, regional anesthetic techniques such as spinal, caudal, and caudal epidural anesthesia have been suggested as alternative for surgical procedures below the umbilicus [25]-[31]. Spinal anesthesia gained popularity since Abajian *et al.* [25] introduced it as an alternative to general anesthesia in preterm high risk neonates, as a tool to reduce the chance of postoperative apnea and bradycardia. The authors reported no postoperative apnea in 78 infants, 36 of whom were preterm and high risk. Welborn *et al.* [26] noted no episodes of apnea in preterm infants undergoing herniorrhaphy under spinal anesthesia, compared to 37% of infants, who received general anesthesia. In line were the findings of Somri *et al.* [27], who randomly compared infants undergoing IH repair under general anesthesia or spinal anesthesia. They found a significant morbidity in terms of apnea, and bradycardia in the group of infants who received general anesthesia. However, Gallagher TM [31] noted that spinal anesthesia is of short duration, it is suitable only for procedures lasting <60 minutes, it has the risk of post-anesthetic apnea is still present [32] [33], and it carries sporadically difficulties in determining the subarachnoid space [25]. In addition, Craven *et al.* [34] in a meta-analysis of Cochrane Collaboration of 4 studies, reported that there was no evidence that spinal anesthesia is superior to general anesthesia in terms of postoperative apnea, bradycardia or oxygen desaturation. Clearly, large randomized studies are needed to clarify whether spinal anesthesia reduces postoperative cardio-respiratory complications. Caudal anesthesia has been commonly used in pediatric patients as an adjunct to general anesthesia and as an efficient agent for postoperative pain relief [31]. Furthermore, it has been used as a sole anesthetic

technique in the awake premature and high risk infants undergoing IH repair and other lower body surgical procedures [35]-[37] or IH repair and coexistence of severe congenital anomalies [38]. However, anatomic deformities, coagulopathy, and infectious process, may impose relative contra-indications.

2.2. Pain Management

Postoperative pain can be difficult to assess in children undergoing IH repair. A substantial number of analgesic strategies including preoperative or intraoperative ilioinguinal and iliohypogastric nerve blockade, wound infiltration with local anesthetic, preoperative caudal blockade, and postoperative analgesics such as opioids and acetaminophen have been used to minimize postoperative pain in children undergoing IH [39]. Splinter *et al.* [39] reported comparable effects by using bupivacaine 0.25% injected either caudally or adjacent to the ilioinguinal and iliohypogastric nerves and into the subcutaneous tissue. Fell *et al.* [40] found that wound infiltration with bupivacaine 0.25% (1 ml/kg) at the end of operation and before closure of the trauma, offers adequate anesthesia postoperatively. Ivani *et al.* [41] compared a ropivacaine 0.2%-clonidine mixture given either caudally or peripherally (ilioinguinal-iliohypogastric nerve block) in children undergoing orchiopexy or IH repair and found no differences. Sasaoka *et al.* [42] evaluated the genitofemoral nerve block with bupivacaine 0.25% in addition to ilioinguinal and iliohypogastric nerve blocks in children undergoing IH repair as an alternative analgesic mode and compared it with ilioinguinal and iliohypogastric nerve blocks. They found no clinical benefits from this combination. Recently, Xiang *et al.* [43] reported that a combination of caudal dexmedetomide (1 μg/kg) and bupivacaine 0.25% (1 ml/kg) inhibits the response to hernia traction and provides prolonged duration of postoperative analgesia in children undergoing IH repair. However, a recent systematic review showed no differences in postoperative pain-scores between caudal blockade and nerve blockade or wound infiltration [44]. The results of the above studies show that there is not an ideal method, and the results of most analgesic methods are comparable.

2.3. Impact of Anesthesia on Neurocognitive Development

It is generally accepted that anesthesia relieves pain, maintains stable vital signs and provides adequate conditions during surgical and diagnostic procedures in children. However, experimental studies in animals, have shown that exposure of the developing brain to anesthetic drugs can lead to neuronal apoptosis or neuro degeneration *in vitro* and measurable functional and neurobehavioural deficits *in vivo* [45]. Unfortunately the available data [45] [46], based mainly in retrospective studies, lack the precise information concerning the age, dose of anesthetics, duration of anesthesia, route of administration, and do not allow conclusions about the neurotoxic effect of general anesthesia nor extraction of reliable recommendations and guidelines are inconsistent.

3. Time to Treatment

A number of complications including technical difficulties, incarceration, prematurity, and anesthetic risk particularly in small infants, should be considered before a decision is made to operate on a child with IH. Premature babies, have a higher risk of injury of the vas deference and subsequent testicular atrophy, while a herniorraphy may be difficult due to a fragile hernia sac, increasing the risk of recurrence [47]. The great risk in IH is related to the development of intestinal incarceration and subsequently, a possible strangulation [48]. This is significantly higher in premature infants, with a referred incidence of 31% or 2 - 5 times more than the 6% - 18% rate reported in older children [48]-[50]. In addition, there is a risk of gonadal infarction ranging from 22% for premature infants [51] to 30% for infants less than 3 months of age [52] when compared to 7% - 14% with irreducible incarceration in the general pediatric population [51]-[53]. Similarly to males, small girls with an IH containing ovary and fallopian tubes are at risk of compression or torsion of the gonadal structures, leading to ischemic infarction of the ovary [54]. In some cases, the uterus may also be identified [55]. As noted above, very small infants are more prone to postoperative respiratory complications compared with full-term infants. However, a postponed operation can lead to adhesions of the thickened hernia sac to the spermatic cord, complicating the operation with a possible increasing risk of cord damage, and longer operative times [56]. In view of these risks factors Grosfeld *et al.* [57] suggested that neonates with reducible IH who are already in the hospital and suffer from respiratory problems or other serious conditions (congenital heart defects, meconium peritonitis, or peritonitis related to necrotizing enterocolitis) a wait and see policy is advised, until the overall condition of the

babies allows for a repair. For low birth-weight infants with reducible IH an elective operation should be carried out after improvement of the health status and the infant weighs more than 2.200 g, and before discharge from the NICU [51] [57] [58]. Former premature infants with a history of ventilator support, or bronchopulmonary dysplasia, and who are referred for an IH repair after hospital discharge, should be treated as inpatients and observed overnight [51] [59]. Early elective IH repair is recommended for newborns and infants hospitalized for concurrent diseases, before discharge from the hospital. Full-term infants and older children with an uncomplicated perinatal history can be operated on safely as outpatients [51] [60]. In older children with an asymptomatic IH, but aged less than 1 year, surgery should not be left to exceed 14 days after initial diagnosis, as the risk of incarceration is twofold greater than children with IH and aged 1 - 2 years [61].

In the case of an incarcerated IH, emergency reduction is mandatory either manually or surgically. Manual reduction should be attempted first, unless the patient has signs of peritonitis or bowel obstruction. In female patients, the content of the sac may be an incarcerated ovary, without signs of bowel obstruction [62]. The success rate is as high as 95% to 100% [63] [64] and depends on the duration of incarceration and the age of the patient. Subsequent surgical repair is attempted 24 to 72 hours later, after successful reduction to allow edema to resolve [48] [57].

4. Open Surgery versus Laparoscopy Repair

An open surgery with ligation of the inguinal hernia sac at the level of the internal ring and while safely handling the vas and testicular artery in boys and the ovary, fallopian tube in girls, is the standard approach for successful repair of IH repair in children [57] [65]. However, a non-ligation of the hernia sac after herniotomy in children has also been proposed [66]. Since the initial reports of laparoscopic procedure in the beginning of 1990s [67] [68], laparoscopy for IH repair in children has changed the standard dogma of open surgery repair. Chan *et al.* [69] in a prospective randomized study found that children after laparoscopy repair of IH suffered less pain, had better recovery and wound scars, and operative times did not differ significantly, when compared to the open surgery. Choi *et al.* [70], in a retrospective single center review, reported that laparoscopic repair of IH in children less than 12 months (mean age 4 months, range 0.1 - 12 months) was safe and had acceptable complications and recurrence rates compared to older children who underwent laparoscopy for IH repair. Furthermore, Nah *et al.* [9] reported that in the case of an incarcerated IH, laparoscopic repair is safe, and has fewer complications than open IH repair. One may argue that laparoscopic repair of IH takes longer operative time than conventional open repair. However, this could be overcome with experience [71]. Although, the above studies, support adequately the laparoscopic repair of IH in children, further studies, are needed to establish the role of laparoscopy versus open repair of IH in children.

5. Contralateral Exploration

The debate about the contralateral asymptomatic side in children has not yet been solved. The controversies based on certain studies are summarized as follows: 1) 38% - 100% of children with a unilateral hernia have a contralateral PPV (Patent Processus Vaginalis) [72] [73], 2) 60% of children with a unilateral hernia have a contralateral PPV at 2 months of age, 40% by 2 years, and half of these children may develop an inguinal hernia [74], 3) there is a risk of about 10% to develop a hernia if the initial hernia is on the left, and 4) contralateral exploration might prevent a second operation that means higher costs, and distress of the child and his parents [75]. However, Tackett *et al.* [76] in a prospective study of 656 children reported a metachronous hernia rate of 8.8%, and Wang *et al.* [77] reported an incidence of 5.2% in 2129 children aged ≥1 year. Furthermore, Ron *et al.* [78], reported that 14 explorations are needed to prevent one metachronous IH, and in the case of a left sided IH, 10 explorations are required to prevent one. A recent review [79] showed that the overall risk to develop later an IH is 5.7%. The authors suggested exploration of patients presented with a left-sided hernia and aged < 6 months after a parental discussion. In addition, a contralateral exploration has potential disadvantages including injury to the contents of the spermatic cord, wound infection, increased cost, increased pain and prolongation of the operation [15]. To resolve this debate, multiple strategies have been introduced [15], the more recent being ultrasound and laparoscopy. Chen *et al.* [80] used as criterion a diameter of 4 mm of the internal ring to define a hernia or processus vaginalis, with a diagnostic accuracy of 97.9%. Miltenburg *et al.* [73] by using laparoscopy to detect a contralateral PPV, reported similar results to those using an open process, with a sensitivity of 99.4% and specificity of 99.5%. The authors concluded that they didn't routinely perform a contralateral exploration, as

the percentage of a clinically PPV is not significant in the majority of patients. Summarizing the results of the above mentioned studies, there are not well defined evidence-based data to support a routine exploration for a possible contralateral IH in children. Further long-term studies are needed to clarify this significant topic.

6. Conclusion

IH is a common problem in the pediatric population, especially in premature and full-term neonates. Despite advances in anesthetic perioperative management, topics such as optimal time of repair, and contralateral exploration have not been clarified yet. The introduction of laparoscopic surgery in the management of IH is a promising method and seems to play an important role as an alternative operative and diagnostic tool. However, the lack of data supported by evidence-based studies, clearly suggests the need of large prospective studies to elucidate these important topics.

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