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Assessment and Management of Inguinal Hernia in Infants

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CLINICAL REPORT

Assessment and Management of Inguinal Hernia in Infants

abstract

FREE

Inguinal hernia repair in infants is a routine surgical procedure. However, numerous issues, including timing of the repair, the need to explore the contralateral groin, use of laparoscopy, and anesthetic approach, remain unsettled. Given the lack of compelling data, consideration should be given to large, prospective, randomized controlled trials to determine best practices for the management of inguinal hernias in infants. *Pediatrics* 2012;130:768–773

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KEY WORDS
inguinal hernia, infants, surgery, anesthesia, laparoscopy

ABBREVIATION
PPV—patent processus vaginalis

INTRODUCTION

Inguinal hernia is a common condition requiring surgical repair in the pediatric age group. The incidence of inguinal hernias is approximately 3% to 5% in term infants and 13% in infants born at less than 33 weeks of gestational age.[1] Inguinal hernias in both term and preterm infants are commonly repaired shortly after diagnosis to avoid incarceration of the hernia. Given the lack of definitive data, optimal timing for repair of inguinal hernias in infants remains debatable. This report reviews the embryology and natural history of inguinal hernias as well as published data regarding the timing and approach to inguinal hernia repair in infants.

EMBRYOLOGY AND NATURAL HISTORY OF THE PATENT PROCESSUS VAGINALIS

Complete understanding of the issues related to surgical repair of an inguinal hernia requires an understanding of the embryology of descent of the testes and the formation of the processus vaginalis.

Testicular descent involves 2 phases: intra-abdominal and extra-abdominal.[2] During the intra-abdominal phase, the testis, which derives from the bipotential gonad originating at the urogenital ridge, is attached to the diaphragm by the craniosuspensory ligament. In the male fetus, regression of the craniosuspensory ligament results in transabdominal migration of the testis between 8 and 15 weeks postconception. Simultaneously, there is thickening of the gubernaculum, which attaches the testis to the scrotum through the external and internal rings of the inguinal canal. As the male fetus grows and the abdomen elongates, the testis is essentially anchored by the thickened gubernaculum.[3] In the female fetus, the craniosuspensory ligament is maintained; hence, the ovary retains its dorsal (retrocoelomic or retroperitoneal)

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intra-abdominal location. In addition, the gubernaculum does not thicken but persists as the ovarian round ligament.

The second phase occurs between 25 and 35 weeks of gestation.[4] The testis descends from its retroperitoneal, intra-abdominal location through the inguinal canal, drawing with it an extension of the peritoneal lining, which defines the processus vaginalis. Normally, the processus vaginalis obliterates and involutes, leaving no communication between the intra-abdominal peritoneal cavity and the extra-abdominal inguinal canal and scrotum. This enveloping involuted layer is the tunica vaginalis. Both human in vitro tissue culture and rodent model studies implicate genitofemoral nerve innervation as critical for regulation of gubernacular length as well as obliteration of the processus vaginalis.[5–7] Incomplete involution results in a patent processus vaginalis (PPV), through which fluid can travel and accumulate extra-abdominally as a hydrocele. If the communication is large, intra-abdominal structures such as bowel may herniate, resulting in an indirect inguinal hernia. The relation of the processus vaginalis with testicular descent is thought to explain why more than 90% of pediatric inguinal hernias are diagnosed in boys.[1] Involution of the left processus vaginalis precedes that of right, which is consistent with the observation that 60% of indirect inguinal hernias occur on the right side.[8]

The prevalence of PPV is highest during infancy and declines with age. Congenital hydroceles, which are essentially clinically apparent PPV, usually resolve spontaneously within 18 to 24 months.[9,10] The reported prevalence of PPV is as high as 80% in term male infants.[11] However, this prevalence is generally extrapolated from findings at time of exploration of the contralateral internal ring during time of inguinal hernia repair. Thus, most reported rates of bilateral PPV are derived from observations in patients with symptomatic unilateral inguinal hernias and likely overestimate the true prevalence of PPV in the general population. Rowe et al reported a 64% rate of contralateral PPV identified at the time of inguinal hernia repair in infants younger than 2 months. Reported rates of contralateral PPV decrease to between 33% and 50% in children younger than 1 year of age and are as low as 15% by 5 years of age.[12–16] Not all cases of PPV result in inguinal hernias. The estimated childhood risk of developing an inguinal hernia if there is a PPV is between 25% and 50%.[17,18] Even though the true prevalence of a PPV in the general pediatric population is likely lower than contralateral PPV reported at the time of hernia repair, it is clearly greatest at birth and declines with increasing age.

RATIONALE AND TIMING FOR ELECTIVE INGUINAL HERNIA REPAIR IN INFANTS

All inguinal hernias in infants are repaired to avoid the risk of incarceration of bowel and gonadal infarction and atrophy.[19–22] However, these risks must be balanced against the risk of potential operative and anesthetic complications. Unfortunately, data regarding these risks are not definitive.

Many investigators have sought to define the risk of inguinal hernia incarceration in young children. However, the physical features of hernia, such as the size of the abdominal wall defect, the amount of the herniating intestine, and the ease with which it can be reduced, do not consistently predict the risk of incarceration. Attempts have been made to correlate the age at diagnosis, the duration between diagnosis and hernia repair, and infants' gestational age with risk of inguinal hernia incarceration. Notably, in an analysis of a Canadian administrative database containing more than 1000 children with inguinal hernia, Zamakshary et al showed that children younger than 1 year had a twofold greater risk of inguinal hernia incarceration when repair was performed ≥14 days after diagnosis compared with children who had repair performed between 1 and 2 years of age.[23] Vaos et al reported a retrospective analysis of preterm infants undergoing inguinal hernia repair at 1 of 2 institutions.[24] They noted that infants undergoing repair later than 1 week after diagnosis were at significantly greater risk of inguinal hernia incarceration, postoperative hernia recurrence, and testicular atrophy, compared with infants undergoing earlier repair. Lautz et al analyzed the risk of inguinal hernia incarceration in approximately 49 000 preterm infants using the 2003 and 2006 Kids' Inpatient Databases.[25] They determined that the overall rate of inguinal hernia incarceration was approximately 16% and that the risk was greatest in infants in whom surgery was delayed beyond 40 weeks' corrected gestational age (21%) compared with those repaired between 36 and 39 weeks (9%) corrected age or less than 36 weeks corrected gestational age (11%). Furthermore, 28% of former preterm infants undergoing repair during a subsequent hospitalization were noted to have inguinal hernia incarceration, suggesting an even greater risk with further delay. Although fraught with limitations inherent to administrative databases, the conclusions of this study are compelling.

Conversely, other data indicate that delay in inguinal hernia repair is associated with low rates of inguinal hernia incarceration. Lee et al reported a 4.6% rate of hernia incarceration in 172 former preterm infants within a single Kaiser system hospital. Of the 127 infants who were discharged from

the hospital with known inguinal hernias and scheduled for a planned elective outpatient repair, there were no episodes of inguinal hernia incarceration while awaiting repair.[26] Uemura et al reported comparable inguinal hernia incarceration rates in 19 preterm infants (birth weight range 492–2401 g) who underwent repair at more than 2 weeks after diagnosis, compared with 21 preterm infants who underwent more urgent repair.[27] Although these studies suggest that inguinal hernia repair can be delayed, the data are not as compelling as those suggesting repair on a more urgent basis.

Inguinal hernia repair is associated with operative complications, including hernia recurrence, vas deferens injury, and testicular atrophy, the rates of which vary from 1% to 8%.[28–31] Long-term complications include chronic pain and infertility in adulthood.[32] In a single-institution, retrospective analysis, Moss et al observed low recurrence and complication rates up to 5 years after surgical repair in infants younger than 2 months of age.[33] Conversely, a retrospective analysis by Baird et al revealed a higher rate of complications in infants who were 43 weeks' corrected gestational age or younger, compared with those who underwent repair at an older age.[34] They speculated that the greater friability of the hernia sac in former preterm infants predisposes to repair failure.

Early repair of inguinal hernias in preterm infants must be further balanced against the risk of postoperative apnea after general anesthesia. Historically, the rate of postoperative apnea in preterm infants has been reported to be as high as 49%.[35,36] The risk of postoperative apnea is associated with perioperative anemia and a history of preoperative apnea as well as associated comorbidities.[35,37] Vaos et al noted that preterm infants undergoing inguinal hernia repair within 1 week of diagnosis experienced a significantly greater rate of apnea compared with those undergoing repair later.[24] Melone et al reported on a cohort of 127 former preterm infants (mean gestational age, 32.7 weeks) who underwent outpatient inguinal hernia repair at a mean corrected gestational age of 45.3 weeks. The authors identified only 2 infants who experienced episodes of apnea: 1 in the operating room, the other postdischarge. They concluded that because the apnea rate is so low, elective outpatient inguinal hernia repair is a feasible option for preterm infants. Lee et al reported no episodes of apnea in a cohort of preterm infants (30.7 weeks' gestation at birth) undergoing outpatient elective hernia repair.[26] However, the authors noted that 13 of 45 former preterm infants who underwent elective inguinal hernia repair before discharge from the NICU remained intubated for longer than 2 days postoperatively.

Younger corrected gestational age is associated with a greater risk of apnea.[38] Allen et al noted a nearly 9% rate of postoperative apnea in their cohort of 57 preterm infants undergoing inguinal hernia repair.[39] In a subset analysis, infants who experienced apnea episodes tended to be younger (41 weeks' corrected gestational age compared with 47 weeks' corrected gestational age); had significantly higher perioperative risk, as measured by American Society of Anesthesia scores (2.6 compared with 1.8); and were more likely to have received intraoperative narcotic and muscle relaxation compared with infants who were not apneic. A recent meta-analysis concluded that former preterm infants undergoing general anesthesia who are less than 46 weeks' corrected gestational age should be observed for at least 12 hours postoperatively and that those who are between 46 and 60 weeks' corrected gestational age should receive more individualized care on the basis of the presence or absence of associated comorbidities.[40]

To reduce the incidence of postoperative apnea, spinal, rather than general, anesthesia has been used for inguinal hernia repair in preterm infants.[41–43] Although some studies have been encouraging, none have been adequately powered. Indeed, Craven et al published a Cochrane Collaboration analysis in which only 108 patients from 4 small randomized or quasi-randomized studies comparing spinal and general anesthesia were identified.[44] The authors concluded that there was no evidence that spinal anesthesia was associated with a reduction in postoperative apnea, bradycardia, or oxygen desaturation. Furthermore, the authors concluded that a large, randomized controlled trial was necessary to determine whether spinal anesthesia reduces postoperative cardiorespiratory complications; to date, no such study has been reported.

Over the past decade, studies performed in rodents and nonhuman primates have shown a dose-dependent association of neuronal apoptosis with general anesthetic agents, including ketamine, propofol, and isoflurane.[45–47] Importantly, there is emerging evidence that the use of general anesthesia in infancy may be associated with long-term neurocognitive and developmental problems, specifically after multiple exposures to general anesthesia before 3 years of age.[48] DiMaggio et al, using a New York State Medicaid database, showed that children younger than 3 years who were given general anesthesia for inguinal hernia repair had a greater than twofold risk of developmental or behavioral disorders than did age-matched control children.[49] A potential bias of this study is that children undergoing surgery at a young age may

also be predisposed to learning or cognitive disorders. Bartels et al attempted to address this issue by using the Netherlands Twin Registry to evaluate monozygotic concordant-discordant twins. In a study of 1143 monozygotic twin pairs, exposure to anesthesia before 3 years of age was associated with reduced educational achievement.[50] However, there was no difference in outcome between twin pairs when one twin had undergone anesthesia and the other had not. The authors concluded that there is no causal relationship between anesthesia exposure and learning disabilities. Hansen et al recently compared ninth-grade test scores of nearly 2700 Swedish children who had undergone inguinal hernia repair as infants with those of randomly selected age-matched controls and found no difference in test performance.[51] Clearly, the issue of whether anesthetic exposure as an infant affects long-term neurodevelopment is unsettled. Two large clinical studies are under way to address this issue.[52]

Ultimately, the timing of preterm infant inguinal hernia repair varies widely in practice. In a 2005 survey of members of the American Academy of Pediatrics Section on Surgery, 63% reported routinely performing hernia repairs just before discharge from the NICU, 18% performed repairs at a specific corrected gestational age, and 5% performed repairs when it was convenient.[53] If a hernia was discovered after discharge, 53% of respondents would repair the hernia when it was convenient, and 27% of respondents would wait to repair until the infant was between 38 and 60 weeks' corrected gestational age (mean, 53.1 weeks' corrected gestational age). In a previous survey performed in 1993, surgeons were more likely to repair an inguinal hernia when convenient.[54]

Timing of inguinal hernia repair in preterm and term infants represents a balance of the risks of inguinal hernia incarceration and of postoperative respiratory complications. At present, the literature does not clearly define what these risks are and how they should be balanced.

CONTRALATERAL INGUINAL EXPLORATION

The utility of contralateral inguinal exploration in children is an area of active debate. The rationale for attempting to diagnose a contralateral PPV is that repair can be performed to prevent any potential contralateral incarceration with no additive anesthetic risk. Historically, surgeons performed routine open contralateral inguinal explorations to identify PPV in either all children or in selected populations (ie, former preterm infants or children younger than 2 years). Marulaiah et al suggested that routine contralateral exploration is not indicated, given the risks associated with such exploration, such as spermatic cord injury.[55] Alternatively, given the high incidence of subsequent hernias if a contralateral PPV is encountered, others support routine exploration.[13,56,57] Lee et al indicated that it is cost-effective to perform routine contralateral groin explorations.[58] Results from the aforementioned 2005 survey of American Academy of Pediatrics Section on Surgery members revealed a variety of practices; 15% of respondents indicated that they never explore the contralateral side in a male patient, 12% responded that they always do, and 73% responded that they had an age cutoff beyond which they would not explore.[53] Respondents also had a wide variation of practices when caring for a girl with a unilateral hernia. For both male and female patients with hernias, however, results of the survey revealed that there were significant reductions in the routine explorations of the contralateral side compared with results from the same survey performed in 1996.[54] Various diagnostic modalities, such as the physical examination, herniography, or ultrasonographic examination are not particularly sensitive or specific, thus making these efforts unreliable.[56,59] With the advent of laparoscopic techniques, inspection of the contralateral internal ring has become increasingly popular as the method of choice for evaluating for a PPV. According to survey responses, use of laparoscopy as the modality with which to explore the contralateral ring has increased from 6% in 1996 to 37% in 2005.[53,54] Use of laparoscopy to explore the contralateral groin has likely increased since then.

LAPAROSCOPIC APPROACH TO INGUINAL HERNIA REPAIR IN INFANTS

Laparoscopic repair has been used effectively in preterm infants. Various techniques have been described, but all routinely use a port placed in the umbilicus to visualize the internal ring. Reported hernia recurrence rates are comparable to those associated with open repair.[60,61] However, data regarding the risk of testicular atrophy are not available.[62,63] A prospective, randomized, single-blinded trial comparing laparoscopic to open repair of inguinal hernias showed that children who were older than 3 months of age when laparoscopic repair was performed required significantly fewer doses of pain medication.[64] The utility of laparoscopic repair of inguinal hernias in younger infants remains undetermined to date.

CONCLUSIONS

- Inguinal hernias are common in the infant population. The risk of hernia incarceration drives the preference to pursue surgical repair.
- Data regarding optimal timing of repair are conflicting and inadequate.

- There is no consensus on when or if contralateral inguinal exploration is necessary.
- Data regarding a laparoscopic approach to inguinal hernia repairs suggest that it is comparable to the standard open technique.
- Given the lack of data supporting evidence-based approaches to inguinal hernias in infants, consideration should be given to large, prospective, randomized, controlled trials to answer these important questions.

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