Inguinal hernia in children

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INTRODUCTION

The epidemiology, clinical presentation, and management of inguinal hernia in children will be reviewed here.

The evaluation of inguinal swelling and the causes and evaluation of scrotal pain and swelling in children and adolescents are discussed separately. (See "Evaluation of inguinal swelling in children" and "Causes of painless scrotal swelling in children and adolescents" and "Causes of scrotal pain in children and adolescents" and "Evaluation of nontraumatic scrotal pain or swelling in children and adolescents".)

DEFINITIONS

Hydrocele — A hydrocele is a fluid-filled collection that can occur anywhere along the path of descent of the testis or ovary. (See 'Embryology' below.)

Hernia — A hernia is the protrusion of a portion of an organ or tissue through an abnormal opening in the wall that normally contains it.

Incarceration — Incarceration describes a hernia that cannot be reduced by manipulation. An incarcerated hernia may or may not be strangulated.

Strangulation — Strangulation refers to vascular compromise of the contents of an incarcerated hernia, caused by progressive edema from venous and lymphatic obstruction.

Strangulation can occur within two hours of incarceration [1]. Prolonged strangulation may rarely lead to necrosis and, in the case of bowel, perforation.

EMBRYOLOGY

Testes — The testes appear on the ventromedial aspect of the urogenital ridge on the posterior abdominal wall during the fifth to sixth week of gestation [1]. By the 10^{th} week, they have descended through the coelomic cavity and can be found close to the groin. The processus vaginalis forms during the third month of gestation from an outward protrusion of the peritoneum that lines the ventral abdominal wall and forms a diverticulum at the internal ring (figure 1) [2]. Between the seventh and ninth months of gestation, the testes descend through the internal canal and into the scrotum, pushing the processus vaginalis ahead and protruding into its cavity. Once this process is complete, the processus vaginalis obliterates spontaneously, usually by age two years [3].

Ovaries — The descent of the ovaries is similar to that of the testes except that the ovaries do not leave the abdominal cavity. The diverticulum of Nuck in girls corresponds to the processus vaginalis in boys and is a pocket of peritoneum that extends from the uterus to the labia majora. It normally closes spontaneously at about seven month's gestation [4].

The closure of the processus vaginalis may be hindered by the persistence of smooth muscle. Myofibroblasts, thought to represent dedifferentiation of smooth muscle and failed apoptosis, were found by electron microscopy in all inguinal hernia sac specimens of 20 children (10 boys and 10 girls) [5].

ANATOMY

The inguinal canal is an oblique channel through the abdominal wall through which the spermatic cord passes from the abdomen into the scrotum in boys and the round ligament passes from the abdomen into the labia majora in girls. It is formed by the aponeurosis of the external oblique muscle (anteriorly) and the transversus abdominus muscle and the transversalis fascia (posteriorly) (figure 2A-B). Hesselbach's triangle, bounded by the inferior epigastric vessels, the inguinal ligament, and the rectus sheath, is an area of the posterior wall at particular risk for direct herniation.

The external inguinal ring is formed by the external oblique muscle just superior and lateral to the pubic tubercle. The internal inguinal ring is located in the transversalis fascia and composed of the transversus abdominus and internal oblique muscles (figure 2B).

In infants, the inguinal canal is short and crosses the abdominal wall perpendicularly rather than obliquely so that the external ring is situated almost directly over the internal ring [1,6]. This anatomic alignment places infants at particular risk for development of inguinal hernia, especially premature infants in whom intraabdominal pressure may be increased by mechanical ventilation [7].

Various types of inguinal hernias and hydroceles may occur depending on where and to what degree the processus vaginalis becomes obliterated. This is illustrated in the following examples:

- A widely patent processus vaginalis that permits herniation of the bowel through the internal inguinal ring results in an indirect inguinal hernia (figure 3A-B).
- A narrowly patent processus vaginalis that only permits passage of peritoneal fluid results in a communicating hydrocele (figure 4).
- A hydrocele of the cord occurs when the processus vaginalis is obliterated proximally and distally, but remains patent in the midportion along the spermatic cord.

The hernia sac generally contains peritoneal fluid (as in a communicating hydrocele) or bowel. In girls, the ovary is commonly involved. Hernias containing fallopian tube and uterus have been reported [8-10].

Indirect inguinal hernias, the most common type in children, pass lateral to the deep epigastric vessels through the inguinal canal (figure 3A-B). Direct inguinal hernias are medial and inferior to the deep epigastric vessels and do not go through the inguinal canal (figure 5). Direct inguinal hernias are rare in children and usually follow an indirect inguinal hernia repair [11]. Femoral hernias, below the inguinal ligament and medial to the femoral artery (figure 6), also are rare in children [12,13].

EPIDEMIOLOGY

Incidence — Primary inguinal hernia occurs in 1 to 5 percent of all newborns and 9 to 11

percent of those born prematurely [14]. Among low- and very low-birth-weight infants, the frequency of inguinal hernia varies by birth weight as follows [15]:

- 500 to 1000 g – 30 to 42 percent [15,16]
- 1000 to 1500 g – 10 percent
- 1500 to 2000 g – 3 percent

The incidence in boys is three to four times higher than in girls, with the right side being affected more commonly in both sexes [17,18]. In boys, the incidence is highest during the first year of life and peaks during the first month [1,18,19].

The right-sided preponderance is related to the later descent of the right testicle and later obliteration of the processus vaginalis. The incidence of bilateral hernias is approximately 10 percent in full-term and nearly 50 percent in premature and low-birth-weight infants [20,21].

Incarceration — The incidence of incarceration ranges from 14 to 31 percent, usually occurring in infants younger than one year of age [22,23]. Among children with incarcerated inguinal hernias, as many as 85 percent occur before the first birthday.

Incarceration is the presenting sign of the hernia in as many as 65 percent of cases [24]. It occurs more frequently in right-sided hernias as compared with left-sided ones (17 versus 7 percent) [17,25].

Incarceration occurs more frequently in girls compared with boys (17.2 versus 12 percent). In girls, when incarceration occurs, an ovary, rather than intestine, is typically involved.

Some authors describe an increased incidence of incarceration in preterm infants [17,25]. However, one review of inguinal hernia in 251 infants younger than six months, including 89 preterm infants, found that incarceration was less common in preterm than in term infants (13 versus 24 percent) [7].

Associated conditions — Inguinal hernias are more common in children with abdominal wall defects (eg, Eagle-Barrett [prune belly] syndrome), conditions that increase intraabdominal pressure (eg, continuous ambulatory peritoneal dialysis, ventriculoperitoneal shunts, ascites, chronic respiratory disease), connective tissue disease (eg, Ehlers-Danlos syndrome), abnormalities of the genitourinary system (eg, ambiguous genitalia, hypospadias, bladder exstrophy, cryptorchid testis), or a family history of inguinal

hernia [17,26]. (See "Prune-belly syndrome" and "Clinical manifestations and initial management of infants with bladder exstrophy" and "Undescended testes (cryptorchidism) in children: Clinical features and evaluation", section on 'Examination'.)

Complete androgen insensitivity should be suspected in phenotypically normal female infants or children who have inguinal hernias or inguinal or labial masses. As many as 1 to 2 percent of girls with inguinal hernias may have this disorder [27,28]. In a survey of androgen insensitivity diagnosis and management in the United Kingdom, inguinal hernia was the presenting complaint in 22 of 29 (76 percent) and was present in 28 of 29 (96 percent) phenotypically female children with complete androgen insensitivity [29]. (See "Diagnosis and treatment of disorders of the androgen receptor".)

CLINICAL FEATURES AND DIAGNOSIS

Children with an inguinal hernia may present with clinical features that include history of an intermittent mass, a mass that is reducible, or incarceration.

No mass — Most children with an inguinal hernia have a history of an intermittent bulge in the groin that may have been noted at times of increased intraabdominal pressure, such as straining or crying [1]. They are usually asymptomatic when this occurs.

An inguinal mass is frequently not present on examination. Maneuvers to increase intraabdominal pressure and demonstrate the hernia are often unsuccessful [30]. The "silk sign" is a palpable silky thickening of the cord that may sometimes be appreciated by placing a single finger parallel to the inguinal canal at the level of the pubic tubercle and rubbing it from side to side. This is not a reliable finding, however [1,17].

Reducible mass — Often, families seek medical care because an inguinal mass has developed that has not spontaneously reduced. Nonspecific symptoms such as irritability and decreased appetite may be reported. The inguinal mass can extend into the scrotum. It should not be tender on examination.

Incarcerated mass — Infants with an incarcerated inguinal hernia usually are irritable and crying. Vomiting and abdominal distention may develop, depending on the duration of incarceration and whether or not intestinal obstruction has occurred [1].

Physical examination of children with incarcerated inguinal hernias usually is diagnostic. A

firm, discrete inguinal mass, which may extend to the scrotum or labia majora, can be palpated in the groin. The mass usually is tender and often is surrounded by edema with erythema of the overlying skin [23]. The testicle may appear dark blue because of venous congestion caused by pressure on the spermatic cord.

DIFFERENTIAL DIAGNOSIS

The causes and diagnostic approach to inguinal swelling, including inguinal hernias, are discussed in detail separately (table 1). (See "Evaluation of inguinal swelling in children", section on 'Causes of inguinal swelling' and "Evaluation of inguinal swelling in children", section on 'Approach'.)

Some scrotal conditions may cause swelling that extends up into the external inguinal ring and appear similar to inguinal hernias. These include the following (see "Causes of painless scrotal swelling in children and adolescents" and "Causes of scrotal pain in children and adolescents"):

- **Hydrocele** – An acute hydrocele generally involves only the scrotum; no mass is palpated in the area of the internal ring. This is in contrast to a communicating hydrocele, which is, in fact, a hernia containing peritoneal fluid (see 'Anatomy' above). Hydroceles transilluminate and usually are cystic, irreducible, and nontender. An acute hydrocele of the spermatic cord may occasionally be difficult to distinguish from an incarcerated inguinal hernia [1]. (See "Causes of painless scrotal swelling in children and adolescents", section on 'Hydrocele'.)

- **Varicocele** – Varicoceles, typically seen in the adolescent age group, are dilated veins of the pampiniform plexus of the spermatic cord. They usually increase with the Valsalva maneuver to produce a large, soft scrotal mass ("bag of worms") that decompresses in the recumbent position. (See "Causes of painless scrotal swelling in children and adolescents", section on 'Varicocele'.)

- **Testicular torsion** – Testicular torsion causes severe pain and vomiting. The affected testicle is typically swollen, tender, and retracted toward the external ring. The cremasteric reflex is absent on the affected side. (See "Causes of scrotal pain in children and adolescents", section on 'Testicular torsion'.)

- **Torsion of the appendix testis** – Torsion of the appendix testis produces a tender nodule on the upper pole of the testicle that may appear as a blue dot once the torsed tissue has become necrotic. (See "Causes of scrotal pain in children and adolescents", section on 'Torsion of the appendix testis or appendix epididymis'.)

- **Retractile testis** – An inguinal mass may represent a retractile testis that has moved into the inguinal canal as a result of an exaggerated cremasteric reflex. It can be distinguished from an inguinal hernia by bringing the testis into the scrotum. A finger is then placed transversely across the top of the scrotum at the base of the penis. This will prevent a retractile testis from ascending into the inguinal canal when the cremasteric reflex is again elicited [1]. In addition, an empty hemi-scrotal sac suggests an abnormal testicular location. (See "Evaluation of inguinal swelling in children", section on 'Testicular dislocation' and "Evaluation of inguinal swelling in children", section on 'Testes: Retractile, ectopic, or undescended'.)

- **Testicular cancer** – Testicular cancer usually presents as a painless mass discovered by the patient or clinician on physical examination, although rapidly growing germ cell tumors may cause acute scrotal pain secondary to hemorrhage and infarction. Other common signs are testicular enlargement or swelling. (See "Causes of painless scrotal swelling in children and adolescents", section on 'Testicular cancer'.)

IMAGING

Plain abdominal radiographs are of limited use in the evaluation of a patient with an incarcerated hernia. An ultrasound examination may be helpful when the etiology of an acute groin swelling cannot be determined on clinical examination. The reported diagnostic accuracy of ultrasound is 93 percent for acute groin conditions [31].

LABORATORY EVALUATION

Routine laboratory work is not helpful in the evaluation of patients with hernias. One study reported white blood cell counts of 4600 to 21,000 cells/μL (4.6 to 21.0 x 10(9)/L) in 69 children with incarcerated hernias and found no correlation between the white blood cell count and the degree of vascular compromise of the entrapped bowel described at surgery [23].

Karyotyping should be considered when a testicle is palpable in the inguinal canal or found at herniorrhaphy in phenotypic females, since there is an association between androgen insensitivity and inguinal hernia. (See 'Associated conditions' above.)

MANAGEMENT

The definitive management of inguinal hernia is surgical repair. Referral to a surgeon and the timing of the repair depend on whether or not the hernia is reducible. In addition, incarcerated hernias must be reduced as quickly as possible to avoid strangulation of the contents of the hernia sac.

No mass, reducible mass — A convincing history of intermittent groin swelling or a reducible inguinal mass are indications for referral to a surgeon. Consultation should be obtained promptly but is not emergent. Once the diagnosis is made, however, repair should be performed soon to avoid complications, such as incarceration. Incarceration has been reported in as many as 13 percent of children awaiting elective repair, with the majority of cases in those less than one year of age [24,32,33]. While awaiting surgical evaluation, caretakers should be informed of the signs and symptoms of incarceration and provided with indications for seeking medical attention.

Inguinal mass in a female — Hernias in females are caused by the persistence of the diverticulum of Nuck and contain the suspensory ligament of the ovary [8,10]. A significant number of these hernias also contain the ovary and/or fallopian tube [34]. Rarely, the uterus may also be present [35]. In one small series of 71 girls with an incarcerated painful mass in the inguinal canal, an ovary was found in 82 percent and a torsed ovary was found in 15 percent [36]. Because of the significant likelihood that reproductive organs are within the hernial sac, the clinician should attempt a gentle reduction and then obtain an ultrasound (US) if **not** successful. If the US indicates that reproductive organs are **not** present, then further efforts at reduction are appropriate [37]. In patients in whom an incarcerated ovary is suspected, ultrasound first, if available, is an alternative approach. Ultrasound examination of the hernial sac is also helpful in identifying the contents prior to surgical repair of irreducible inguinal masses in girls [8].

Incarcerated inguinal hernia — An incarcerated inguinal hernia must be emergently reduced, either manually or surgically. Once the diagnosis has been made, children should

have nothing by mouth, since emergent surgery may be required to reduce the hernia.

Manual reduction — Unless the child appears extremely ill and has signs of peritonitis, intestinal obstruction, or toxicity from gangrenous bowel, manual reduction should be attempted. Manual reduction is successful in 95 to 100 percent of patients [22,38-40]. Elective repair after successful manual reduction has a lower complication rate than emergent operative reduction [17].

Success rates for manual reduction are influenced by the duration of incarceration and the age of the child. In one report of 85 children younger than two years, those with failed, compared with successful, manual reductions were younger (three versus five months) and had longer duration of symptoms (34 versus 12 hours) [41]. Successful manual reduction may be facilitated by pain control (eg, intranasal or intravenous fentanyl) and reverse Trendelenburg positioning.

One technique of manual reduction of incarcerated inguinal hernias is as follows (figure 7):

- Pressure is applied along the proximal inguinal canal with one hand, while the other hand attempts to "milk" the gas or contents out of the incarcerated bowel with gentle pressure, for up to five minutes.
- After reducing the contents of the incarcerated bowel, pressure should be slightly increased over the distal aspect of the hernia to reduce the bowel.

Alternatively, the examiner uses the thumb and index finger of one hand to form a funnel where the mass exits the inguinal ring and then exerts steady, circumferential pressure with the other hand on the inferomedial aspect of the mass. A "hiss" of air and a decrease in the size of the mass may accompany a successful reduction. Success is indicated by a reduction of the mass.

Alternatively, the practitioner sweeps along the inguinal hernia into the scrotum and applies longitudinal tension, while providing traction that opens the internal and external hernial rings (figure 8). The hernia is then walked through the opening.

If the above steps are not successful, a surgeon should be consulted. Most authorities would then recommend procedural sedation, Trendelenburg positioning, and an ice pack to the groin, followed by another attempt at manual reduction [42]. Up to 40 minutes of continuous pressure may be necessary to achieve reduction.

Attempts at manual reduction of a prolapsed ovary are painful and should be performed only with sedation. In addition, torsion of the ovary within the hernia sac can occur. (See 'Complications' below.)

The timing of repair after reduction of a hernia is discussed below. (See 'Timing of repair' below.)

Surgical reduction — In the small percentage of cases where manual reduction is not successful, the hernia must be reduced surgically. Repair is generally performed at that time. A small observational series has described success using a laparoscopic approach for the reduction and repair of incarcerated inguinal hernias in children [43].

Surgical repair — The following procedures may be used for the repair of inguinal hernias in children:

- High ligation and excision of the processus vaginalis, the most common procedure, is used when the hernia is small and of recent onset. In girls, confirmation that the hernia sac does not contain the ovary, fallopian tube, or uterus is necessary before it is ligated [44].
- In addition to ligation and excision, plication of the floor of the inguinal canal (the transversalis fascia) may be necessary when the inguinal ring has been enlarged by repetitive herniation.
- Complete reconstruction of the floor of the inguinal canal using the conjoint tendon is occasionally required in small infants who have large hernias that have gone untreated, causing progressive enlargement of the inguinal ring and total breakdown of the transversalis fascia [45].
- Laparoscopic herniorrhaphy has been performed for many patients with good results [46-50].

Boys who have an associated undescended testis should have orchidopexy at the same time as inguinal hernia repair [1,17,44].

Timing of repair — Although the methods of repair are standard, the optimal timing is debatable. Immediate surgical repair after successful manual reduction of incarceration eliminates the risk of repeated incarceration. However, if performed immediately, the

repair can be technically difficult, increasing the risk for development of a direct hernia as a complication. In addition, tissue swelling after incarceration can cause distortion of the anatomic landmarks, rendering detection of a coincident direct hernia difficult. On the other hand, a delay in definitive repair carries the risk of recurrent incarceration and the need for emergent surgery. Risk of recurrent incarceration is between 16 and 35 percent, with the second episode occurring at a range of 0.5 to 120 days after the initial incarceration [24,39].

Many pediatric surgeons hospitalize children after successful manual reduction of incarcerated inguinal hernia and repair the hernia within 24 to 48 hours. The short delay allows the involved tissues to return to their normal texture before surgery. To minimize the risk of recurrence, definitive hernia repair should be performed within five days (within two days for infants born prematurely) of the manual reduction [39].

In children with asymptomatic inguinal hernias, longer waiting time for elective surgery is also associated with increased risk for incarceration, especially in infants less than one year of age [2,24,32,33]. An observational study from Canada found that a wait time for surgery that exceeded 14 days from the time of diagnosis in a physician's office was associated with an absolute increase of 7 percent (5 versus 12 percent) in the occurrence of incarceration in infants and young children (<1 year of age) [33]. This finding suggests that a waiting time less than 14 days is advisable for asymptomatic inguinal hernias in this pediatric age group.

Approximately one-third of preterm infants with birth weight less than 1000 g have inguinal hernias. These infants can be observed in the neonatal intensive care unit (NICU) as long as the hernias are reducible. The optimal timing of repair is uncertain. In a metaanalysis of six retrospective, observational studies, repair prior to discharge from the NICU was not associated with more surgical complications or incarceration compared with repair after NICU discharge [51]. Early repair was associated with a higher likelihood of recurrent hernia. However, the number of events was small in all analyses. Regardless of timing of repair, preterm infants who are at risk for apnea and bradycardia should be monitored closely in the postoperative period.

Contralateral exploration — The need for contralateral inguinal exploration also is controversial [2]. The natural history of a patent processus vaginalis is closure within two months after birth in 40 percent and within two years in an additional 20 percent [21]. Of

the remaining 40 percent, clinical hernias may develop in one-half, so the finding of a patent processus vaginalis in the absence of a clinical hernia is not a clear indicator of a future hernia.

Although routine contralateral exploration had been a common practice, surveys of members of the American Academy of Pediatrics Section on Surgery conducted in 1993 and 2003 noted that the number of respondents who routinely explore the contralateral groin of boys less than two years of age declined from 65 percent to 44 percent [52,53]. Similarly, routine contralateral exploration of girls less than four years dropped from 84 percent to 47 percent.

This decline in routine contralateral exploration is supported by data from large prospective studies and a meta-analysis of children with unilateral inguinal hernia that identify an overall risk of metachronous hernia between 5 and 12 percent [54-57]. These reports all concluded that the low incidence of contralateral hernia did not justify routine exploration. One report in 656 patients noted that the risk of metachronous hernia was higher in premature infants (15 percent) and those with incarceration (28 percent) and suggested that contralateral exploration may be advisable in these children [54]. However, a subsequent review of 964 premature boys with unilateral hernia found that bilateral repair was associated with a higher risk of complication than unilateral repair followed by elective surgery only in the patients who developed metachronous hernia (2 versus 1 percent) [58]. Only 11 percent of premature males with a unilateral hernia developed a metachronous hernia. Thus, prematurity may **not** be an indication for contralateral exploration.

Contralateral exploration is warranted for children at particular risk for metachronous inguinal hernia, including those with ventriculoperitoneal shunts, increased intraabdominal pressure, connective tissue disease, or chronic pulmonary disease [17,44], as should those who have an underlying medical condition that increases the risk of anesthetic complications [54].

Thus, the risks and benefits of open contralateral exploration for each child must be weighed individually. The risks of open contralateral exploration include damage to the spermatic cord, testis, or vas deferens in boys and damage to the ovary in girls. The benefit of contralateral exploration and repair of patent processus vaginalis or diverticulum of Nuck is the elimination of risk of future incarceration and the need for subsequent surgery.

Transinguinal laparoscopic evaluation of the contralateral side during ipsilateral repair has been suggested as an alternative to open surgical exploration and leads to successful visualization of the contralateral inguinal ring in up to 97 percent of patients [59,60]. This technique has a sensitivity of 99.4 percent and a specificity of 99.5 percent for detecting a patent processus vaginalis and can be performed with a mean operative time of six to eight minutes with a complication rate under one percent [60-62].

POSTOPERATIVE CARE

Most children who undergo repair of inguinal hernia have an uncomplicated postoperative course. Scrotal edema can occur as a postoperative complication; it usually resolves spontaneously over approximately three weeks. Postoperative hematomas and hydroceles, on the other hand, can take up to three months to resolve and should be followed to resolution by the operating surgeon. Postoperative infection occurs with a frequency of less than 1 percent [44].

COMPLICATIONS

Bowel infarction, as a result of strangulation, is the most serious complication of an inguinal hernia. Infarction may occur within two hours of incarceration. Despite the fact that incarceration is not uncommon (particularly in young infants), the need for intestinal resection is rare [22,25].

Incarceration of an inguinal hernia can compromise the blood supply to the testis, resulting in ischemic necrosis and atrophy. Incidences of testicular atrophy from 2 to 9 percent have been reported after emergent operative reduction of incarceration [22,63]. Boys with inguinal hernias also can have injury to the vas deferens, with the development of sperm agglutinating antibodies [64,65].

In girls with incarcerated inguinal hernia, torsion rather than direct compression compromises the blood supply to the ovary. Strangulation is reported to occur in between 2 and 33 percent of girls with inguinal hernias with an irreducible ovary. Because torsion can occur in an irreducible ovary while awaiting elective inguinal hernia repair, some surgeons recommend immediate reduction and repair [66].

After surgical repair of an inguinal hernia, a risk of recurrence, ranging up to 6 percent and occurring at various times after the initial repair, exists [67-69]. Risk factors associated with recurrence include elevated intraabdominal pressure (ventriculoperitoneal shunt, cystic fibrosis, ascites), malnutrition, prematurity, arrested testicular descent, connective tissue disorders, and a history of incarceration.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Inguinal hernia in children".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Inguinal and femoral (groin) hernias (The Basics)" and "Patient education: Groin (inguinal) hernias in children (The Basics)")

SUMMARY AND RECOMMENDATIONS

- An inguinal hernia develops when the processus vaginalis fails to obliterate during late gestation, allowing communication between the abdominal cavity and the

inguinal canal to persist. Abdominal contents can then herniate into the inguinal canal. The vast majority of hernias in children are indirect, with contents protruding through the internal inguinal ring into the inguinal canal (figure 1 and figure 2A-B and figure 3A-B). (See 'Embryology' above.)

- Inguinal hernias in children generally present in the first year of life as an intermittent, reducible inguinal mass. The diagnosis may be made by history alone, without the presence of a mass on physical examination. Between 14 and 31 percent of cases will be incarcerated at the time of diagnosis. (See 'Epidemiology' above and 'Clinical features and diagnosis' above.)

- Other causes of an inguinal mass are described in detail above. (See 'Differential diagnosis' above.)

- The management of inguinal hernia ultimately requires surgical repair. Incarcerated hernias must be emergently reduced:

  - Children with a compatible history and those with a reducible mass should be referred to a surgeon for evaluation. Because incarceration can occur in children awaiting elective repair, particularly in those less than one year of age, we suggest that repair be performed soon after diagnosis (**Grade 2B**). (See 'No mass, reducible mass' above.)

  - We recommend that manual reduction be attempted for children with an incarceration without signs of peritoneal irritation (figure 7 and figure 8) (**Grade 1B**). Immediate referral to a surgeon is recommended if manual reduction is not successful. Children with an incarcerated hernia should have nothing by mouth, in case emergent surgical reduction is required. (See 'Incarcerated inguinal hernia' above.)

  - Hernias in females are caused by the persistence of the diverticulum of Nuck and contain the suspensory ligament of the ovary. Because of the significant likelihood that reproductive organs are within the hernial sac, the clinician should attempt a gentle reduction and then obtain an ultrasound (US) if **not** successful. In patients in whom an incarcerated ovary is suspected, ultrasound first, if available, is an alternative approach. If the US indicates that reproductive organs are not present, then further efforts at reduction are appropriate. (See 'Inguinal mass in a female'

above.)

- Following successful manual reduction of an incarcerated inguinal hernia, children should be referred to a surgeon. We suggest that definitive hernia repair be performed within five days (within two days for infants born prematurely) of the reduction (**Grade 2B**). (See 'Timing of repair' above.)

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