Umbilical Hernia in Babies and Children

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Introduction

Umbilical hernia is a protrusion of intra-abdominal contents through the umbilical ring, within a peritoneal sac, and is one of the most common conditions managed by pediatric surgeons (Fig. 12.1). Debate exists regarding its natural history, expectant management before surgery, and supposed infrequent incarceration rate.

History of Umbilical Hernia Management

Observations regarding the management of pediatric umbilical hernia date back to the first century. Celsus described an operation by "ligature" for umbilical hernia, whereas Soranus (A.D. 98–117) suggested "doubling the cord over, rolling it in wool and laying it gently against the middle of the navel" [1].

In 1884 Erichsen declared that "these small umbilical hernias never strangulated, never caused death, and were rarely seen over the age of ten" [2]. Woods observed that no case of strangulation of an infantile umbilical hernia had ever been recorded, and treatment by strapping may actually delay the disappearance of the hernia or even increase its severity [1].

Surgical closure is now the accepted treatment if spontaneous resolution has not occurred or if complications arise. Recent reports would suggest that incarceration with or without strangulation occur more commonly than was previously thought [3–9].

Umbilical Pathology in Children

Umbilical disorders are common in pediatric surgical practice and usually present with umbilical discharge, pain, or mass. The majority occur due to abnormal embryologic or physiological processes. Umbilical hernia falls into the spectrum of congenital abdominal wall defects (see Table 12.1)

Formation of the Anterior Abdominal Wall and Its Relation to Umbilical Hernia

During embryonic development the umbilical area is highly complex. After birth however the normal umbilicus is a relatively simple structure. During fetal life anterior abdominal wall development depends on differential growth of embryonic tissues. This occurs by a combination of cranial, caudal, and lateral infolding of the head and tail folds as well as acute ventral flexion beginning in the 4th fetal week. Return of the midgut and a reduction in the relative size of the body stalk also play an important part [10]. The rectus muscles approximate and become closed by the 12th week, except for the umbilical ring. The connective tissue of the umbilical cord originates from the primitive mesoderm, whereas the rectus sheath, the linea alba, and the fascia of the anterior abdominal wall are formed from intraembryonic mesoderm. Fusion of these two types of mesoderm occurs at the embryonic rim which then becomes the umbilical orifice. Proliferation of lateral connective tissue plates is then responsible for closure of the umbilical ring; when this is incomplete, a patent ring is the result [1].

There are also anatomical theories for predisposition to development of umbilical hernia in addition to the embryonic theories (Table 12.2).

Physiology/Natural History of the Umbilicus After Birth

Shortly after birth there is a natural clamping of the blood flow through the umbilical cord, a physiological process triggered by the fall in temperature. Wharton's jelly swells and blood vessels within the cord collapse. After cord ligation,

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A.N. Kingsnorth and K.A. LeBlanc (eds.), *Management of Abdominal Hernias*,
DOI 10.1007/978-1-84882-877-3_12,

Fig. 12.1 Umbilical hernia

Table 12.1 Congenital umbilical disorders

		Delayed cord separation
Failure of normal physiology		Umbilical granuloma
Congenital	Abdominal wall defects	Hernia of umbilical cord
		Exomphalos/omphalocele (gastroschisis)
		Umbilical hernia
	Others	Dermoid cyst
		Vascular malformation
	Embryological remnants	
	Vitelline duct remnants	Umbilical polyp
		Patent vitellointestinal duct
		Meckel's diverticulum/band/cyst
	Urachal remnants	Umbilical polyp
		Patent urachus
		Urachal sinus/cyst

Table 12.2 Summary of the embryologic and anatomical theories predisposing to development of umbilical hernia

Failure of the recti to approximate in the midline after return of the midgut
Variability in the attachment of the ligamentum teres and median umbilical ligament
Variability in coverage of the umbilical ring by umbilical (Richet's) fascia
Anatomical maturity of the umbilical fascia

the vessels thrombose and the cord dries and sloughs. This leaves a granulating surface that heals by cicatrization and becomes covered by epithelium.

Elastic fibers that reinforce the umbilical ring, together with proliferation of the lateral connective tissue plates, originally from the cord, are responsible. Atrophy and obliteration of the umbilical vessels continue the process with the scar contracting resulting in a retracted umbilicus. Delay in development during the latter stages results in umbilical defects with minor degrees of herniation of the umbilicus observed in many neonates [11].

Table 12.3 Conditions associated with umbilical hernia

Prematurity and low birth weight
Racial variation
Trisomy 21, 13, 18
Beckwith–Wiedemann syndrome
Congenital hypothyroidism
Malnutrition/rickets
Mucopolysaccharidosis type 1

Natural History of Congenital Umbilical Hernias

The expectant approach to management of pediatric umbilical hernias relates to their natural history and asymptomatic nature. Umbilical hernias regress spontaneously in the majority of children. Early reports demonstrated that up to 93% of children resolve automatically in the first year of life [1]. Recent series have established spontaneous closure occurring in most children by the age of 4 years [12–15]. In Africa however some demonstrate resolution continuing up to 14 years of age [16].

If not repaired in childhood, 10% of umbilical hernias will persist to adulthood [17] and have an increased risk of incarceration compared to childhood hernias [18]. Emergency surgery for an incarcerated umbilical hernia in adults has significant morbidity and carries a mortality rate of up to 6% [19].

Some authors have observed that the size of the fascial defect, and even its sharpness, is indicative of its ability to close naturally [12, 20, 21]. Walker demonstrated in a series of 314 children that fascial rings measuring less than 1 cm in diameter tend to close spontaneously, while those larger than 1.5 cm rarely do [21]. A hernia with a thicker, rounded fascial edge is suggested by some as more likely to close than one with a thin, sharper edge [20].

Epidemiology of Umbilical Hernia

As the majority of umbilical hernias resolve naturally, their exact incidence is unknown. A true figure could only be obtained by large population-based studies. Incidence figures in the literature vary, due to differing definitions and methods of patient selection. Incidence is also dependent on factors such as the age and ethnicity of the patient group (Table 12.3).

Age

One author found that 106 (19%) of 583 healthy infants below the age of 6 months attending a welfare clinic had an umbilical hernia. It was also found that in a group of 105 children at nursery school, 10 children (9.5%), all age 2 years, had umbilical hernias. These all resolved by 5 years of age [1].

Prematurity

Umbilical hernias occur in 75–84% of premature (<1,500 g) neonates at birth [22, 23] but only 20% of larger neonates (2,000–2,500 g) [22].

Racial Variation

Umbilical hernias occur in 4–30% of Caucasian infants [1, 12, 13] and are up to ten times more common in persons of African origin [23, 24]. This difference is seen in different parts of the world. In the West Indies, 58.5% of children of African origin have umbilical hernias compared with 1–8% of white, Indian, and Chinese children [17]. Similarly in East Africa, 60% of African origin children have umbilical hernias, compared with 4% of Indian origin [25], and in South Africa 61.8% of children among the Xhosa tribe have umbilical hernias [26].

Meier and colleagues prospectively evaluated the umbilical area of 4,052 Nigerians. "Outies" (umbilical protrusion past the periumbilical skin in an erect subject) were identified in 92% of subjects below the age of 18 years and 49% of those above the age of 18 years. There was no palpable fascial opening in 39% of children with "outies." Umbilical hernias, defined as protrusion of at least 5 mm and a diameter of at least 10 mm, were present in 23% of patients under the age of 18 years [16]. One study from South Africa showed no significant racial disparity in incidence, with umbilical hernias present in 23% of blacks and 19% of white South Africans [12].

An interesting suggestion is the association between umbilical hernia and socioeconomic class. A prospective study of 7,968 Nigerian children seeking admission for private school found only 1.3% had umbilical hernias, a prevalence of 1.8 per 1,000 [27]. This is a much lower frequency than that usually observed in Nigeria [16].

Other factors predisposing to umbilical herniation (Table 12.3) are low birth weight [1, 22, 23], respiratory distress syndrome, and malnutrition [1]. Conditions such as trisomy 21, 13, and 18 [18], Beckwith–Wiedemann syndrome [18], congenital hypothyroidism [18], and mucopolysaccharidosis [18, 28] are also associated with umbilical hernias. However, the majority of umbilical hernias in children occur with no other associated anomaly. There is no gender difference.

Incarceration and Strangulation

Incarceration is the most common complication of umbilical hernia, followed by strangulation of bowel or omentum. Rupture and evisceration of contents is a rare but alarming condition that has a risk of mortality.

Incidence of Incarceration

Historically, obstruction of an umbilical hernia was considered "rare," occurring in approximately 1:1,500 (0.06%) umbilical hernias [12]. In 1975 a large European study of 590 children found 5% of umbilical hernias incarcerated [13]. More recently, several case series and retrospective studies of incarcerated umbilical hernias [3, 5–9] have highlighted that this complication is more common than previously thought. One author reported seven cases in 3 years and suggested a possible increasing trend of this complication [3] (Table 12.4).

There may be geographic, genetic, or socioeconomic factors involved in complication of hernias, though some of the difference in incarceration rates may simply reflect the increased incidence of umbilical hernias in these areas. Retrospective studies from Africa show a relatively high frequency of incarceration and other complications, up to 37.5% for acute incarceration and 54% if those that were recurrently incarcerated were included [5–8]. However, these patients are likely to be a self-selected group with the majority only presenting when symptomatic, as umbilical hernia is considered normal in their society and presentation for cosmesis is rare [16]. In the same continent, a South African study of mainly Caucasian (93%) children observed an incarceration rate of 7% [4], a figure more in line with the 5% from the only comparable European series [13].

Contrary to these findings is a retrospective analysis from Nigeria that only identified two children who had emergency surgery for umbilical hernia in 15 years [16] and a report from Kansas children's hospital where they did not observe any emergency surgery for umbilical hernia over a 15-year period [29]. Clearly there are geographical differences.

Predicting Which Umbilical Hernias will Incarcerate

Conflicting evidence suggest defect size has a role in predicting complications. Lassaletta observed that small defects (<1.5 cm) are at higher risk [13], a finding confirmed by others [3]. Several case series however found the opposite, with their complications arising in defects 1.5 cm or larger [5, 6]. Brown et al. suggest that size has no impact on whether the hernia incarcerates [4].

In the literature, age at presentation of patients with acute incarceration ranged from 14 months to 5 years. Why these age groups are more at risk is not clear, though this may represent a closing defect.

Severe abdominal wall spasm associated with an umbilical hernia incarceration during vigorous swimming has also been described in two children. High intra-abdominal pressures from breathing using the abdominal muscles is suggested as causing umbilical herniation and incarceration under such circumstances [30].

Table 12.4 Table summarizing literature on complicated umbilical hernias

Author	Location of study	Type of study	Time period (years)	Total number children	Age	Incarceration cases/% of total	Comment
Woods [1]	UK	Po		283	Infants only	0	All Caucasian
Lassaletta [13]	Europe			590		5%	• 2/3 children of Afro-Caribbean origin
				377 repaired		3.7% age <1 y	
						4.7% age ≥4 y	• Incarceration most frequent in defects 0.5–1.5 cm
Mawera [8]	Zimbabwe	R	4	38	1 mth–13 y	37.5%	• 86% of obstructed group reduced spontaneously
						20% S/RI	
							• Only 2 needed operative reduction
Vrsansky [9]	France	CS	5	N/A		4	1 strangulated
Papagrigoriadis [20]	UK	CS	20	N/A	22/40/48 mths	3	• Caribbean descent
							• 2 had mass of undigested material in the incarcerated bowel
Meier [16]	Nigeria	R	15	Unknown	0–18 years (adults also studied)	2	• No denominator
Keshtgar [3]	UK	CS	3	N/A	Median 3 y	7	• 4/5 reduced under G/A or at surgery. 1 with taxis
						5 acute	
						2 recurrent	• 1 necrotic omentum
							• Defects <1.5 cm
Ameh [5]	Nigeria	R	14	47	≤12 y	25 (53%)	• 1/15 reduced spont
						15 A (32%)	• 2/15 had bowel resection
					Median age of:	10 RI (21%)	
					1) Acute—5 y		• 5 others (11%) had spontaneous evisceration
					2) recurrent—3 y		• Complications in hernias ≥1.5 cm
Brown [4]	Cape Town S Africa	Pr	15	389	6 y (average)	28 (7%)	• 2 had resection of ischemic omentum
							• 5 had pica
							• Only 22 African origin, 6 colored
							• 5 spontaneously reduced 14 reduced by taxis 9 at surgery
					Incarcerated—3 y (average)		• Mean defect size 2.24 cm
Chirdan [6]	Nigeria	CS	8	52	4 y (median)	23 (44%)	• Acute—defect 2 cm (median). Recurrent 2.5 cm
					Median age	17 A (33%)	
						6 RI (11%)	• 1 resection gangrenous bowel and Meckel's
					Acute—4 y		• 12/15 reduced by taxis 3/15 at emergency surgery
					Recurrent—8.5 y (average)		

Fall [7]	Senegal	R	5	Unknown	14 mths	41 (15%)	• 5 necrotic bowel (1 had perforated Meckel's diverticulum) • 5 reduced at anesthetic induction • All operated as emergency
Snyder [29]	USA		15	Unknown		0	Statement in review article Presumed retrospective
Khakhar 2009	UK	R	4	184	20 mths	10 (5%) A 4 (2%) S/RI	Personal series

Po population based, *CS* case series, *R* retrospective, *Pr* prospective, *Y* years, *Mths* months

Pica leading to accumulation of undigested foreign material in bowel, such as chewing gum, sand, or even the presence of ascarids, may predispose to irreducibility of a hernia. They have been observed in incarcerated hernias, and it is presumed that the size of the mass prevents reduction through a narrow neck [4, 20].

Recurrent Incarceration

Recurrent incarceration may be due to intermittent trapping of omentum within a closing hernia and presents as episodes of vomiting with umbilical pain [31]. Studies show this is not uncommon and is reported in a fifth of the patients in African studies [5, 6, 8] and is also described in the United Kingdom [3]. Recurrent incarceration may be significantly underreported as some studies may not have included those patients [4, 13, 15].

Outcome of Incarcerated Umbilical Hernia

Two studies found that 86% of incarcerated umbilical hernias spontaneously reduced, in or just prior to arriving at the hospital [8, 32]. Others showed that only 6–18% of irreducible hernias resolved without intervention with 50–80% being reduced by taxis with sedation or analgesia [4, 6]. Reduction at surgery was necessary in 18–32% of these incarcerated hernias. In contrast to these results, one study from Senegal found that all 41 of their patients were operated on as an emergency, five of which reduced at anesthetic [7].

Strangulation of hernia contents is also reported in up to 13% of incarcerated hernias undergoing bowel resection [4–7, 16] and up to 14% excising omentum only [3, 4]. Postoperative infection is reported to occur in 4–7% of those that had been previously been incarcerated or strangulated [4–7]. There was no mortality in any published study.

Conditions Mimicking Incarcerated Umbilical Hernia

Tender distended umbilical hernias occur in and mirror intraperitoneal disease, peritonitis, intestinal obstruction, and ascites. Recent reports in the pediatric literature illustrate how other pathology, such as appendicitis [33] or an inflamed Meckel's diverticulum [34], can present as an incarcerated umbilical hernia.

Rupture and Evisceration

Spontaneous rupture is a rare complication of umbilical hernias in children, with only 14 cases in the literature [28, 35, 36]. It is usually bowel that eviscerates [31, 32, 35, 37, 38] but can be omentum alone [26] or more rarely the urinary bladder dome [36]. Factors implicated in spontaneous rupture [35] include local trauma or ulceration of skin [31, 32, 37], umbilical sepsis [38], and prematurity with prolonged positive pressure ventilation [37]. Severe coughing [31] and excessive crying [32, 35] may also contribute. It also appears that those hernias with larger fascial defects ≥1.5 cm are at higher risk [35]. There is one case report of rupture of an umbilical hernia in an infant with Hurler's syndrome (mucopolysaccharidosis type 1), a condition in which umbilical hernias are commonly seen though rarely repaired due to high anesthetic risk and short life expectancy [28]. Spontaneous rupture has also been reported in a previously healthy 8-month-old infant [35].

Clinical Definition of Congenital Umbilical Hernia

A congenital umbilical hernia can be defined clinically as a herniation of intra-abdominal viscera, usually intestine, through the umbilical ring within a peritoneal sac. It is covered by skin and is present from birth. Some authors specify that a true umbilical hernia is a saccular swelling, present and protruding on straining [1, 12, 16]. Others use less strict criteria, with palpability of a gap at the umbilical orifice alone being sufficient [13]. Some studies do not state their definition.

Diagnosing Umbilical Hernia

The diagnosis of umbilical hernia is a clinical one. The usual history is of an umbilical protrusion since birth and a trend of either growth of the size of the hernia or, as in most cases, a reduction. Age at presentation to a surgeon often depends upon the parental or local medical knowledge of the natural history of umbilical hernia.

During a consultation parents will often comment on the size of the hernia and its worsening during crying. A history of recurrent abdominal discomfort and believing the hernia to be responsible is often given, especially as increasing size is associated with crying. The child may repeatedly play with the protruding skin which is also taken as a sign of discomfort.

Clinical examination should focus on the position of the hernia and its differentiation from an epigastric or supraumbilical hernia and embryological remnants such as a residual urachal cyst [39]. An umbilical hernia has at its base a circumscribed central defect, whereas a supraumbilical hernia is often a transverse or irregular defect which is outside the central umbilical area. In addition, the defect in an umbilical hernia is often relatively small in comparison to that of the herniated contents, and the contents reduce without difficulty or discomfort.

Table 12.5 Chelsea and Westminster Hospital Series 2004–2009

185 patients
Median age at surgery—55 months
158 elective (85.4%). Median age—58 months
10 underwent emergency surgery for incarceration (5.4%); Median age 24 months
5 symptomatic hernias/recurrent incarceration (3%) 11 repaired incidentally when other surgery being performed 6%

The diameter and sharpness of the fascial edge of the hernia orifice can be recorded during the examination. A smooth edge and a diameter of less than 1.5 cm are seen by some as predictors of spontaneous closure [12, 20, 21].

Acute incarceration usually presents as an emergency. The clinical picture for incarceration is one of developing tenderness in the umbilical region with a history of umbilical hernia. In our own series of 185 cases over a 10-year period, 10 patients (5%) presented with incarceration, and an additional five patients (3%) reported intermittent abdominal pain associated with a temporary irreducible hernia. The true denominator in our community is of course unknown (Table 12.5).

Consent and Indications for Surgery

Consent

Consent for umbilical hernia repair should focus on the position of the incision, the nature of the repair, the absorbability of the suture used, the dressing immediately following surgery, and the potential complications. Complications occur in 0.5–1% of patients undergoing umbilical hernia repair and include wound infection, hematoma, and recurrence. Excessive skin and hypertrophic scarring should also be mentioned as being possible short-term observations particularly in the proboscoid-type hernia and those of African–Caribbean descent [16, 21, 23, 40].

Indications for Operating on Umbilical Hernia

Indications for surgery include incarceration, recurrent abdominal discomfort associated with herniation, or umbilical port closure following laparoscopy (Table 12.6).

The precise age at which surgery should be carried out in an asymptomatic umbilical hernia is debated. Most pediatric surgeons have a tendency to offer repair for an asymptomatic hernia prior to regular schooling. In our own recent series, the median age at operation for elective patients was 58 months (Table 12.5). For most surgeons cosmetic appearance is not an indication to operate until the natural regression of the defect has occurred. Parental desire is often for their child not to look different from other children, and teasing from an umbilical bulge is not an infrequent complaint from school-age children. Increasing size as an adult also carries a greater incarceration risk in later life and therefore represents an indication to operate earlier in life.

Table 12.6 Indications for surgery in umbilical hernia

Absolute	Incarceration and/or strangulation
	Spontaneous rupture and evisceration
Relative indications	Hernia causing pain
	Cosmesis
	Large rings—unlikely to close >1.5 cms
	Asymptomatic age 3 years +
Incidental	At time of other surgery?
	At laparoscopic surgery

If there was a desire to avoid surgery at 3–4 years of age, then expectant management could continue. Parents should be made aware of the low risk of incarceration and what to expect if it should occur.

Incidental Closure

Any laparoscopic procedure that results in an umbilical insertion of a Veress needle or open insertion of trocar would, for most pediatric surgeons, result in the closure of an incidental hernia at that time. A recent poll of clinical investigators in a multicenter international randomized controlled trial into pediatric laparoscopic inguinal hernia repair indicated that most would also close an incidental umbilical hernia, regardless of age (S. Clarke. Personal Correspondence). An umbilical procedure that occurs in most laparoscopy converts a natural orifice into an unnatural one, making it unlikely to be subject to the normal forces of closure.

In our own recent series of laparoscopic inguinal hernia repair associated with an umbilical hernia, one umbilical hernia did reoccur [41]. This was presumed to be due to an inadequate umbilical herniotomy at time of umbilical port closure.

Management Options for Umbilical Hernia

Observation

An initial conservative approach is the suggested management for most children presenting at preschool age. Parental reassurance is important, as the size of the herniation can be of considerable concern. Follow-up is not indicated in the majority unless reassurance is difficult to convey. A referral back to a surgeon once the child is of schooling age is typical.

Diagnostic Work-Up

Prenatal diagnosis of congenital umbilical hernia is possible using ultrasound and must be differentiated from persistent omphalomesenteric duct or omphalocele [42]. Postnatally, imaging studies are not usually required for umbilical hernia to be confirmed. An ultrasound may help if there is doubt as to the site of the defect, i.e., paraumbilical or umbilical. However, clinical confusion in children is rare.

Procedural

Preoperative Reduction

Any umbilical hernia incarceration should be considered for reduction following resuscitation. Sedation should always be carried out in a suitable environment that can provide for the resuscitation of children [43]. Reduction after administration of simple analgesia should be attempted first. Discussion with a pediatric anesthetist is advisable if further sedation is thought necessary. Any doubt as to the viability of the herniated contents or failed reduction should result in an examination of the contents and open reduction with repair under general anesthesia.

In the unlikely event of spontaneous rupture with evisceration, the child should be resuscitated, and the eviscerated bowel should be covered with cling film to protect and prevent heat loss. The hernia should then be repaired urgently.

Anesthesia for Umbilical Hernia

General anesthesia is preferred in children. Local anesthesia using 0.25% bupivacaine (0.8 mL/kg) within the fascia or as a pararectal block is recommended. Some evidence also exists for reduced postoperative pain requirement with a preoperative caudal anesthetic [44].

Surgical Options for Umbilical Hernia

Operative technique for umbilical hernia repair was highlighted by Mayo more than a century ago [45]. Over the past few decades, observational studies have continued to describe alterations in technique as well as outcome [12, 14, 15, 46, 47].

The most established accepted technique for strength and closure in an adult is similar to that originally described by Mayo and involves closing of the defect using an overlapping fascial technique. In children, where the defect is usually not large as in adults, the most commonly performed method involves a primary interrupted repair of the defect following control and excision of the sac [15].

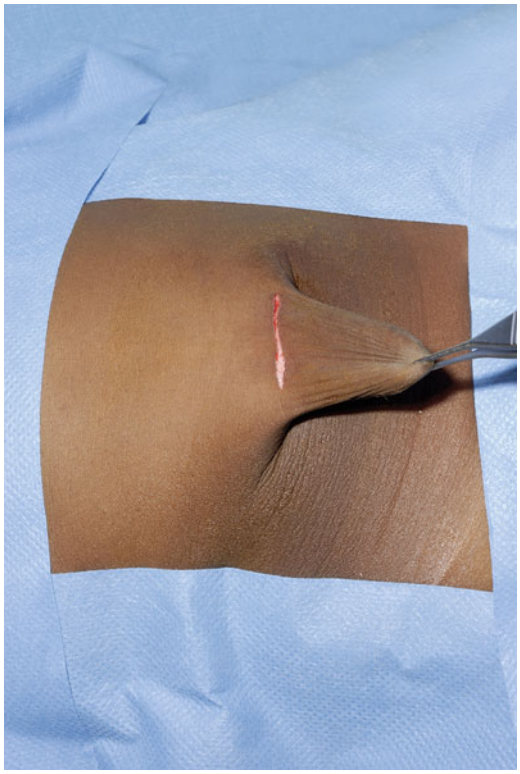

Fig. 12.2 Incision

Position and Prepping of the Patient

The child is placed on his back (supine) on the operating table. A warming device or cotton wool sheets are placed around the child to prevent heat loss during surgery. Antibiotics are not routinely given for umbilical hernia repair. Careful aseptic technique combined with a Betadine or chlorhexidine prep will suffice.

Draping

Drapes are applied so that the umbilical area is exposed throughout the operation.

Incision

Most pediatric surgeons carry out a simple curved sub- or supraumbilical incision, with circumferential dissection of the sac around its base to control it (see Fig. 12.2). The supraumbilical incision is seen by many as preferable, as with growth this is hidden within the superior umbilical fold itself and is not visible to the patient. Hernia reduction has usually occurred following anesthesia, though it is important the operator should confirm reduction of contents before opening the sac.

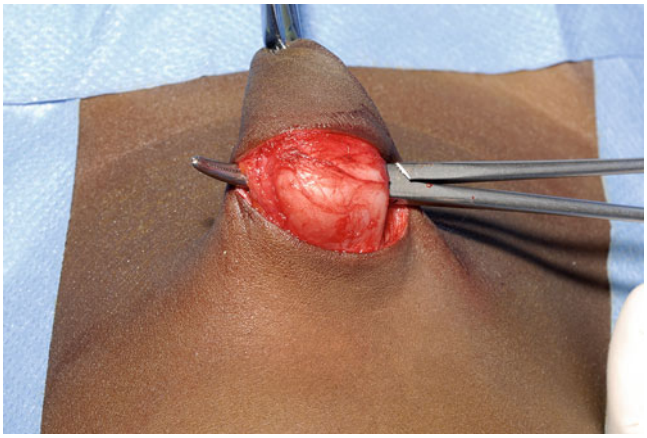

Fig. 12.3 Controlling the sac

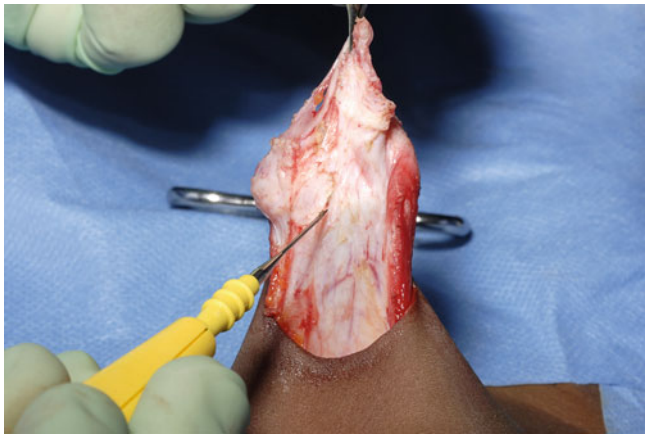

Fig. 12.5 Excising the sac

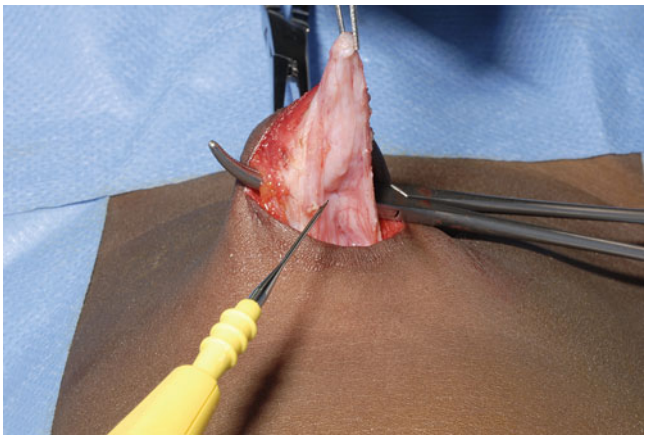

Fig. 12.4 Freeing the sac from the defect

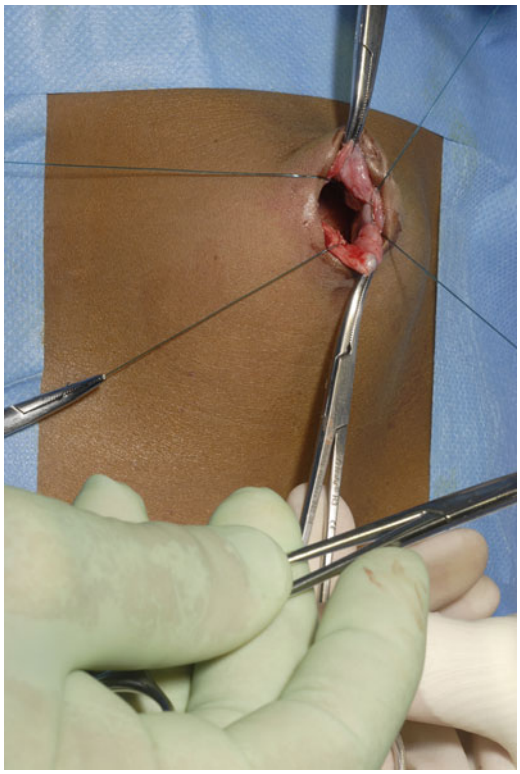

Fig. 12.6 Interrupted sutures to defect

Sac Dissection

A circumferential dissection then begins to isolate the sac (Fig. 12.3). Once controlled, the sac can be incised at its base (Fig. 12.4) and the distal part removed from the overlying skin to avoid a bulky appearance (Fig. 12.5).

An alternative method, or if the sac is particularly large, involves opening the sac immediately following the skin incision. The umbilical ring can be seen from inside the sac. The sac can then be stripped from the umbilical fascia and overlying skin [47–49].

Regardless of technique, removing some of the sac especially in the larger hernias will result in an improved and inverted cosmetic appearance. Care must be taken when stripping the sac off the overlying skin to avoid postoperative skin necrosis and ulceration. It is not customary to excess excise overlying skin in children as this usually resolves with time, and excision may result in a distorted or flattened appearance.

The defect itself, once identified clearly, can be closed with an overlapping fascial technique. A monofilament absorbable suture such as PDS (Ethicon) 2-0 or 3-0 will suffice in most children. A monofilament suture runs easily through the thickened umbilical fascia than a braided suture. The peritoneum and muscle are closed as one layer either transversely or in a midline fashion depending on the shape of the umbilical defect. Applying a hemostatic clip to each suture (see Fig. 12.6) and tying after all have been placed allows for a controlled repair as well as superior retraction and avoidance of damage to intraperitoneal viscera (see Fig. 12.7).

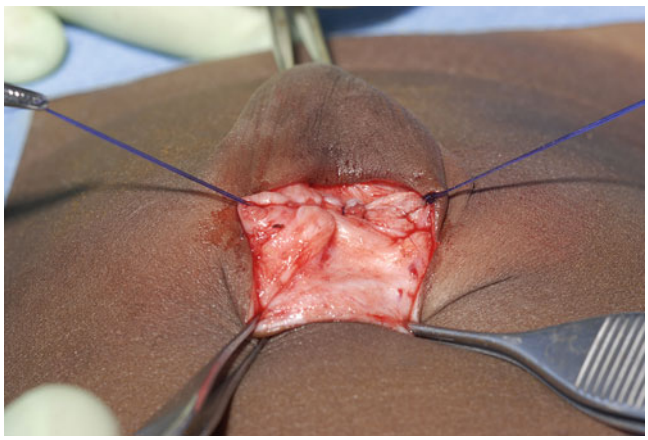

Fig. 12.7 Defect closed with knots buried

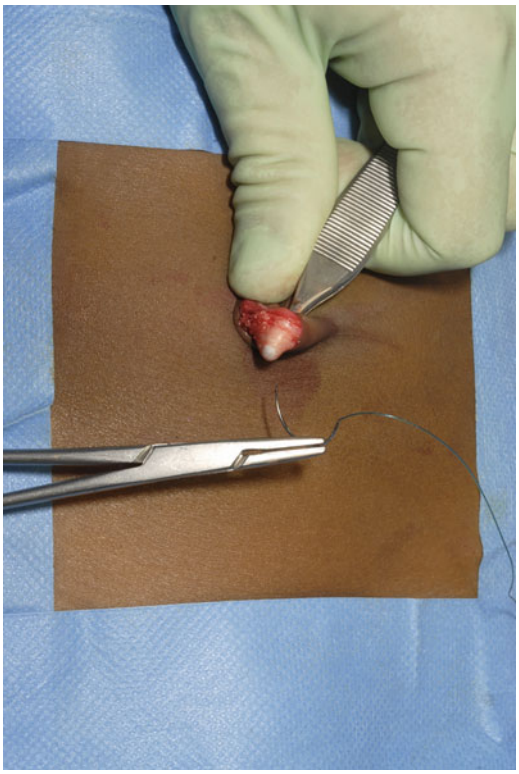

Fig. 12.8 Inverting the umbilicus

One suture is then used to anchor the central subdermal area of the umbilicus to fashion an inverted appearance (see Fig. 12.8). The superficial fascia can then be closed with an interrupted nonabsorbable suture. Finally, the skin can then be closed with either a continuous subcuticular absorbable suture or glue (see Fig. 12.9).

A dressing can be applied which may or may not have a pressure pad to avoid hematoma formation. Some authors doubt the necessity of this step [50].

In larger hernias one can adopt the Mayo technique as used in adults [45], or a patch can be placed if the muscle is weak or the hernia recurrent. This would be unusual in children.

Fig. 12.9 Final appearance

Minimally Invasive Technique for Umbilical Hernia Repair

Minimally invasive techniques have been described for treating umbilical hernia in children. These involve the injection of polymers or using laparoscopy. Feins et al. described twenty-five children with umbilical hernias of 1.5 cm or less, where Deflux, a biodegradable compound of dextranomer microspheres in hyaluronic acid, was injected percutaneously in the border and preperitoneal space in 4 quadrants of the hernia defect occluding the lumen. They reported 21 of the 25 (84%) umbilical hernias as being closed at follow-up. The average age at the time of the procedure was 6 years and 7 months, and the average defect was more than 6.4 mm [51]. Albanese et al. describe a novel technique for the repair of umbilical and epigastric hernia using 3-mm laparoscopy. They repaired 41 umbilical hernias using two 3-mm lateral ports at a mean age of 4.2 years and reported excellent cosmetic and patient satisfaction outcomes [52].

Recommendations Based on Level of Evidence

The surgical method described in this chapter is effective and easily replicated though no level 1 evidence exists for this method of congenital umbilical hernia repair. The Mayo technique is widely used in adults and as such has little to compare it with. Recommendation is therefore based solely on level 2 and level 3 evidence. The lack of need for a

pressure dressing is based on one randomized controlled trial in children [50].

Expected Posttreatment Course and Postoperative Care

Children should expect a full and quick recovery following umbilical hernia surgery, provided that no complications occur. A dressing, if used, is usually removed 48–72 h after surgery. Follow-up is not routinely offered in our own unit if the defect is large or at parents' request.

Postoperative Complications and Treatment of Complications

Bleeding

Bruising around the umbilicus is a possibility and often results from the pararectal anesthetic block. Hematoma from the surgical dissection is rare but if large and painful, may require evacuation.

Infection

The incidence of infection in one reported series is 1% and is not influenced by the use or not of a dressing [50]. Infection should be treated with antibiotics and would rarely require abscess drainage.

Cosmetic Concerns

In the author's own series, excess skin has occasionally demanded umbilicoplasty at the patient's request during teenage years. Twelve patients (6.5%) voiced cosmetic concerns, of which four went on to further corrective surgery. Two African–Caribbean patients experienced hypertrophic keloid scarring and were treated conservatively.

Recurrence

In adults the recurrence rate is reported as being between 8 and 20%. Associated risk factors include high body mass index, cirrhosis with ascites, and large defects [53–55].

In children, recurrence is much less common 1–2% [56]. In our own recent series, there were two recurrences (1%). There were no clear indications in either case as both occurred some months after the initial repair, though an incomplete closure at the initial surgery is presumed. Postoperative wound infection, hematoma, or obesity are likely risk factors for recurrence in children.

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