Pediatric Umbilical Reconstruction

Principles and Techniques

Melvin A. Shiffman
Editor

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Foreword

I must say that it is an honor to present a unique piece of art in the medical literature edited by Dr. Melvin Shiffman.

Umbilical disorders have long been of enormous interest and importance to families, pediatricians, and surgeons. Prenatally, the umbilical cord connects us to life at birth; actually, it is a tool to keep in emergencies due to the presence of stem cells in the embryo's structure.

However, we should also take into account the symbolic values assigned to the navel by different cultures. It is well known that Cuzco means navel (of the cosmos) for the Incas and that the omphalos was the conical stone placed in Apollo's temple in Delphi that was considered the center of the world. Moreover, Calypso Island is called navel in the Odyssey for being the center of the sea.

The umbilicus is the only corporal scar that must be restored and preserved to maintain a natural result after a surgery as a part of the body's aesthetics.

Until today, there were only a few scientific articles in journals and book chapters of specific umbilical disorders, but I have never seen anything like this book that focused exclusively on umbilical reconstruction.

This textbook covers the principal concepts of embryology, anatomy, and different techniques for umbilical reconstruction in children brought from experienced physicians.

It is not only an astounding compilation, but it is also beautifully illustrated and superbly published.

Truly, this masterpiece will be an important addition for everybody in the field of abdominal wall reconstruction for children and infants.

Buenos Aires, Argentina — Guillermo Blugerman

Preface

There has never been a book devoted solely to umbilical reconstruction in children and infants. There have been many reports concerning embryologic abnormalities that result in the loss of the umbilicus but little on the umbilical reconstruction in these infants. There have been articles on hernias in children but little on the umbilical reconstruction. The editor is bringing all this together with embryology, classification of huge hernias, techniques in children, benign tumors of the umbilical cord, and techniques in embryologic disorders such as exstrophy, gastroschisis, and urachal pathology. International experts present their techniques and discussions.

The information will be of interest to pediatric surgeons, general surgeons, neonatologists, and family physicians.

Tustin, CA — Melvin A. Shiffman

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Part I
Embryology

Chapter 1
Embryology of the Umbilicus and Associated Newborn Defects

Robert K. Minkes and Mark V. Mazziotti

1.1 Introduction

The embryology of the umbilicus and the developmental basis for surgical abnormalities has been well described for more than 100 years. Umbilical hernias, abdominal wall defects, umbilical polyps and drainage, and omphalomesenteric remnants are well described [1].

Treatment of some umbilical disorders, such as umbilical granulomas with silver nitrate, has changed little over the last century. In the early 1900s, umbilical hernia repair was a challenging procedure. Spontaneous closure of these hernias and preservation of the appearance of the natural umbilicus were recognized. Today, umbilical hernia repair is one of the most common procedures performed by pediatric surgeons. The umbilicus is currently a common site for port entry for laparoscopic surgery.

Newborns with umbilical disorders usually present with an abdominal wall opening, drainage, a mass, or combination of findings. Most umbilical disorders result from failure of normal embryologic or physiologic processes. Unusual umbilical anatomy, such as a single umbilical artery or abnormal position of the umbilicus, may be associated with other congenital anomalies or syndromes [2, 3]. Omphalocele and gastroschisis are common major abdominal wall defects associated with the umbilicus [4]. Ectopia cordis and bladder exstrophy are other major abdominal wall defects and are beyond the scope of this chapter [5].

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The frequencies of the many different umbilical disorders vary. Umbilical infections are now identified in fewer than 1 % of hospitalized newborns.

Umbilical hernias are commonly identified in early infancy, however, most spontaneously close [6]. No sex predilection is noted. The incidence at age 1 year ranges from 2 to 15 %. Incidence is increased in infants who are black and in infants with low birth weight, Down syndrome, trisomy 13, trisomy 18, or Beckwith–Wiedemann syndrome [7].

1.2 Embryology

The development of the anterior abdominal wall depends on differential growth of embryonic tissues (Fig. 1.1) [8]. As the embryo grows, the yolk sac is divided into an intra-coelomic portion and an extra-coelomic portion. The intra-coelomic

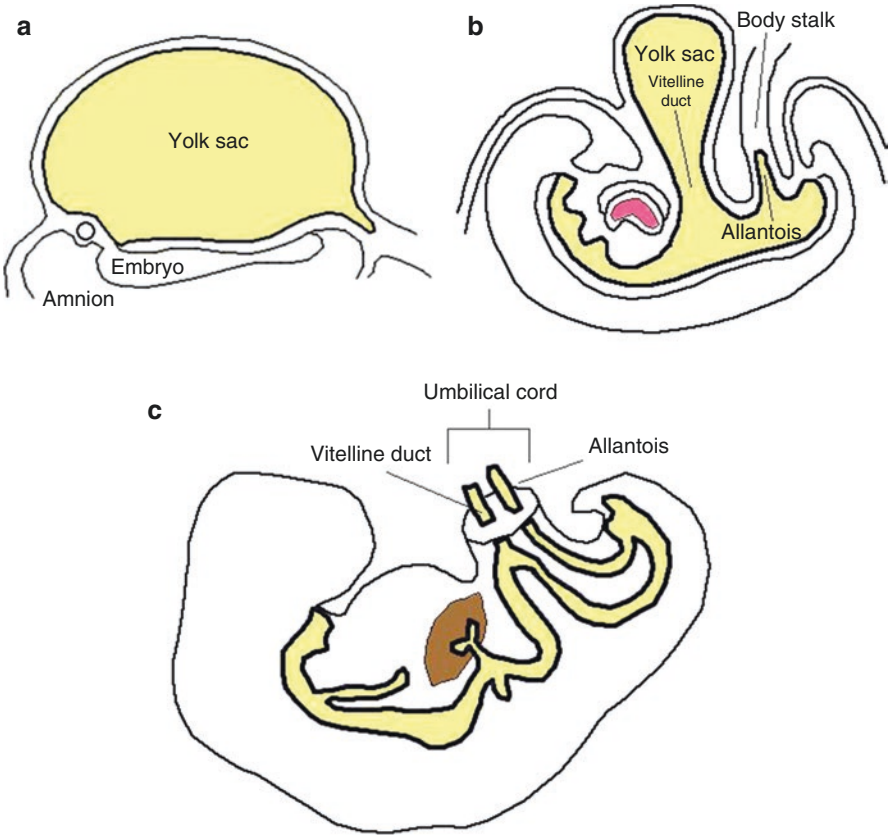


Fig. 1.1 The developing umbilical cord. (**a**) Embryonic disk: At this stage, the ventral surface of the fetus is in contact with the yolk sac. (**b**) The yolk sac narrows as the fetus grows and folds. The intra-coelomic yolk sac forms the intestine and communicates with the extra-coelomic yolk sac through the vitelline duct. The vitelline duct is also referred to as the omphalomesenteric duct and the yolk stalk. The allantois has begun to grow into the body stalk. (**c**) The yolk and body stalks fuse to become the umbilical cord (Image used with permission from Minkes et al. [28])

portion becomes the primitive alimentary canal and communicates with the extracoelomic portion through the vitelline duct, also known as the omphalomesenteric duct. This communication is lost at 5–7 weeks' gestation. Persistence of part or all of this connection results in omphalomesenteric anomalies.

In the third week, the yolk sac develops a diverticulum, the allantois, which grows into the body stalk. As the distal hindgut and the urogenital sinus separate, the developing bladder remains connected to the allantois through a connection called the urachus [9]. Persistence of the urachus or urachal tissue leads to urachal remnants. Subsequently, the yolk and body stalks fuse to become the umbilical cord. Development of the abdominal wall narrows the umbilical ring, which should close before birth. Persistence of the ring results in an umbilical hernia.

Failure of the normal obliterative processes of the vitelline duct and the urachus leads to abnormal communications or cysts. Retention of components of the umbilical cord can also produce a mass or drainage.

A patent umbilical ring at birth is responsible for most umbilical hernias. The umbilical opening is usually inferiorly reinforced by the attachments of the median umbilical ligament (the obliterated urachus) and the paired medial umbilical ligaments (the obliterated umbilical arteries) and is more weakly superiorly reinforced by the round ligament (the obliterated umbilical vein) (Figs. 1.2 and 1.3).

Richet fascia, derived from the transversalis fascia, covers the ring. The peritoneum covers the innermost portion of the ring. Variability in the attachment of the ligaments and the covering by Richet fascia may predispose some children to developing umbilical hernias. This fascia may completely or partially cover the umbilical ring or be completely absent. These variations predispose to umbilical hernia formation and are responsible for the range of defects encountered clinically. It is important to note that many children undergo spontaneous closure in the first few years of life. The pressure exerted on the umbilical skin, even when only a small umbilical defect is present, can result in marked stretching of the skin and a proboscis appearance.

Masses of the umbilicus may be related to lesions of the skin, embryologic remnants, or an umbilical hernia. Masses associated with the skin include dermoid cysts, hemangiomas, and inclusion cysts. Umbilical drainage is associated with granulomas and embryologic remnants. Failure of the normal physiologic processes results in postnatal disease. The umbilical cord separates from the umbilicus between 1 and 8 weeks postnatally [10, 11]. Topical antimicrobials are applied after delivery, followed by isopropyl alcohol until the cord separates. Delayed separation of the cord may signify an underlying immune disorder [12].

1.3 Umbilical Granuloma

Umbilical granuloma is a common finding resulting from persistent granulation tissue after cord separation. Umbilical granulomas appear as 1 mm to 1 cm or more pink friable tissue at the base of the umbilicus. They produce variable amounts of drainage that can irritate the surrounding skin. Histologically, this tissue is composed of fibroblasts and capillaries. Most respond to silver nitrate, and larger lesions

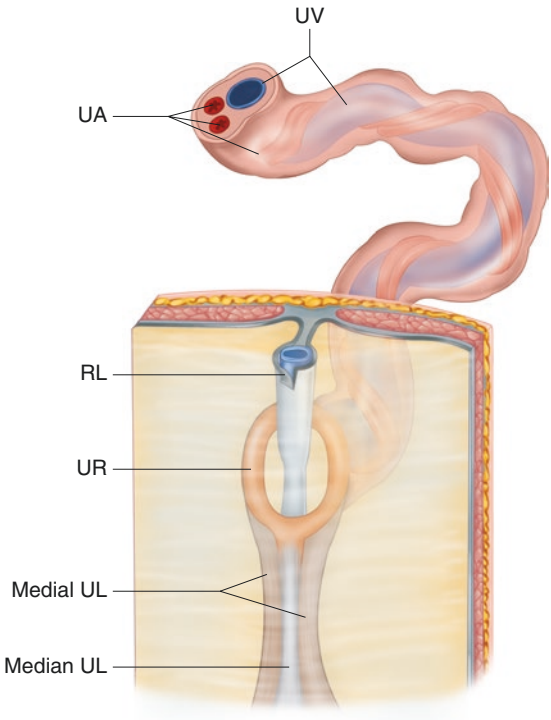


Fig. 1.2 Umbilical region viewed from the posterior surface of the abdominal wall of an infant with the umbilical cord attached. *UA* umbilical artery, *UV* umbilical vein, *RL*, round ligament (obliterated umbilical vein), *UR* umbilical ring, *UL* umbilical ligament, medial (obliterated umbilical arteries), median (obliterated urachus). Note fascial covering of surface and umbilical ring (Image used with permission from Minkes et al. [28])

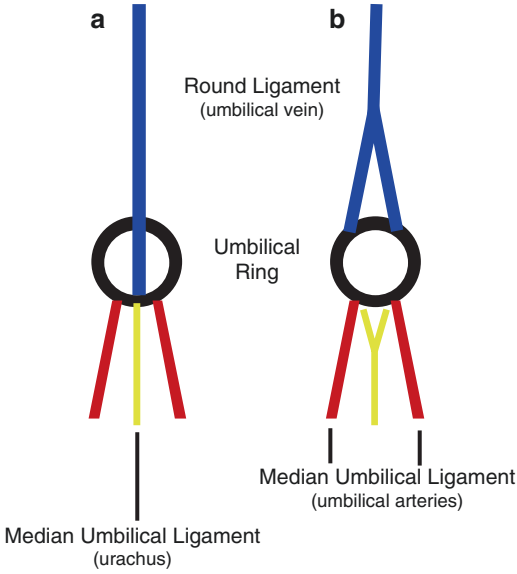


Fig. 1.3 Variations in the umbilical ring structure. (**a**) Usual configuration of the round ligament and urachus. (**b**) Less common configuration that can result in weakness at the umbilical ring (Image used with permission from Minkes et al. [28])

can often be safely excised with scissors in the office setting [13]. Persistent or recurrent granulation may suggest an umbilical polyp and warrant further investigation or umbilical exploration. An umbilical polyp is brighter red than a granuloma and represents retained intestinal or gastric or urogenital tissue from the omphalomesenteric duct or urachus [1, 13–15].

1.4 Umbilical Infections

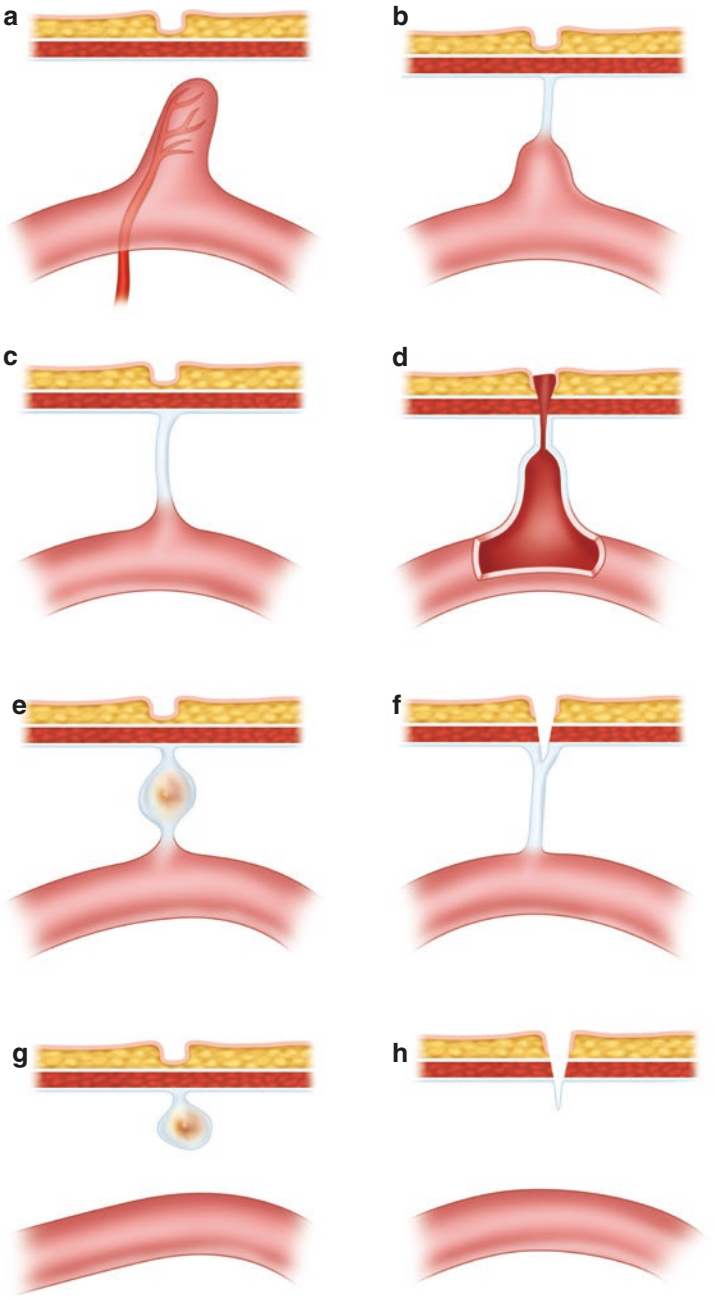
Umbilical infections can occur because of an embryologic remnant or poor hygiene. Newborns or infants with omphalitis may present with purulent umbilical discharge or periumbilical cellulitis. Current aseptic practices and the routine use of antimicrobials on the umbilical cord have reduced the incidence of umbilical infection to less than 1 %. Umbilical infections can be life threatening in the newborn period. Patients with umbilical infections can present with drainage from the umbilicus, swelling, and redness. Cellulitis may rapidly progress and lead to necrotizing fasciitis. Necrotizing fasciitis is characterized by abdominal distention, tachycardia, purpura, leukocytosis, and other signs of sepsis that may not respond antibiotic therapy. A simple appearing cellulitis may become severe within hours and progress to necrotizing fasciitis and generalized sepsis.

Traditionally, gram-positive organisms, such as *Staphylococcus aureus* and *Streptococcus pyogenes*, were most commonly identified. Gram-negative and polymicrobial infections are seen today, especially in rapidly progressing cellulitis and necrotizing fasciitis. For necrotizing fasciitis and gangrene of the umbilical skin, emergency surgical debridement is required and can be life-saving.

1.5 Omphalomesenteric and Urachal Remnants

The presentation of omphalomesenteric and urachal remnants represent persistence of all or portions of the omphalomesenteric (vitelline) duct. They can result in fistulas, sinus tracts, cysts, congenital bands, and mucosal remnants [16]. Omphalomesenteric remnants and urachal remnants require surgical excision. The precise diagnosis is often not confirmed until surgery is performed, and the anatomy of the umbilicus is established. The presentation depends on the specific type of defect (Fig. 1.4). If a communication persists from the terminal ileum to the umbilicus, intestinal contents or stool can be observed leaking from the umbilicus. Prolapse of the intestine through an omphalomesenteric fistula can also be observed (Fig. 1.5). The drainage from a fistula that does not communicate with the ileum varies, as it may be clear, bloody, or purulent. Cystic remnants may become infected and manifest with pain and swelling.

The developing bladder remains connected to the allantois through the urachus, and remnants of this connection include a patent urachus, urachal sinus, and urachal cysts. Umbilical polyps can also be observed in association with a urachal remnant. The presentation of urachal remnants also varies. Clear drainage from the umbilicus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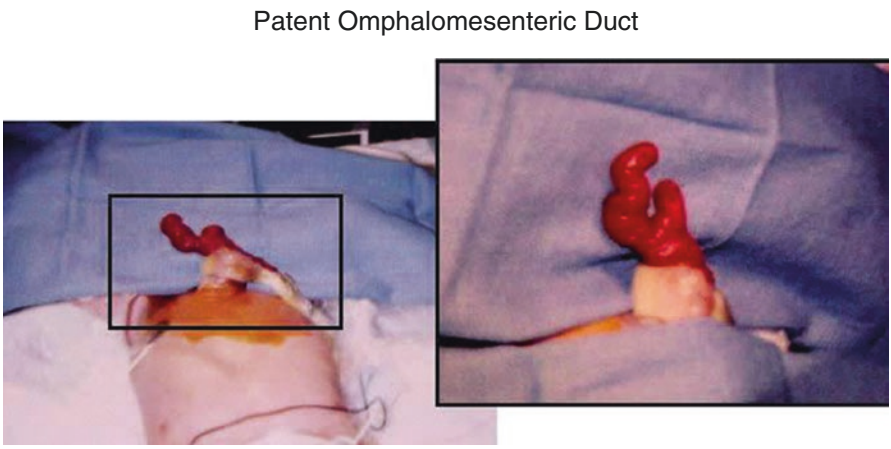

Fig. 1.5 (*Left and Right*) Newborn with intestinal prolapse through a patent omphalomesenteric duct. Both the proximal and distal limbs of the intestine have prolapsed. The umbilicus was explored, the bowel was easily reduced, and the patent duct was excised. The child was discharged from the hospital 2 days later (Image used with permission from Minkes et al. [28])

is characteristic of a urachal fistula. Drainage of urine from the umbilicus may suggest bladder outlet obstruction and warrants further investigation.

A urachal cyst is usually discovered as a painful mass between the umbilicus and suprapubic area when it becomes infected. Pain and retraction of the umbilicus during urination may suggest a urachal anomaly [17]. A urachal sinus manifests with drainage that can be clear or purulent and occurs through the umbilicus or midline skin below the umbilicus (Fig. 1.6).

1.6 Umbilical Hernia

Umbilical hernias result from persistence of a patent umbilical ring (Fig. 1.7). Most small umbilical hernias close spontaneously, but many require surgical repair [6, 7, 18]. Patients with umbilical hernias present early in life with bulging at the umbilicus. The swelling is most prominent when the infant or child is crying or straining. Umbilical hernias are usually asymptomatic and rarely cause pain but may become incarcerated

Fig. 1.4 Omphalomesenteric duct remnants. (**a**) Meckel's diverticulum. Note feeding vessel. (**b**) Meckel's diverticulum attached to posterior surface of anterior abdominal wall by a fibrous cord. (**c**) Fibrous cord attaching ileum to abdominal wall. (**d**) Intestinal-umbilical fistula. Intestinal mucosa extends to skin surface. (**e**) Omphalomesenteric cyst arising in a fibrous cord. The cyst may contain intestinal or gastric mucosa. (**f**) Umbilical sinus ending in a fibrous cord attaching to the ileum. (**g**, **h**) Omphalomesenteric cyst and sinus without intestinal attachments (Image used with permission from Minkes et al. [28])

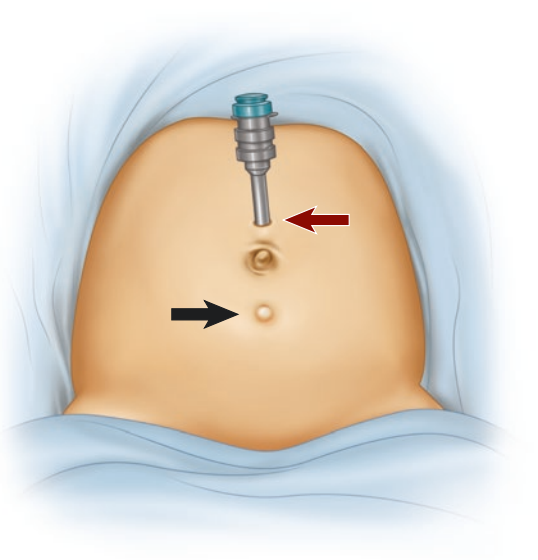

Fig. 1.6 Urachal sinus with purulent drainage in midline below the umbilicus (*black arrow*). A laparoscope was placed in the supraumbilical crease (*red arrow*) for mobilization of the internal portion of the urachal remnant as depicted in the next image (Image used with permission with permission from Minkes et al. [28])

Fig. 1.7 Preoperative patient demonstrating umbilical hernia with redundant skin (Image used with permission from Minkes et al. [28])

especially later in life. The skin can become severely [18–20] stretched, which may be alarming to parents and physicians. Parents often mention that the child plays with the redundant skin.

The diameter of the umbilical ring defect is predictive of spontaneous closure. The length of the protruding skin is not prognostically significant. Umbilical hernias with ring diameters less than 1 cm are more likely to spontaneously close than those with ring diameters more than 1.5 cm. Surgery is indicated for all symptomatic umbilical hernias. Incarceration, strangulation, skin erosion, and bowel perforation are indications for immediate surgery. Similarly, patients presenting with pain should be repaired on an elective basis.

Asymptomatic umbilical hernias can be safely monitored until the child is aged 4–5 years to allow spontaneous closure, especially if the ring defect is small.

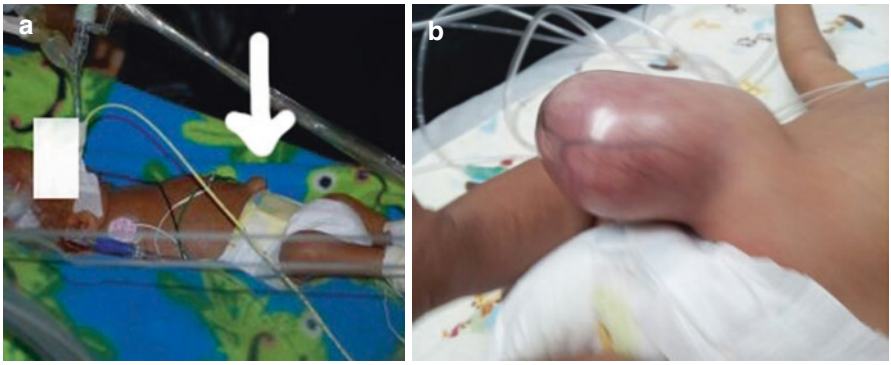

Fig. 1.8 (**a**) Small umbilical hernia (*arrow*) in premature infant. (**b**) Progressed into large symptomatic hernia. Note skin erythema that eventually resulted in skin ulceration

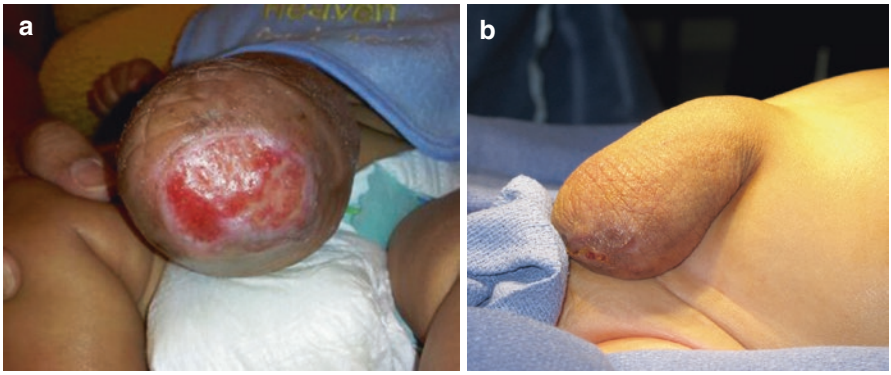

Fig. 1.9 (**a**, **b**) Skin ulceration and presentation at surgery. The hernia was no longer reducible

Because umbilical hernias with larger defects (i.e., >1.5 cm) are unlikely to close spontaneously, surgery can be performed at an earlier age.

Similarly, closing umbilical hernias with large ring defects is reasonable in younger children if the child is having a general anesthetic for another procedure, such as an inguinal hernia repair. It is also reasonable to consider surgery in younger children who have a large protrusion of the umbilical skin that is causing distress to the parents.

Incarceration, strangulation, bowel obstruction, erosion of the overlying skin (Figs. 1.8 and 1.9), and bowel perforation are rare events in infants and small children. The risk of incarceration increases significantly in adults with umbilical hernias.

1.7 Imaging

Radiography is not indicated in most children with umbilical disorders. Umbilical hernias are diagnosed by means of physical examination.

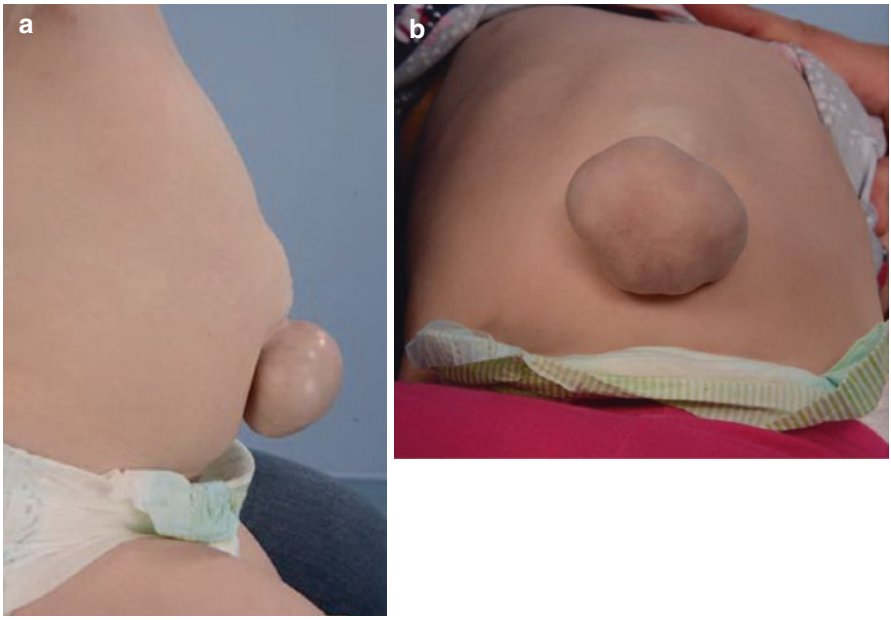

Fig. 1.10 (**a**, **b**) Complex abdominal wall defect with umbilical and associated ventral defect

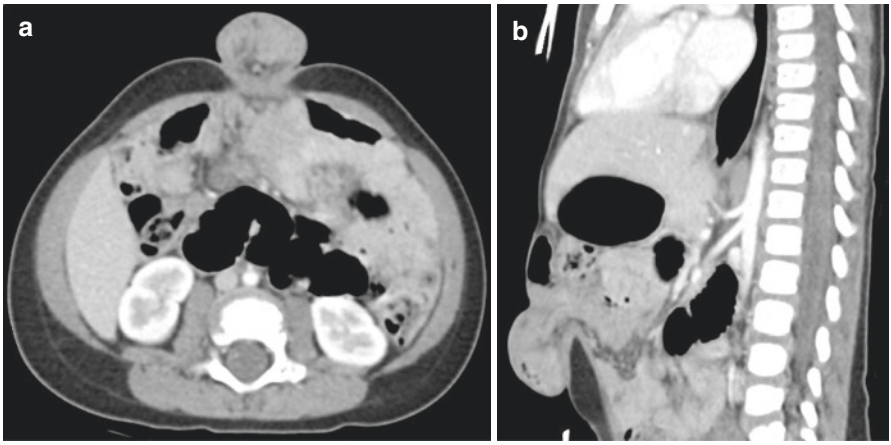

Fig. 1.11 (**a**, **b**) Computed tomography defining complex abdominal wall defect

Fistulography or sinography may be performed if a definitive opening is observed within the umbilicus. Fistulography can be performed by injecting water-soluble contrast medium into the opening at the base of the umbilicus. If the track is blind-ended, the child has a sinus; if it enters the intestine or bladder, a fistula is present.

Ultrasonography is helpful when a mass is present. Ultrasonography may be useful in identifying cysts of the umbilicus. Evaluating for a urachal cyst is useful; this cyst most commonly appears as a mass between the umbilicus and suprapubic area.

Computed tomography may be useful for surgical preparation for more complex abdominal wall defects (Figs. 1.10 and 1.11)

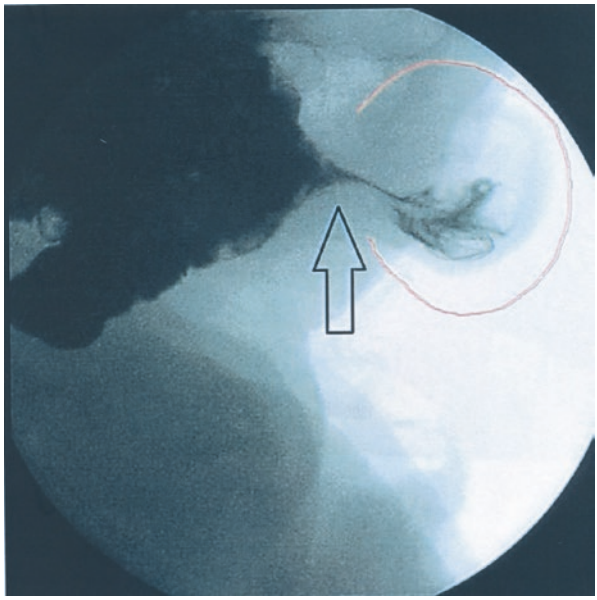

Fig. 1.12 Upper gastrointestinal contrast study showing incidental umbilical hernia in an infant. *Red line* outlines the umbilical hernia. The *arrow* shows contrast flowing into the intestine within the umbilical hernia. The umbilical hernia was easily reducible, and no intervention based on this study was performed (Image used with permission from Minkes et al. [28])

Plain radiography may be useful in children with omphalitis. Air in the subcutaneous tissue or muscle planes is an ominous sign. An umbilical hernia may be incidentally observed on an upper gastrointestinal tract contrast study with small-bowel follow-through (Fig. 1.12).

Cystography or cystoscopy may be indicated to identify bladder outlet obstruction in children draining frank urine from a urachal fistula. However, studies suggest that, in most cases, history and ultrasonography are sufficient for the diagnosis [21].

1.8 Technique

Surgical therapy is the mainstay of treatment for the following umbilical conditions:

1. Large persistent umbilical granulomas
2. Umbilical polyps
3. Omphalomesenteric remnants
4. Urachal remnants
5. Umbilical gangrene and necrotizing fasciitis
6. Umbilical hernias that are symptomatic or do not spontaneously close

Often, surgery on the umbilicus is performed for a mass or drainage without a specific preoperative diagnosis. Surgical principles include identification of all structures of the umbilicus, excision of urachal or omphalomesenteric remnants, closure of the umbilical ring, and preservation of the natural appearance of the umbilicus.

Laparoscopy is a valuable adjunct to open umbilical exploration [22]. It allows identification of both normal and abnormal structures. The laparoscopic approach can be used to remove urachal remnants, as well as omphalomesenteric abnormalities.

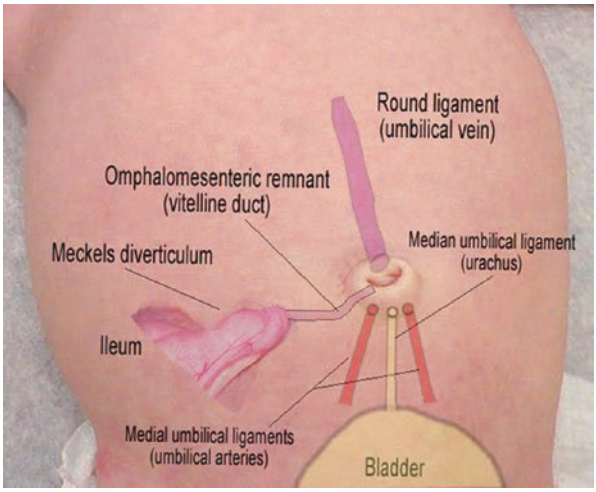

Fig. 1.13 Anatomic relationship between the umbilicus and its embryologic attachments (Image used with permission from Minkes et al. [28])

If acute infection with an abscess is present, surgical drainage is carried out in the operating room or by means of interventional radiology. In most cases, definitive surgical resection of the underlying lesion is needed several weeks following the initial infection.

Wide surgical debridement of the umbilicus and abdominal wall can be life-saving in patients with necrotizing umbilical infections [23–25].

Most umbilical procedures can be performed on an elective basis, and surgery should be scheduled when the child is in his or her usual state of health. The exceptions are infants with necrotizing infections and those with stool draining from the umbilicus, indicative of an enteric-umbilical fistula.

Mechanical bowel preparation is not needed. Perioperative antibiotics are used for sinuses and fistulas. Antibiotics are not needed for umbilical hernia repairs.

General anesthesia is used. The child is placed supine. The abdomen should be widely prepared with antiseptic solution and draped in standard fashion. Omphalomesenteric and urachal remnants can be approached directly through the umbilicus or through an incision in the infraumbilical or supraumbilical crease. Larger children may need additional or larger incisions. Laparoscopy can be performed through the umbilical incision.

During exploration of the umbilicus, an attempt is made to identify all anatomic structures (Fig. 1.13). A history of infection and resultant inflammation or scar tissue can complicate identification of normal and abnormal structures. Dissection of the umbilicus off the fascia is often useful and can provide access for a small port to perform laparoscopy. The umbilical vein (round ligament), the umbilical arteries (medial umbilical ligaments), and the urachus (median umbilical ligament) can often be identified.

A patent vitelline duct must be traced to its origin and divided. If a Meckel's diverticulum is present (see the image below), it is excised. Similarly, the urachus should be traced to its origin and divided. Broad-based connections of the urachus and bladder are closed in two layers.

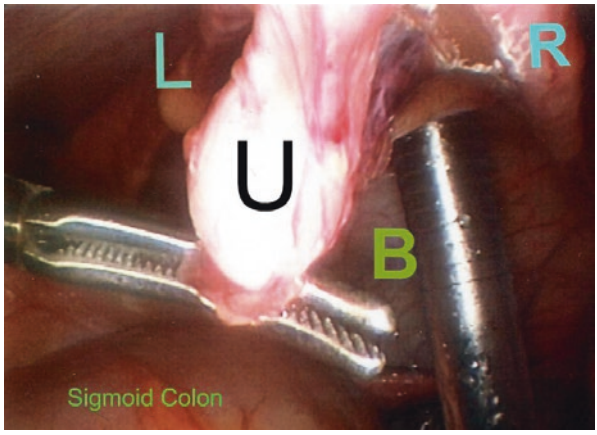

Fig. 1.14 Laparoscopic removal of urachal cyst (*U*). *L* indicates the left medial umbilical ligament. *R* indicates the right medial umbilical remnant. *B* indicates the bladder. The distal attachment to the bladder is being grasped (Image used with permission from Minkes et al. [28])

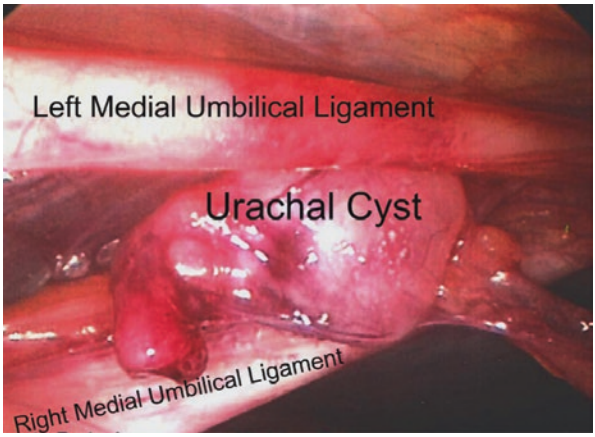

Fig. 1.15 Laparoscopic removal of urachal cyst. View is from left lower abdomen port. The umbilicus is on the right and the bladder on the left. The attachments or the urachal cyst to the bladder and the umbilicus have been clipped (not shown) and divided. Note the convergence of the right and left medial umbilical ligaments as they approach the umbilical ring on the right (Image used with permission with permission from Minkes et al. [28])

Laparoscopy is a useful adjunct, especially when there is a confirmed preoperative diagnosis or when no anomaly is found during the exploration (Figs. 1.14 1.15, 1.16, 1.17, and 1.18) [5]. Additional ports can be placed to remove identified urachal or omphalomesenteric structures. Removed structures are sent to pathology for histologic examination.

The umbilical fascia is closed with interrupted or running suture. The umbilical skin is then closed. Attempts should be made to create a natural-appearing umbilicus. Antibiotic ointment and a light dressing can be applied to the incision. If an abscess is identified preoperatively or found intraoperatively, an incision-and-drainage procedure is indicated. Definitive resection should be delayed.

Fig. 1.16 Laparoscopically removed urachal cyst and its attachments (Image used with permission from Minkes et al. [28])

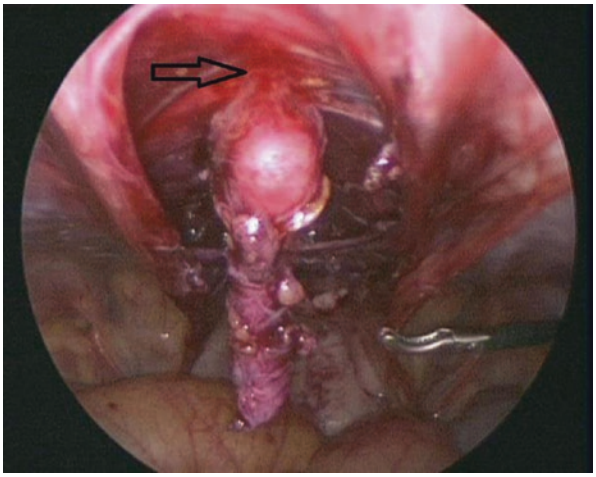

Fig. 1.17 Urachal cyst mobilized by the laparoscopic approach. *Arrow* demonstrates sinus communication through abdominal wall and skin 3 cm inferior to the umbilicus (Image used with permission from Minkes et al. [28])

Umbilical hernias are approached through an incision in the infraumbilical or supraumbilical crease. Dissection is carried down to the level of the fascia. The hernia sac is identified at its base and encircled. Contents from the hernia sac should be reduced. The sac is then disconnected from its attachment with the umbilicus.

Care is taken to avoid injury to contents within the hernia sac and to the umbilical skin. Opening the anterior surface of the sac may help to avoid injury to the bowel. The sac is resected down to the level of the fascia. The umbilical fascia is closed with interrupted or running absorbable suture. For large or recurrent hernias,

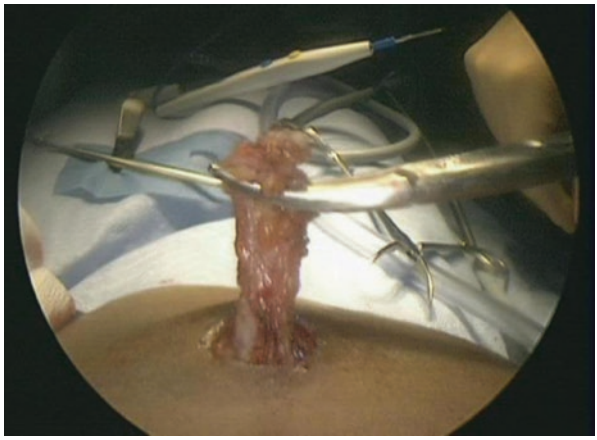

Fig. 1.18 External mobilization of urachal sinus through abdominal wall incision 3 cm inferior to umbilicus. Patient presented with recurrent drainage and infection from sinus. The internal portion was mobilized laparoscopically (Image used with permission from Minkes et al. [28])

Fig. 1.19 Neoumbilicus following umbilicoplasty (Image used with permission from with permission from Minkes et al. [28])

nonabsorbable suture is used by many surgeons. The wound should be inspected and meticulous hemostasis achieved.

The umbilicus is tacked down to the fascia with an interrupted suture. The subcutaneous tissue is reapproximated with a few interrupted sutures, and the skin is closed with a subcuticular suture. Bupivacaine can be injected for postoperative analgesia. The skin is cleaned, and Steri-Strips are applied. A pressure dressing may be used for large hernias to prevent a postoperative hematoma or seroma.

Routine umbilicoplasty (Fig. 1.19), the removal of excessive umbilical skin, is generally not needed. In most cases, a redundant umbilicus appears more natural than a neoumbilicus. Several techniques can be used for extremely protuberant umbilical hernias (Figs. 1.20, 1.21, 1.22, and 1.23) [26, 27]. A simple technique is to invert the umbilicus over a finger so that the undersurface is exposed. The skin is

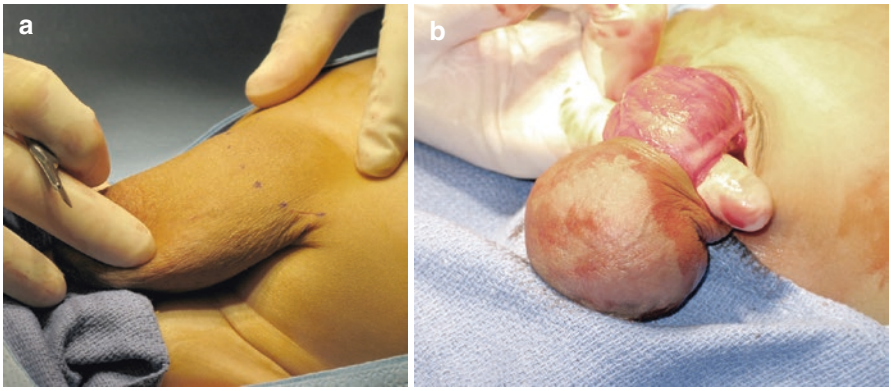

Fig. 1.20 Large proboscis umbilical hernia after healed ulcer of skin. (**a**) Incision line has been marked. (**b**) Hernia sac with nonreducible bowel has been encircled

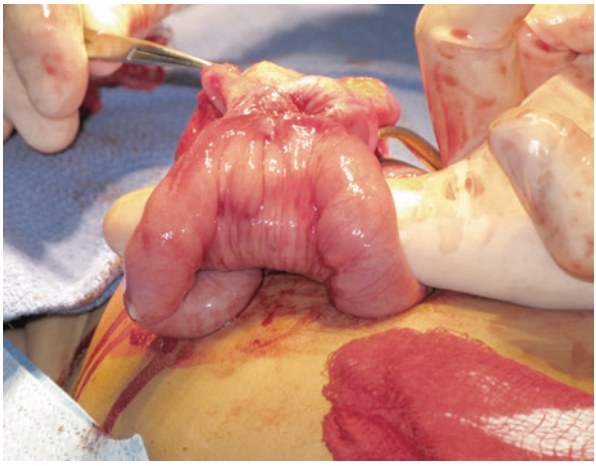

Fig. 1.21 Small intestine adherent to hernia sac. The bowel was dissected free and safely returned to the peritoneal cavity

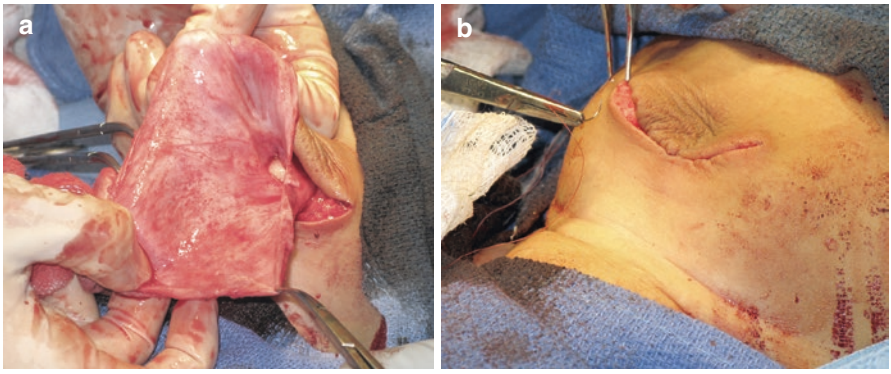

Fig. 1.22 (**a**) Hernia sac after bowel was reduced. (**b**) The sac was resected, and the fascia was closed with interrupted suture. Lower image shows initial closure

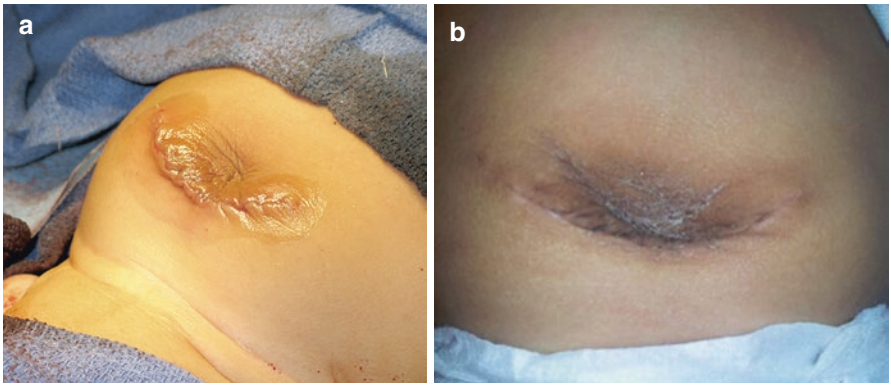

Fig. 1.23 (**a**) Completed closure. (**b**) One month after surgery

then incised circumferentially so that a 1–2-cm rim of umbilicus remains. The umbilical skin defect is reapproximated from within the umbilicus and tacked down to the fascia.

1.9 Conclusions

During development, the embryonic disk is in contact with the yolk sac anteriorly. As the embryo grows and differential growth of tissues leads to the folding appearance of the embryo, the ventral attachment of the yolk sac narrows. The intracoelomic portion of the yolk sac becomes the primitive alimentary canal and attaches to the extra-coelomic portion through the vitelline duct. The allantois buds from the hindgut and grows into the body stalk. The yolk stalk and the body stalk eventually fuse to become the umbilical cord.

As the abdominal wall forms, the umbilical ring is narrowed. The vitelline and umbilical vessels, vitelline duct, and allantois should be absent in the umbilicus at term. Residual tissue leads to remnants that require surgical intervention. During exploration for a sinus or fistula, all structures, including the round ligament, median, and medial umbilical ligaments, must be identified. Umbilical hernias are common, and many will close spontaneously.

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Part II
Classification

Chapter 2
Classification of Umbilical Hernia

Gamedzi Komlatsè Akakpo-Numado, Komlan Anani Mihluedo-Agbolan, Missoki Azanledji Boume, Komlan Adabra, Yawa Sesime Sanni, and Hubert Tekou

2.1 Introduction

Umbilical hernia (UH) is frequent in children [1, 2]. Its volume is variable from a child to another. The treatment is surgical and consists of closure of the umbilical ring and refixation of the umbilicus [3]. The closure of the umbilical ring is generally done without difficulties. The refixation of the umbilicus is done without skin excision when the UH is small. It cannot be done without umbilicoplasty when the volume of the UH is important. In those cases, the UH is called huge umbilical hernia (HUH). It is important for the surgeon to classify the UH before surgical procedure, in order to choose the well adapted technique and to appreciate the postoperative result according to the importance of the UH.

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2.2 Definitions

The base diameter (BD) is the diameter of the UH at its base on the xipho-pubic line. Its measurement is shown on Figs. 2.1 and 2.2. The height (H) of the UH is the length from the basis of the UH on the upper side and on the xipho-pubic line to its summit (Figs. 2.1 and 2.2).

2.3 Classification

A normal umbilicus has a rim and a central depression, which has at its center, the scar of the umbilical cord like a tuber (Fig. 2.3). This normal morphology is modified by UH. There are different types of UH according to the sizes of the hernia.

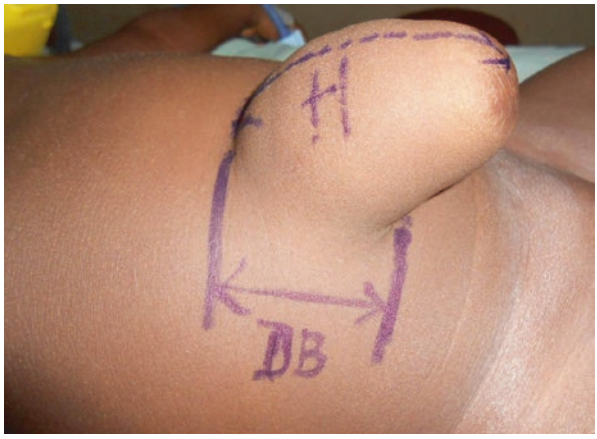

Fig. 2.1 Landmarks for measurement of the sizes of the umbilical hernia

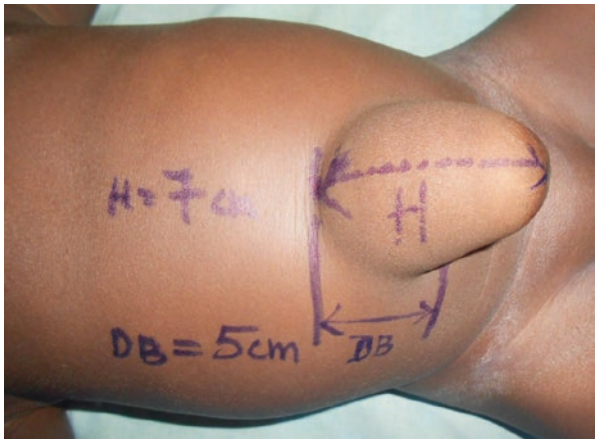

Fig. 2.2 Measurement of the basis diameter or diameter of the basis (DB) and the height (H) of an umbilical hernia. Here, it was a group 1 pedunculate huge umbilical hernia (DB = 5 cm)

2.3.1 *Classified as Small and Huge*

A. Small umbilical hernia

The UH is small when the BD is equal or less than 3 cm and/or its height is equal or less than 1.5 cm (Fig. 2.4). According to the diameter of their fascial defect, they correspond to classes 1 and 2 of the classification of El-Dessouki et al. [4].

B. Huge umbilical hernia

When the BD exceeds 3 cm and/or its height exceeds 1.5 cm, the UH is a HUH [2] (Fig. 2.5). All the HUH are from class 3 of El-Dessouki et al. [4]. HUH are classified according to their BD and according to their morphology [2].

Fig. 2.3 Normal umbilicus in a child

Fig. 2.4 Small umbilical hernia

Fig. 2.5 Huge umbilical hernia

2.3.2 According to the Base Diameter of the HUH We Distinguish Three Groups

1. Group 1: 3 cm < BD ≤ 5 cm
2. Group 2: 5 cm < BD ≤ 7 cm
3. Group 3: BD > 7 cm

2.3.3 According to the Morphology of the HUH We Distinguish Three Types

1. Sessile HUH (Figs. 2.6 and 2.7): The biggest diameter of the hernia is at its base, and the whole hernia has a conic shape
2. Pedunculate HUH (Figs. 2.8 and 2.9): The diameter of the base is smaller than that of the middle part of the hernia.
3. Hornlike HUH (Figs. 2.10 and 2.11): It is like a pedunculate one, but in addition, its summit, sharp, is pushed down; the whole hernia has a shape of a comma or a horn.

The morphology of the HUH is determined by the location and the width of the fascial defect. Sessile HUH have large defect located straight at the umbilical ring place. The edge of the fascial defect is slack. Rigid edge of umbilical defect located at the umbilical ring place, with medium size, gives pedunculate HUH. When the large umbilical defect is associated or is extended with a sub-umbilical defect, the HUH is hornlike. The summit of the HUH in this case is pushed down. During the growth of the child, HUH tend to increase in size. Spontaneous closure of HUH cannot be expected.

Fig. 2.6 Sessile huge umbilical hernia

Fig. 2.7 Sessile huge umbilical hernia

Fig. 2.8 Pedunculate huge umbilical hernia

Fig. 2.9 Pedunculate huge umbilical hernia

2.4 Discussion

The classification of UH is very important because it permits to appreciate and compare the results of different authors. Several techniques [1, 4–6] are proposed for HUH, but authors do not describe the HUH.

There is a classification of UH in children based on the diameter of the fascial defect [4]. El Dessouki et al. [4] distinguished three classes, and for the class 3, the diameter of the fascial defect is more than 3 cm. All the HUH have their fascial defect more than 3 cm in diameter. The measurement of the fascial defect is not important in HUH. The main parameter that determines the choice of the surgical

Fig. 2.10 Hornlike huge umbilical hernia

Fig. 2.11 Hornlike huge umbilical hernia

technique and the cosmetic prognosis is the BD. The morphology of the new umbilicus is independent on the BD. The BD determines the length of the added scar. In our technique [2], the length of the added scar equals the BD. So, the more is the BD, the more will be the length of the added scar [2]. In our series, we found 7 HUH of group 3, 4 of group 2, and 1 of group 1.

The morphologic classification permits to describe the aspect of the HUH. All the three morphologic aspects that we described can be from the three different groups according to the BD. We had, in our series [2], 8 sessile HUH, 2 hornlike HUH, and 2 pedunculate HUH. The morphologic type of the HUH does not modify our surgical technique. Nevertheless, it can be a trap for the surgeon during the drawing of the flaps. The drawing of the flaps must not follow the summit of the HUH.

It is not useful to try to evaluate the volume of the HUH, because it is neither necessary for the umbilicoplasty nor for the evaluation of postoperative result. The BD and the height indicate together the importance of the UH. The main parameter is the BD.

2.5 Conclusions

UH can be small or huge. The measurement of the diameter of the fascial defect and the volume of the UH is useless in HUH. The morphologic classification does not influence the surgical technique but describe only the aspect of the HUH. The BD is the best parameter for the classification of HUH because the choice of the surgical technique and the cosmetic result depend on it.

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Part III
Techniques

Chapter 3
A New Umbilicoplasty for Children: Creating a Vertically Long and Deep Umbilical Depression Facing Forward at the Correct Position

Akiyoshi Kajikawa

3.1 Introduction

Many surgical techniques have been reported for umbilicoplasty. These techniques can be divided into suture fixation methods and local flap methods. The flap methods using a modified V–Y advancement flap are useful to form a deep umbilical depression for paediatric patients with a thin layer of abdominal fat. However, although many plastic surgeons approve of a vertically long umbilical depression as an ideal, conventional flap methods often result in only a longitudinal scar line with a depression at the end of the scar. The wide and upward- or downward-facing umbilicus shifted caudally or cranially creates an unnatural impression (Fig. 3.1). To resolve these problems, I have developed a new method of umbilicoplasty with an S-shaped skin incision [1, 2]. Using this method, a vertically long and deep umbilical depression facing forward can be created at the correct umbilical position.

3.2 Technique

First, imaging a square over the umbilical region, a diagonal line is drawn from the cranial right corner to the caudal left corner. Next, equilateral triangles are drawn on the cranial and caudal sides of the square. Thus, an S-shaped skin incision line has been designed (Fig. 3.2). The incision makes a pair of long, obliquely opposing

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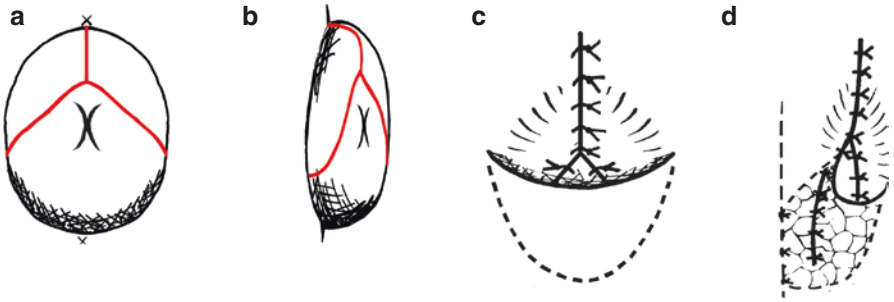

Fig. 3.1 The conventional V–Y advancement flap method. (**a**, **b**) Design. (**c**, **d**) Postoperative

flaps with their bases at the left and right sides of the umbilical position. The cranial flap is elevated to the left side and the caudal flap to the right side. In patients with umbilical herniation, fascial defects are closed longitudinally using absorbable sutures.

The left and right flaps are sutured together in the midline to form a skin pouch with rapid absorbable sutures. Then, this pouch is turned inside out to make a skin pocket at the correct umbilical position, and the median line of the dermal side is sutured and fixed on the median line of the abdominal wall, closing the hernia orifice using absorbable sutures from the window of the cranial and caudal wounds. Finally, the cranial and caudal donor sites are closed finely along the median line with dermal sutures using absorbable sutures and coaptation sutures using black nylon. The procedure is completed by packing a small amount of antibiotic petrolatum gauze in the formed umbilical depression. Neither bolster suture nor stents are needed to maintain the depression in this method.

3.3 Cases

3.3.1 Case 1

A 4-year-old boy had a protruding umbilicus, which was 15 mm in diameter (Fig. 3.3). A small hernia orifice 5 mm in diameter was palpable in the umbilicus. I performed the new umbilicoplasty described above on the patient. The size of the square and each regular triangle was 15 mm at each side. The double flaps were elevated, and the hernia orifice was closed longitudinally. The left and right flaps were sutured together to make a skin pouch. The pouch was turned inside out and sutured along the linea alba. Then, the cranial and caudal donor sites were closed. A vertically long and deep umbilical depression facing forward was shown 1 year after the surgery. The short scar appearing at the cranial and caudal aspects of the umbilicus was not conspicuous.

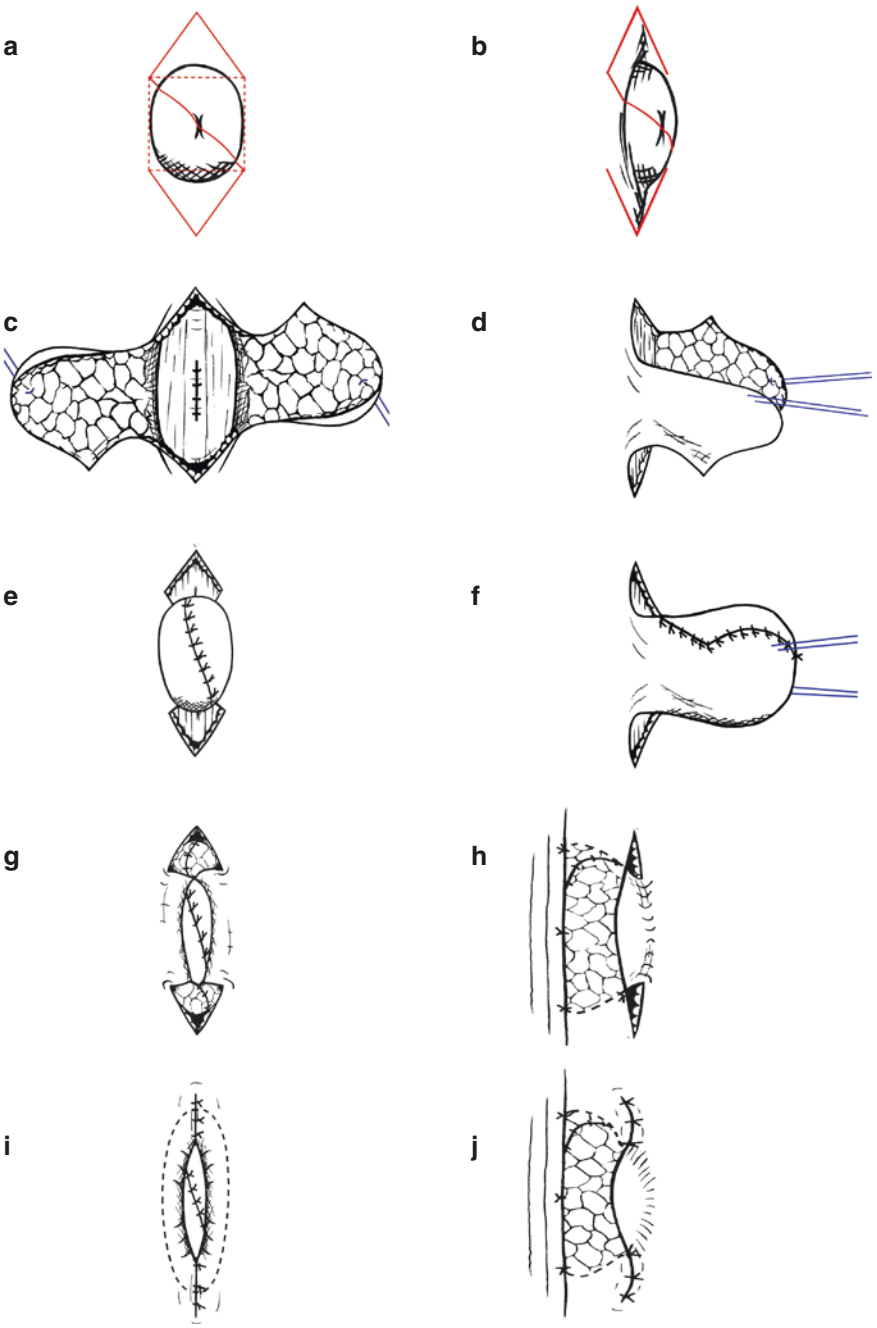

Fig. 3.2 The new method of umbilicoplasty. (**a**, **b**) An S-shaped skin incision line is designed. (**c**, **d**) A pair of long obliquely opposing flaps is elevated, and the herniated orifice is closed. (**e**, **f**) The left and right flaps are sutured to form a skin pouch. (**g**, **h**) The pouch is turned inside out and sutured along the linea alba. (**i**, **j**) The cranial and caudal donor sites are closed

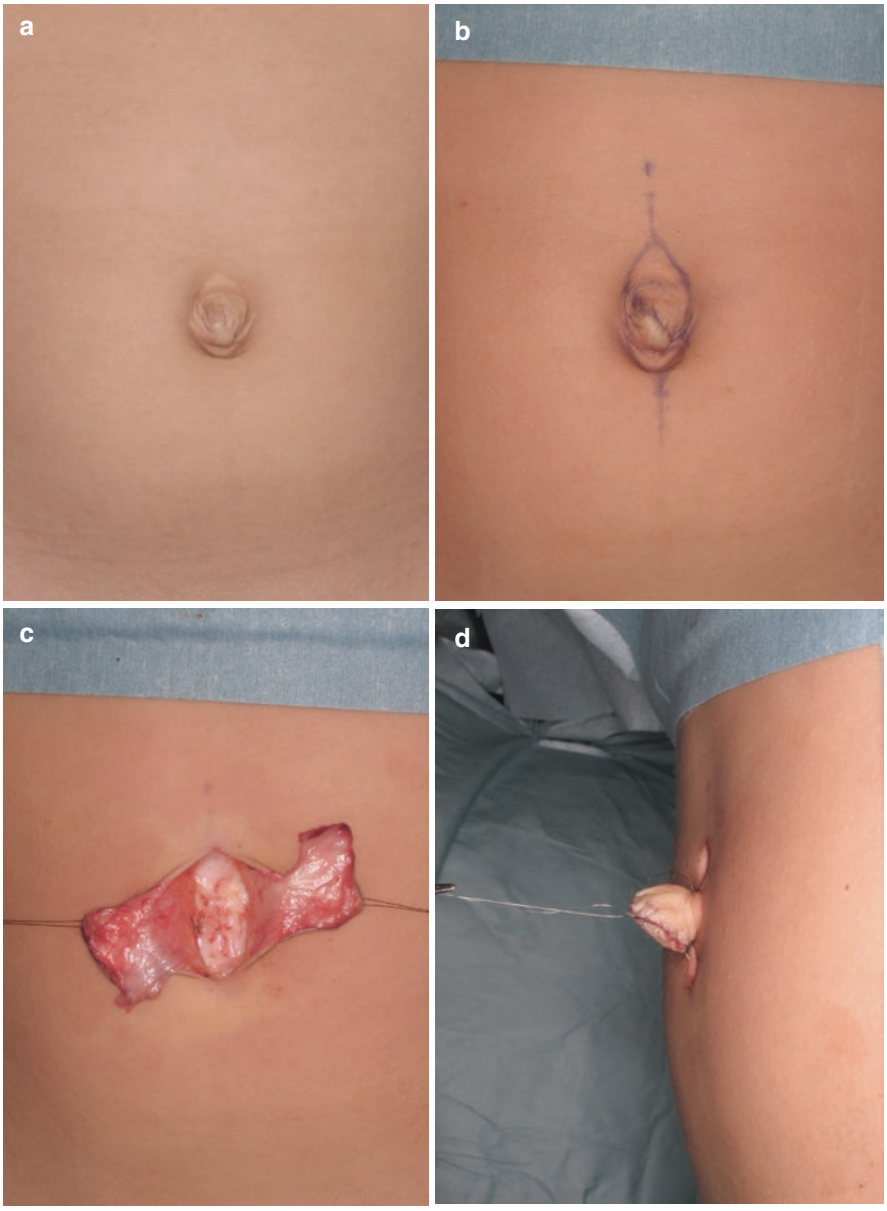

Fig. 3.3 A 4-year-old boy with an umbilical protrusion. (**a**) Preoperative. (**b**) Design of the flaps. (**c**) The double flaps were elevated. (**d**) The flaps are sutured together to make a skin pouch. (**e**) The skin pouch was turned inside out and sutured along the linea alba. (**f**) The natural vertically long and deep umbilical depression was shown 1 year after the operation

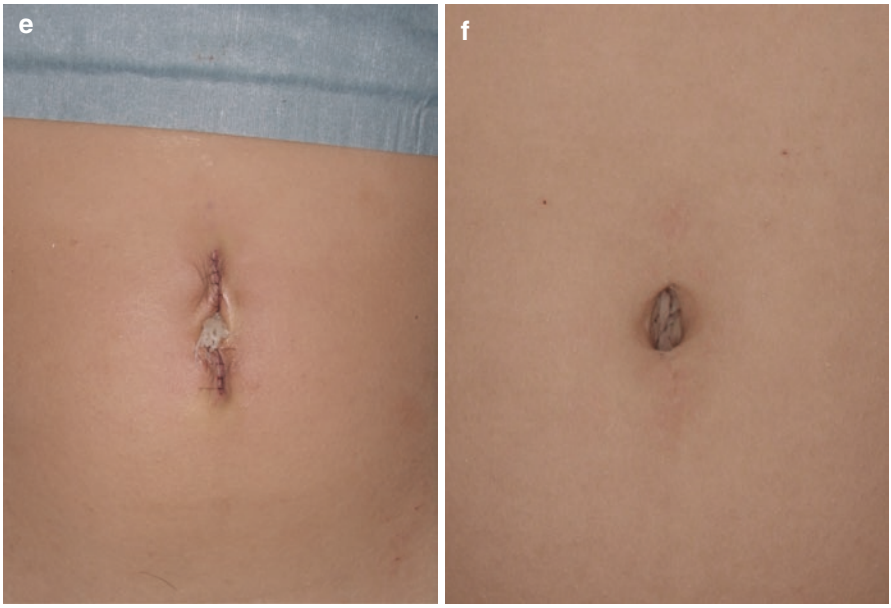

Fig. 3.3 (continued)

3.3.2 Case 2

A 6-year-old girl had an umbilical hernia, which was 17 mm in diameter (Fig. 3.4). A hernia orifice 5 mm in diameter was palpable. The S-shaped skin incision line was designed. The size of the square and each regular triangle is 15 mm at each side. The left and right flaps were elevated, and the hernia orifice was closed. Both flaps were sutured together to make a pouch. The pouch was turned inside out and fixed on the median line of the abdominal wall, and the cranial and caudal wounds were closed. The vertically long and deep depression gave a natural impression 2 years after the surgery.

3.4 Discussion

Many surgical methods of umbilicoplasty using suture fixation methods [3–8] and the flap methods [9–14] have been reported. Suture fixation methods are relatively advantageous for obese adults with thick deposits of cutaneous fat. However, these methods are unsuitable for children and lean adults with a thin layer of abdominal fat. Conversely, flap methods allow creation of deep depression. The most common method is the V–Y advancement flap method, which

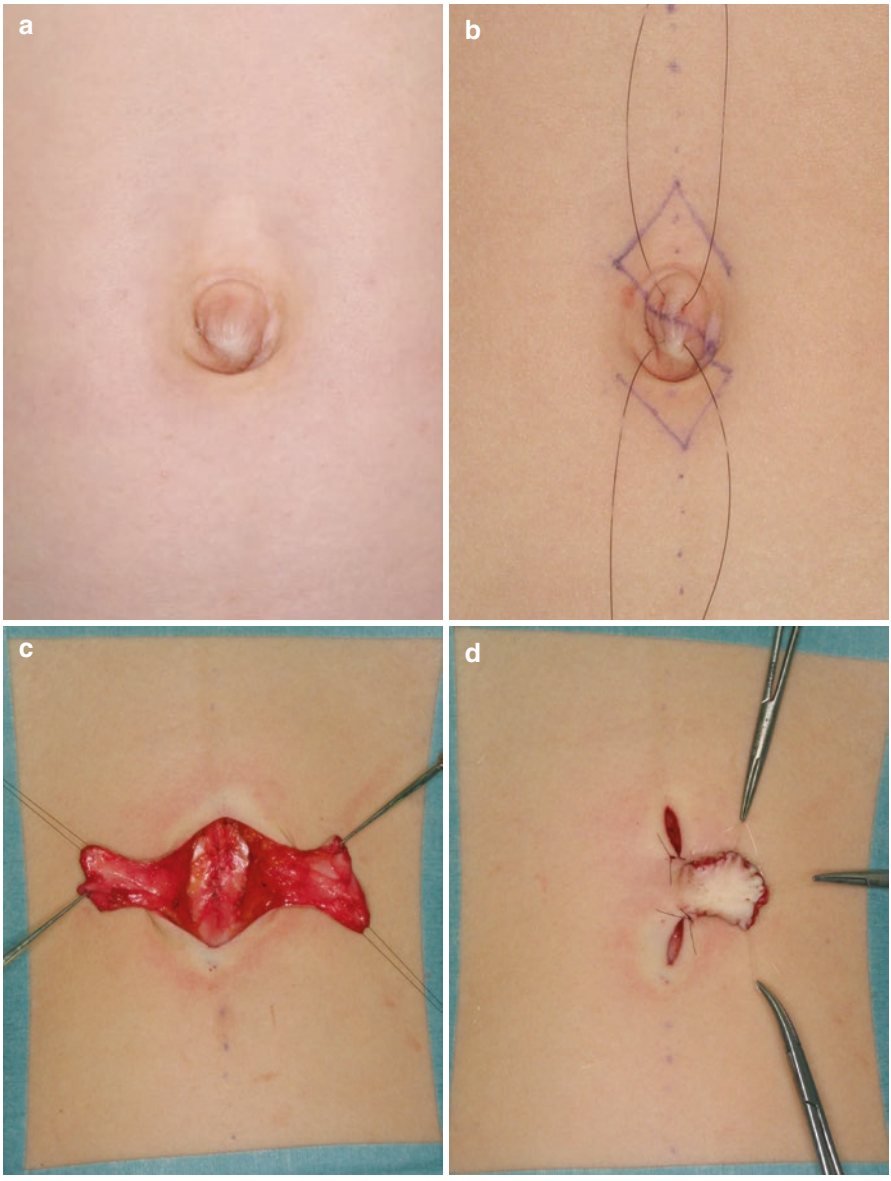

Fig. 3.4 A 6-year-old girl with an umbilical protrusion. (**a**) Preoperative. (**b**) Design of the flaps. (**c**) The double flaps were elevated, and the hernia orifice was closed. (**d**) The flaps are sutured together to make a skin pouch. (**e**) The skin pouch was turned inside out and sutured along the linea alba. (**f**) The natural vertically long and deep umbilical depression was shown 2 years after the operation

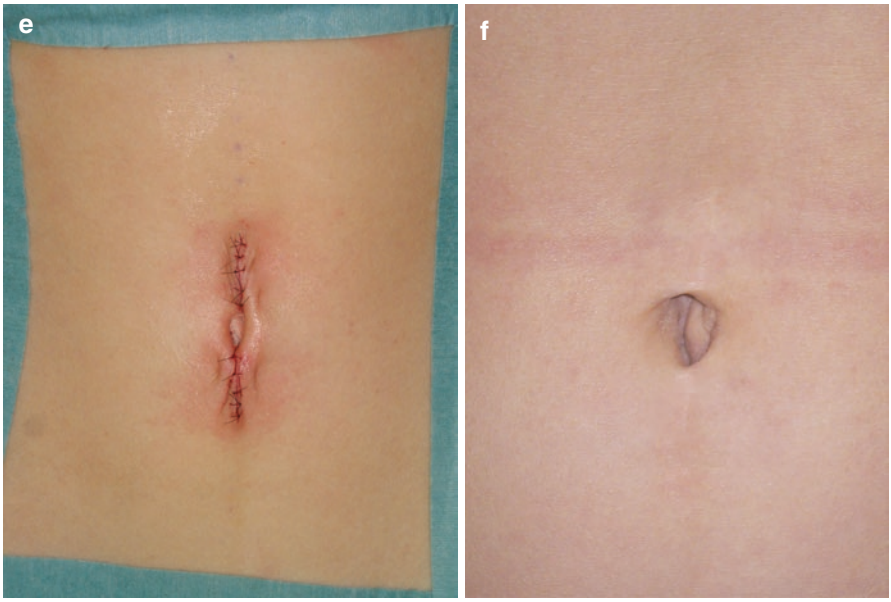

Fig. 3.4 (continued)

has a lot of variations of the flap shapes, such as V shape, U shape, multiple triangles, etc. Although numerous plastic surgeons suggest vertically long umbilical depression as an ideal, conventional flap methods typically create only a vertically long scar line with a little shifted umbilical depression facing upward or downward at the end of the scar (Fig. 3.5). To form a cosmetically pleasing umbilicus with natural direction, position and shape, I devised the new umbilicoplasty method [1, 2] described above. The greatest advantages of the method are decreasing tissue of the cranial and caudal aspects of the umbilicus and increasing tissue of the lateral aspects by a pair of obliquely opposing long flaps (Fig. 3.6). Skin closure of the cranial and caudal donor sites and creating lateral walls with enough tissue enable formation of a truly vertically long and deep umbilical depression. The new umbilical depression faces forward, as the direction of the skin pocket is sagittally wide from cranial to caudal. In addition, the level of the new umbilical depression is not shifted, as the bases of the bilateral flaps are just beside the original umbilicus (Fig. 3.5). In this method, a deep umbilical depression is crated with no tension by double long flaps laterally based. The subsequent shallowing of the depressin can be prevented by the enough size skin pocket inside of which is larger than the

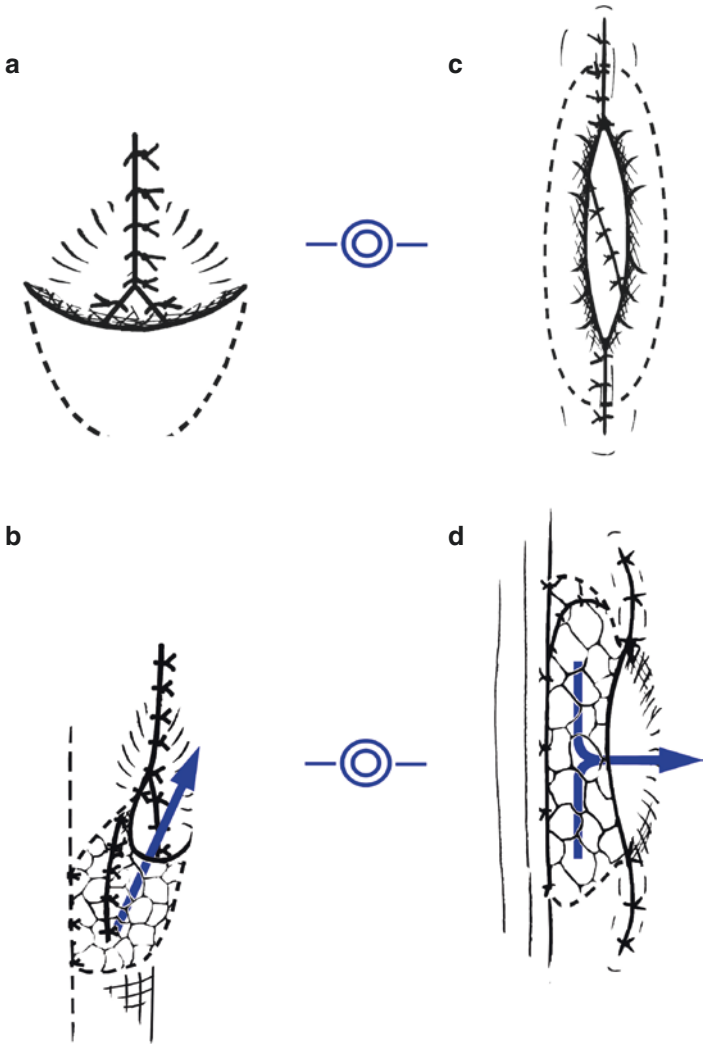

Fig. 3.5 The comparison between the conventional V–Y advancement flap methods and the new method. (**a**, **b**) In the conventional V–Y advancement flap method, only a longitudinal scar line and shifted umbilical depression facing upward at the caudal end of the scar are formed. (**c**, **d**) In the author's new method, a longitudinal deep umbilical depression facing forward can be created at the correct position. The inside of the pocket is larger than the entrance. -◎-: The level of the original umbilicus. →: The facing direction of the created umbilicus

entrance (Fig. 3.5). In this method, neither bolster sutures nor stents are needed to keep the deep depression.

Moreover, the technique leaves only inconspicuous scarring. Scar contracture and hypertrophic scarring are prevented by the three-dimensional, W-plasty effect of the single suture line and the absence of a three-point or circular suture line. The

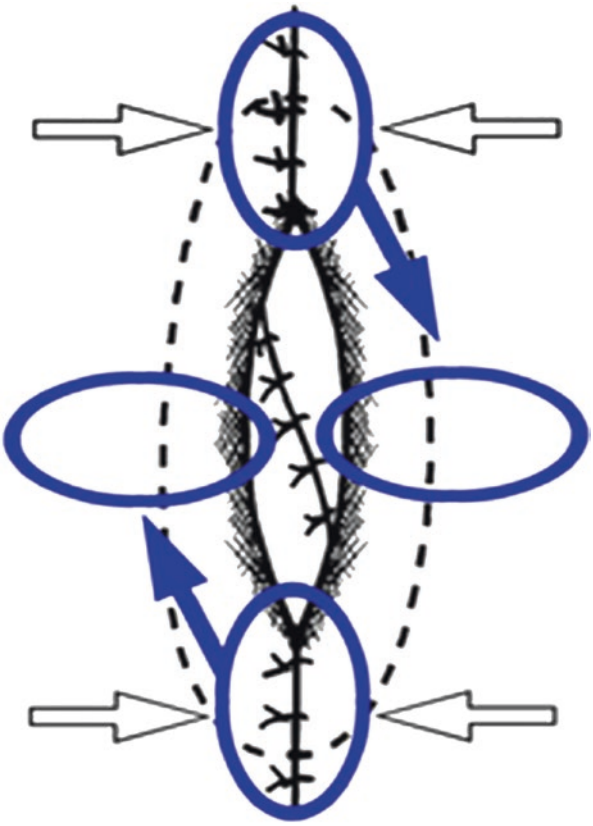

Fig. 3.6 The tissue transfer from the cranial and caudal aspects to the lateral aspects creates the vertically long and deep umbilicus in the new method

short scar appearing at the cranial and caudal aspects of the umbilicus was not conspicuous in our cases.

Compared with the conventional flap methods, this method enables formation of a deep and natural umbilicus. All patients and the families have been satisfied with the aesthetic result by the method

3.5 Conclusions

I have developed a new method of umbilicoplasty with an S-shaped skin incision for children. The transferring of a pair of obliquely opposing flaps decreases tissue of the cranial and caudal aspects of the umbilicus and increases tissue of the left and right lateral aspects. The method creates a vertically long and deep umbilical depression facing forward at the correct position with inconspicuous scarring. The umbilical depression is stable by the inside of the skin pocket being larger than the entrance.

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Chapter 4
Umbilicoplasty: A Novel Technique

Parshotam Gera and Guy Henry

4.1 Introduction

Umbilical hernias are a common finding in the pediatric community, with a preponderance to effect Afro-Caribbean and premature children [1, 2]. Cosmetic outcome is a common cause of parental anxiety after reconstruction of umbilicus in abdominal wall defects and large umbilical hernia. Apart from cosmetic concerns, there can be rare complications associated with incarceration. Based on South African data, congenital umbilical hernias are present in approximately 15 % of children with an incidence of incarceration estimated at 1:1,500 [3]. The data suggests that defects of any size may incarcerate and defects larger than 1.5 cm are unlikely to close [4–6]. Furthermore there is evidence that these hernias may incarcerate later in life [7]. As the surgeon, it is important to be able to accurately inform anxious parents of the risk of significant complications should the hernia remain.

In the USA where acute presentations comprise 7.4 % of hernia repairs advocate for repair of hernias larger than 1.5 cm in diameter in girls over two and boys over 4 years old [4]. Surprisingly this conclusion was not based on study data but that of other studies advocating for repair of defects above 1.5 cm as they rarely close and were suspected to cause incarceration in adult females [8].

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4.2 Classification of Umbilical Hernia

Umbilical hernia in children is classified according to the diameter of the fascial defect:

Class 1 defect: defect diameter is less than 1.5 cm.
Class 2 defect: defect diameter is 1.5–3 cm.
Class 3 defect: defect diameter is more than 3 cm.

More than 95 % of class 1 defects will close by age 5 without surgery, while larger defects of classes 2 and 3 seldom close spontaneously [3, 9].

4.3 Exomphalos

Exomphalos is herniation of intra-abdominal contents via the umbilical ring. Exomphalos can be categorized as minor (Fig. 4.1) or major depending upon the size of defect (<2, 2.5–5.0, and >5.0 cm [10]). The surgical options include complete reduction of herniated viscera, fascial, and skin closure if possible [11]. Both the location and appearance of umbilicus are critical, the normal umbilical position being 60 % of the way from inferior border of the xiphisternum to the superior border of the pubis in midline [12].

There are many techniques for reconstruction of the umbilicus [12–15]. The results of the plastic surgery are sometimes unsatisfactory due to postoperative flattening or disappearance of the umbilical depression.

Fig. 4.1 Exomphalos minor

4.4 Large Umbilical Hernia

Under general anesthesia, the authors performed the following steps:

Step 1: An infraumbilical incision along the skin crease was made inside the umbilicus. The hernial sac was dissected, and the fascial defect was closed with 3–0 polydioxanone sutures.

Step 2: A nonabsorbable purse-string 4–0 Prolene was placed at the >2/3 of depth of the skin defect (depending upon the target periumbilical skin collar height for respective patients). The suture was kept untied (Fig. 4.2).

Step 3: Another purse string with 5–0 polyglactin sutures was placed at the margin of skin with the subcutaneous tissue. This suture was passed through the rectus sheath at the 6 o'clock and12 o'clock. The suture was tied initially anchoring the skin to the fascia

Step 4: The outer suture (Prolene 4–0) was tied loosely subsequently to produce the umbilical ring. The outer Prolene suture was removed after 2 weeks (Fig. 4.3).

4.5 Exomphalos Minor

A circumferential incision is made at the junction of sac and skin. The sac was removed, and the contents reduced in the abdomen. The site for neoumbilicus was marked. Rest of the repair was performed by the previously described technique.

A normal umbilicus consists of a ring, a tubular wall, a sulcus, and a bottom without any excess skin to preserve the esthetic aspect of the umbilicus. Many

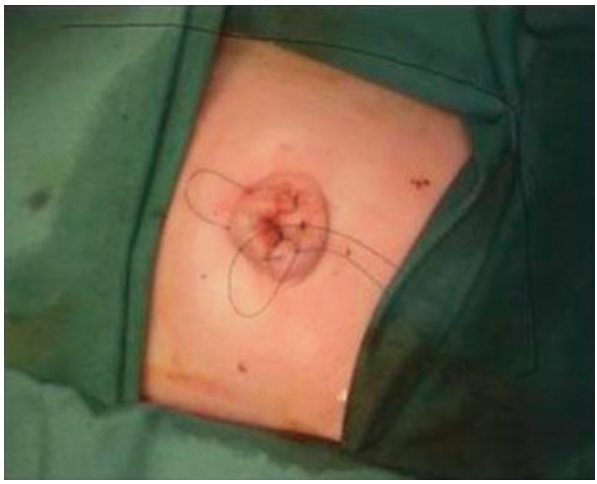

Fig. 4.2 Purse string at >2/3 depth of the skin defect

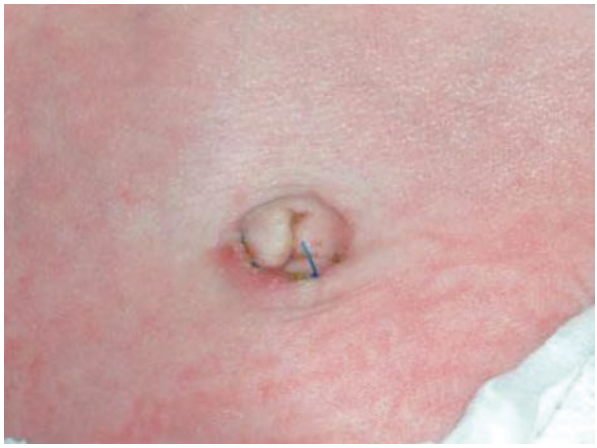

Fig. 4.3 Umbilical ring 2 weeks postoperatively

techniques have been described using local flaps [13, 15–17]. However, the results are unsatisfactory due to postoperative flattening and disappearance of umbilical depression. The current technique does not require excision of skin flaps, and there is minimal dissection resulting in minimal scarring.

Repair of exomphalos minor using purse-string suture has been described [18]. The circumferential purse-string suture results in bunching of skin and is not cosmetic.

However, in comparison, with the current technique, neoumbilicus had nice sulcus and a ring without using the local flaps. On follow-up, there was no flattening or disappearance of umbilical depression. Periumbilical skin collar height and circumference of the neoumbilicus were nearly similar when compared with normal anatomy. The current umbilicoplasty technique is very simple to perform and can be used with an umbilical hernia or exomphalos repair [19].

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Chapter 5
The "Y- to-V" Plastic Surgery: A Solution of Skin Excess Following Herniorrhaphy of Pedunculated Umbilical Hernia in the Infant and the Child

Aloïse Sagna, Aïssata Ly, and Ibrahima Fall

5.1 Introduction

The pedunculated umbilical hernia with a collar diameter included in 2–5 cm is frequent in African infant and child [1]. Its surgical repair by umbilical aponeurosis closure is simple. Different excision techniques of skin excess are described with good outcomes often with regard to the scar. The umbilical skin "Y-to-V" plasty experienced in our practice is to highlight the need of aesthetic surgery together with parietal defect repair and gives precise different umbilical cosmetic criteria.

5.2 Technique

A general anesthesia is administered in all cases with paraumbilical nerve blocks. There was no need for intubation after the age of 3 months in contrast to infants under 3 months old that went for orotracheal intubation.

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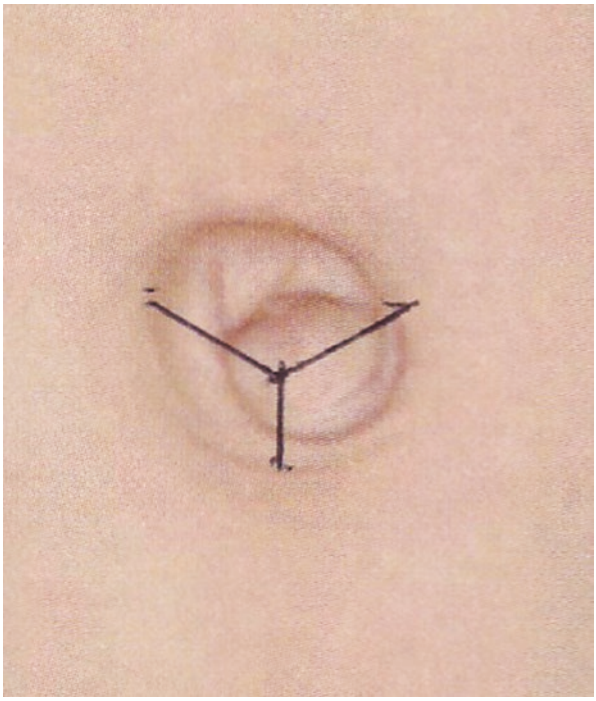

Fig. 5.1 Y line marking

The operating procedure consisted of several stages:

1. Pencil drawings on the skin (Fig. 5.1)
2. Straight blade incision starting with the vertical branch of the "Y" which length included in 2–3 cm
3. A subcutaneous sharp circular undermining leading to the fibro-peritoneal sac of hernia which is resected
4. Herniorrhaphy consisting of 3–5 "X" sutures on abdominal wall fascia using nonabsorbable braided suture
5. Skin excess geometrical excision characterized by lateral twin isosceles triangular flaps whose lower bases are on both sides of the abdominal median line (Fig. 5.2)

This resection forms the "v" branches, and a new umbilical valley is reconstructed by one or two subcutaneous quilting stitches of residual umbilical flap. Thereafter a congruent closure of the wound is made in two layers using absorbable suture (Fig. 5.3).

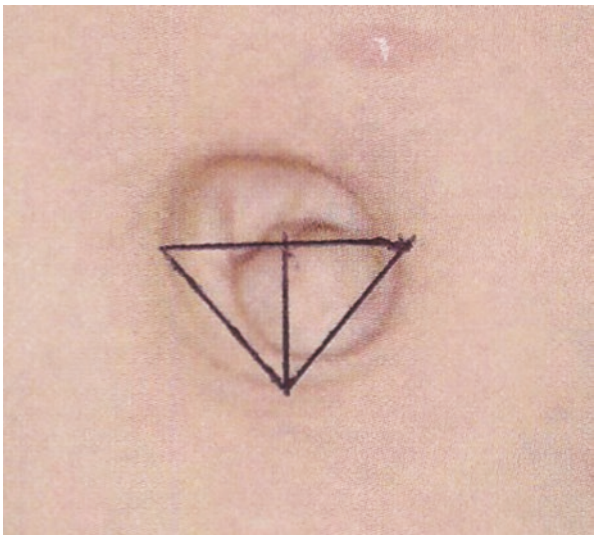

Fig. 5.2 Lateral twin isosceles marking

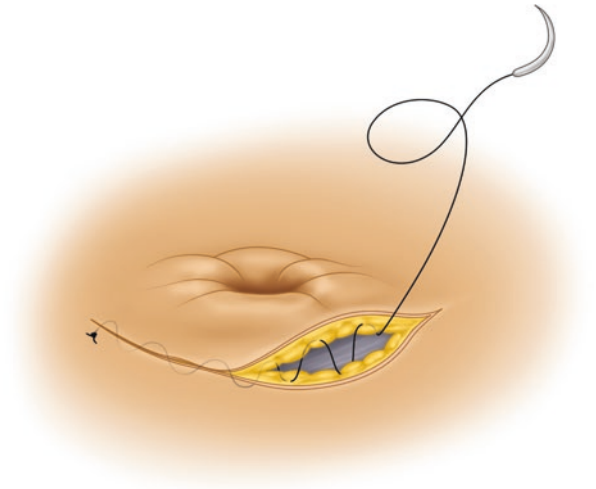

Fig. 5.3 New valley and running suture

5.3 Discussion

Voluminous umbilical hernia is frequently associated with the black African. The prevalence of this condition according to age varies from one country to another. It occurs in early childhood between 3 and 5 years in 61.5 % of the cases in Niger, and according to Fargy it reached 5 % of infants and up to 50 % of the children in some African regions. Our study reveals an infant predominance of around 5-month-old

in 75 % of cases [3, 4]. The age younger than most recommended is due to the fact that in our practice umbilical hernia and abdominal pain are strongly correlated in infancy and strangulation condition is not rare.

Indication of a general anesthesia with orotracheal intubation was applied to all our patients whose age was under 3 months. This approach intended to improve preoperative comfort of the child and to prevent frequent bronchospasm at that age.

The study of the technical approach was limited to pedunculated hernias with a collar diameter included in 2–5 cm. These indicated limitations of the umbilical "Y-to-V" cutaneous plasty were motivated on one hand by the concern to preserve an umbilical cutaneous flap and on the other hand in order to exclude the umbilical reconstruction after complete cutaneous excision from our study. Cannistra [5] reserved his "double M" plastic surgery procedure with minimal scar to umbilical hernias with collar diameters inferior to 5 cm.

The excision of cutaneous umbilical excess has to comply with precise and rigorous technical procedures. The equal lengths of the "V" segments are of capital importance as regards aesthetic. This resection is realized using a geometric design in the form of an isosceles triangle skin excision. These lateral twin triangles have their lower bases coinciding with the umbilical groove.

In 2002, Sankale [6] at Dantec Hospital proposed three procedures of umbilical cutaneous plastic surgery according to the size of the hernia. They were in the form of an arc-shaped left lateral excision, a "Horseshoe" excision, or a total skin grafting surgery after complete umbilical cutaneous resection.

The "Y-to-V" plasty, by preestablished landmarks with various geometrical references, brings precision mainly in cutaneous resection. It seems important also to us to rebuild umbilical valley by fixing the residual skin flap with subcutaneous quilting stitches. The scar ransom is the rule in various techniques reported in the literature [7]. However, it is possible to obtain a beautiful scar by performing congruent stitches or intradermal running suture. The standing cone of tissue that often occurs at the point of incision is usually removed when the apex of the scar is in the groove: i.e., "dog-ear" resorption [8].

The repair of pedunculated umbilical hernia in the infant and the child within "Y-to-V" skin plasty shows aesthetically good results in more than 87.5 % of our cases. We used nonabsorbable braided suture for orifice closure, but we think that an alternative to that procedure is the use of slow resorption suture to prevent the suppuration we have experienced in five patients. Simple, easily implemented methods which are proposed in the literature do not focus on umbilical cosmetic reconstruction, although they bring a solution to skin excess [9].

Our technique highlights the importance of aesthetic units that constitute orientation, depth, and peripheral landscape of the umbilical valley.

5.4 Conclusions

The skin excess after aponeurosis ring closure in pedunculated umbilical hernias of the infant and child raises an important problem in our daily practice. Several solutions are proposed from simple reduction to cutaneous excision followed by skin grafting [2]. The umbilical cutaneous “Y-to-V” plasty we propose is to emphasize on aesthetic criteria following the anatomic ring closure.

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Chapter 6
Umbilicoplasty in Children with Huge Umbilical Hernia

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6.1 Introduction

Umbilical hernia (UH) is a frequent pathology in children [1, 2]. The UH is huge when its basis diameter exceeds 3 cm and/or its height exceeds 1.5 cm [2]. The treatment of UH generally consists of surgical closure of the umbilical ring and re-fixation of the umbilicus [3]. In huge UH (HUH), the re-fixation of the umbilicus cannot be done without excision of the protruding skin. Thus, the excess skin (Fig. 6.1) remains a problem to the surgeons after closure of the umbilical ring. To restore an umbilicus esthetically close to the natural one, many techniques of umbilicoplasty have been developed [1–6]. We want to describe here our technique of umbilicoplasty [2] which is simple and well adapted for every HUH.

6.2 Technique

The measurement of the base diameter (BD) allows to classify the HUH in groups 1, 2, or 3 (Fig. 6.2) [2]. The shape of the HUH can be classified according to morphologic classification [2].

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Fig. 6.1 Excess of the skin in a huge umbilical hernia

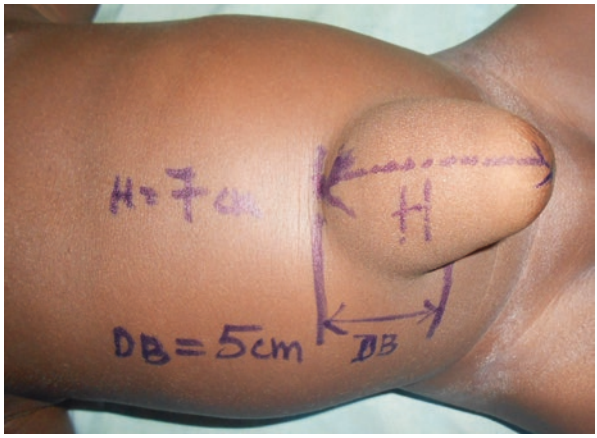

Fig. 6.2 Measurement of the base diameter in huge umbilical hernia

Our technique [2] is a technique of two lateral flaps, performed under general anesthesia with a good muscular relaxation. We draw first the xipho-pubic line, going straight over the summit of the HUH. Two pull wires are placed at the summit of the HUH, up and down in order to maintain the HUH tight during the procedure. Some landmarks are placed on the HUH as shown in Fig. 6.3. The points A and D are placed at 1 cm of the HUH basis. The points B1and B2 and C1 and C2 are placed, respectively, each in front of the other, on the basis of the HUH, at its middle part according to its base circumference. One must not consider the native umbilical scar, which is displaced by the HUH, especially in pedunculate and hornlike HUH (Fig. 6.4).

The segments B1C1 and B2C2 are equal and correspond to the basis of the flaps. Their length (L) depends on the diameter (d) of the neo-umbilicus to be made. The two values are joined by the following formula: $L = \frac{\pi}{2} d$. In children, we usually

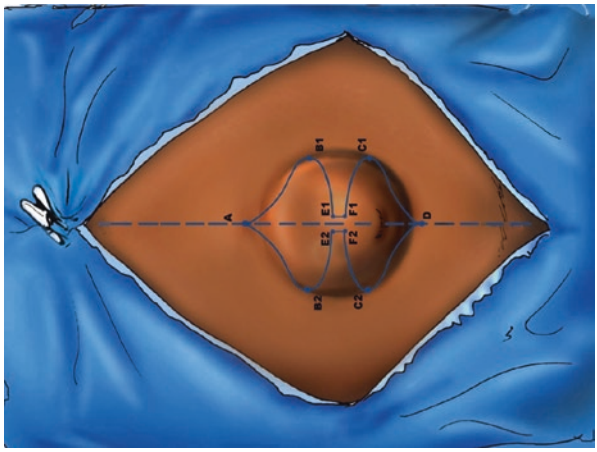

Fig. 6.3 Drawing of landmarks and lines of incisions for the umbilicoplasty

Fig. 6.4 Hornlike huge umbilical hernia (the summit of the umbilicus – umbilical scar – is pushed down

choose to make a neo-umbilicus of 2 cm of diameter. For this, *L* equals π (3.14) and we choose 3 cm.

The points E1 and E2 and F1 and F2 are placed as nearer as possible to the xipho-pubic line, in order to have in the beginning the maximal height of the flaps. The definite height of the flaps (*h*) depends on the thickness (*t*) of the abdominal subcutaneous panniculus. We usually take this formula: $h = t + 0.5\ cm$. The segments E1F1 and E2F2 are equal and symmetric and measure 0.5 cm. The flaps so drawn must be perpendicular to the xipho-pubic line (Figs. 6.5. and 6.6). They must not follow the summit of the HUH, which is pushed down in pedunculate and hornlike HUH (Fig. 6.5).

The incisions are not straight but semicircular or arc-like. Incisions have a superior concavity from A to B (B1 and B2) and from B to E (E1 and E2) and inferior concavity from F (F1 and F2) to C (C1 and C2) and C to D. The incisions are joined

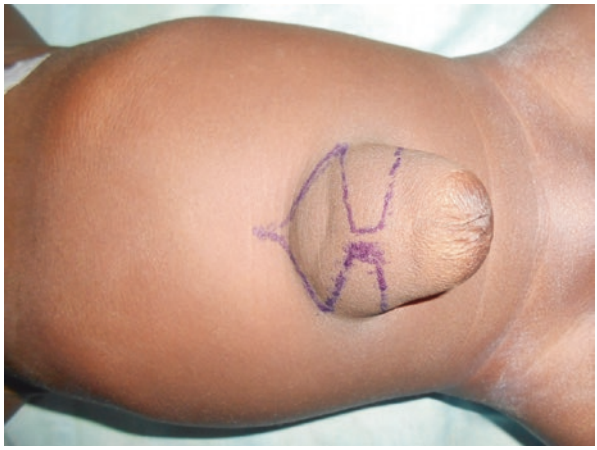

Fig. 6.5 Drawing of flaps

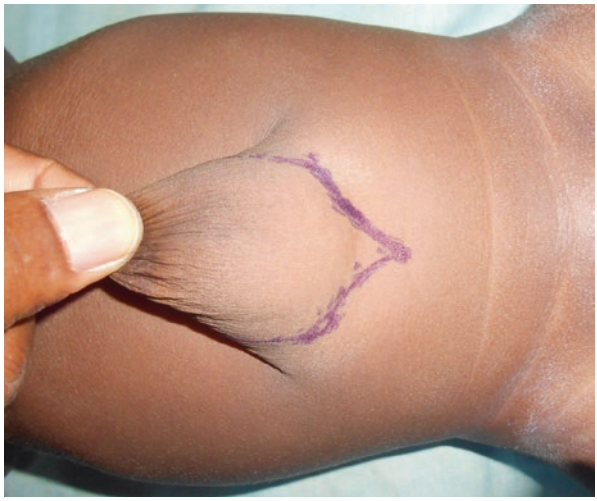

Fig. 6.6 Drawing of flaps

at A and D at a point, whereas they are rounded at B1, B2, C1, and C2. The two lateral flaps look like towers widened to their bases (Fig. 6.5).

After this drawing, incision is done on the marks. The flaps are removed from the aponeurosis plan with their subcutaneous panniculus (Figs. 6.7, 6.8, and 6.9). In the same way, all the lateral skin is dissected with its subcutaneous panniculus from the aponeurosis plan. The skin is also removed from the aponeurosis of the umbilical sac, and the sac is opened at its top. The excess of aponeurosis is resected longitudinally and removed with the excess skin. The level of resection is well checked in order to have good and sufficient tissue for a regular and strong new aponeurosis plan that will not allow eventration and that will provide a regular shape to the abdomen. The height of the flaps is reviewed as specified earlier. The wound, with the flaps, looks like an hourglass (Fig. 6.10). Their summits are correctly sutured one to

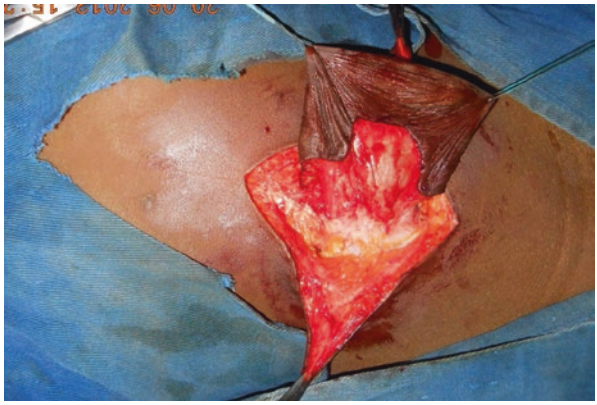

Fig. 6.7 Liberation of the left flap from aponeurosis plane

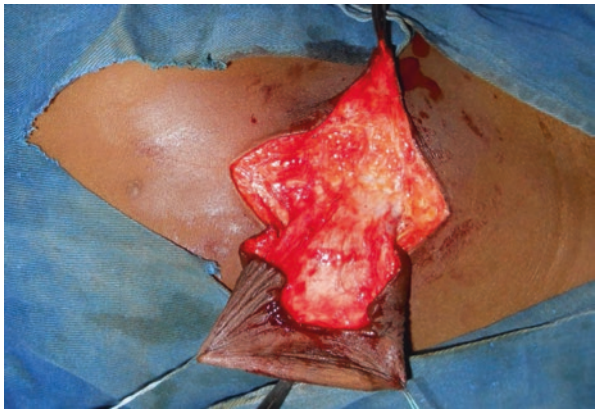

Fig. 6.8 Liberation of the right flap from aponeurosis plane

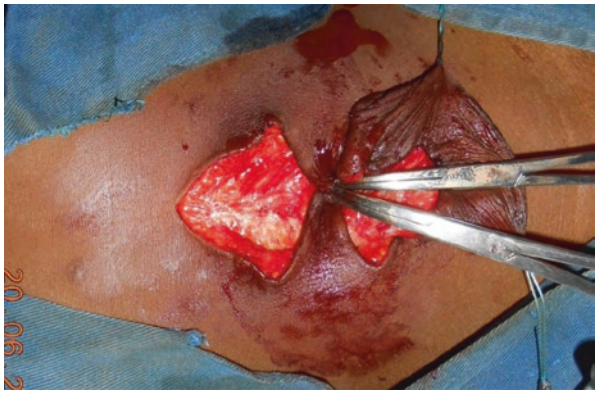

Fig. 6.9 Aspect after liberation of the two lateral flaps from the aponeurosis plane

the other and fixed by two points to the aponeurosis plane by 2/0 absorbable suture. Their sides are sutured by subcutaneous separated points of 4/0 absorbable suture, from depth to surface. After this, the neo-umbilicus is well drawn, with its peripheral

Fig. 6.10 After closure of aponeurosis plane: hourglass aspect of the wound

Fig. 6.11 Neo-umbilicus with a central depression and a well-raised rim

rim well raised (Fig. 6.11). Two separate points are placed at the superior and the inferior part of the neo-umbilicus. The remainder wound is closed in two planes, the subcutaneous plane by separated points and an intradermal continuous suture, both with 4/0 absorbable suture. The definite aspect of the umbilicoplasty is then obtained (Fig. 6.12).

Figs. 6.13 and 6.14 show the result for two children.

6.3 Results

Satisfaction of the results: we rated the results as excellent, fair, or bad according to criteria in Table 6.1. In addition to these criteria, we have the self-satisfaction of the surgeon and the satisfaction of the parents or the child. We asked the parents or the child how they found the neo-umbilicus. From their answer, we rated the umbilicoplasty:

Fig. 6.12 Final aspect of the umbilicoplasty

Fig. 6.13 (**a**) Sessile huge umbilical hernia of group 2 (basis diameter = 6 cm and height = 4 cm) in a 4-year-old girl. (**b**) Immediate postoperative. (**c**) Two years postoperative

Fig. 6.14 (**a**) Hornlike umbilical hernia of group 1 (basis diameter = 5 cm and height = 7 cm) in a 13-month-old girl. (**b**) Immediate postoperative. (**c**) Two months postoperative. The loss of pigmentation of the scar will disappear progressively

Table 6.1 Appreciation criteria of the umbilicoplasty [2]

	Excellent	Fair	Bad
Aspect of peripheral rim	Raised	Flattened	Depressed or exuberant
Aspect of the central depression	Deep	Little deep	Absent

1. Excellent if the answer is "the neo-umbilicus looks like a normal umbilicus"
2. Fair if the answer is "the neo-umbilicus is better than before"
3. Bad if the answer is "we prefer the anterior aspect of the umbilicus"

6.4 Discussion

The treatment of HUH in children includes two actions: the closure of the umbilical ring and the reconstruction of an umbilicus close to the normal. The best attitude would be the operation of the HUH before the school age, in order to avoid mockeries of friends at school. The umbilicoplasty needs to be simple to perform and to

provide a cosmetic and permanent result with no external scar [7]. Many techniques have been described [1, 5–9], some more complex than others, with variable results. Our technique [2] is easy to perform with precision and provides satisfactory results. A simple umbilication of the skin after resection of the excess skin [9] cannot restore the different parts of an umbilicus. The morphology of the umbilicus must not influence the drawing of the flaps. The flaps must be drawn perpendicularly to the xipho-umbilical line and must not follow the direction of the HUH.

1. *The umbilical rim*: it determines the cosmetic aspect of the umbilicus. It gives to the neo-umbilicus its diameter (d). It is raised with young children and become little flattened when the abdominal panniculus thickens. The curvature of our incisions especially at points B1, B2, C1, and C2 (Fig. 6.3) permitted us to raise the umbilical rim. In addition, the height of flaps must pass the thickness of the abdominal panniculus by about 0.5 cm. The regulation of the flaps' height according to the thickness of abdominal panniculus is very important: short flaps lead to depressed rim; on the other hand, too long flaps can lead to exuberant rim that will not be cosmetic. We had no depressed or exuberant rim in our series [2]. Other techniques [5, 6] try to reconstitute a raised rim, but it can be irregular or incomplete. In our technique, symmetric flaps with equal height and equal basis permit to have a regular and complete rim. The diameter of the umbilical rim depends on the width of the flaps at their basis (*L*). We usually choose 3 cm for the L in children, in order to have a diameter of umbilical rim of 2 cm. One can choose to create a neo-umbilicus with a rim more or less than 2 cm large, according to the age and the morphology of the child. In that case, the following formula must be used: $L = \frac{\pi}{2} d$.
2. *The central depression of the umbilicus*: it is the second element constituting the umbilicus. Its depth gives to the umbilicus its particularity. Without this depression, we cannot have an umbilicus. In our technique, the fixation of the flap's summit to the aponeurosis plan permits to create this depression. Other techniques of umbilicoplasty [1, 5–8, 10] do that fixation with the same purpose.
3. *The added scar*: the avoidance of an added scar is the very challenge of all the techniques of umbilicoplasty. The surgeon must create a neo-umbilicus close to the normal, without added scar if possible. The absence or not and the length of the added scar are related to the BD of the HUH. The "lazy M" and omega flap technique [1] can permit to have a neo-umbilicus without added scar but only in UH with reduced BD, less than 3 cm. With the double half-cone umbilicoplasty [11], after 3 cm of facial defect, the cosmetic result will be discussed because the neo-umbilical rim will be too large. The technique of Ikeda et al. [12] is adapted for UH that BD is between 2 and 2.5 cm; it cannot provide good result with what we call HUH. With HUH, even in group 1, there will be an added scar, even with the "lazy M" and omega flaps. The other techniques [1, 5, 8] as ours let an added scar whose length depends on the BD of the HUH. We noticed in our series that no matter how long was the added scar, the results were excellent for children and parents, and they preferred the neo-umbilicus with added scar to the

HUH. The LAS equals the BD, and this length is distributed approximately for half up and half down the neo-umbilicus. So, more is the BD, more will be the LAS, because the excess skin that may be excised begins at the basis of the HUH. The LAS is independent to the morphology of the HUH [2]. Our classification in three groups according to the BD permits us to know how long will be the LAS. The maximum care must be given to the closure of the incision, in order to let a scar less visible as possible; one must avoid skin transfixing separate points and use intradermal continuous suture.

4. *Postoperative complications*: subcutaneous hematoma can occur in early postoperative period (one case in our series [2]). It regressed spontaneously. Other complications like parietal infection in 5 % and erythema of flaps in 29.2 % were found by Kaneko and Tsuda [6]. The late complications that we encountered were keloid scar (one case) and granulation tissue (two cases) [2]. Keloid scar reduces the cosmetic aspect of the neo-umbilicus but is preferred to HUH. If the patient has some keloid scar before umbilicoplasty, subcutaneous injection of corticoid in the edge of incision just after healing of the wound could help to avoid it. As for granulation tissue, they are due to insufficient closure of the skin at the summit of the flaps before their fixation to the aponeurosis. Takasu and Watanabe [5] found it at the center of the neo-umbilicus in 9 % and in the gap between adjacent skin flaps in 4 % of cases. A correct closure of the summit and the gap between the flaps permits to avoid them.

   Postoperative eventration must not be found.

6.5 Conclusions

The authors' umbilicoplasty is a simple and precise technique which provides excellent esthetic results. Among the techniques described, it is well adapted to HUH often encountered in African children. A good application of the technique permits avoidance of complications. Despite the added scar, the results are excellent.

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Chapter 7
Double Half-Cone Flap Umbilicoplasty for the Proboscoid Umbilical Hernia in Children

Sherif M. Shehata, Nagi I. Eldesouki, and Hesham M. Almohamady

7.1 Introduction

The umbilicus is an important and essential aesthetic component in the abdomen. Features of the umbilicus include a centrally placed depressed scar surrounded by skinfolds forming the superior hood [1]. The reconstruction of a deformed and flat umbilicus by neo-umbilicoplasty during umbilical hernia repair was first described by McMillan in 1955 [2].

Other indications for umbilical reconstruction include congenital conditions associated with umbilical agenesis (bladder exstrophy, gastroschisis, omphalocele, cloacal exstrophy) or umbilical loss due to umbilical sepsis or mass (Fig. 7.1) [3].

Proboscoid umbilical hernia is a large hernia with downward displacement of the umbilicus appearing as descending from above. Several techniques have been reported for umbilicoplasty. These techniques can be divided into suture fixation methods and flap methods [4]. Suture fixation methods are relatively advantageous for obese adults with thick deposits of subcutaneous fat. However, these methods are unsuitable for children and lean adults with a thin layer of abdominal fat. Conversely, flap methods allow creation of a deep umbilical depression. The most common method is the V–Y advancement flap method, which has a lot of variations of the flap shapes. Although numerous plastic surgeons suggest longitudinal umbilical depression as an ideal, conventional flap methods typically create only a longitudinal scar line with a shifted umbilical depression facing upward or downward at the end of the scar [5].

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Neo-umbilicoplasty can be performed by lateral skin excisions and a rotation of two small paramedian flaps as reported by Borges [6] or two flaps V–Y advancement designed by Jamra [7]. The management of the large protuberant umbilical hernia has been a subject of controversy. The main cause of parental anxiety is the resultant redundant umbilical skin following closure of the fascial defect rather than the hernia defect itself [8].

According to Blumberg, the umbilical hernia in children is classified according to the diameter of the fascial defect: class 1 in which the defect is less than 1.5 cm, class 2 in which the defect diameter is between 1.5 and 3 cm, and class 3 in which the defect is more than 3 cm. More than 95 % of class 1 defects will close by age 5 without surgery, while larger defects of classes 2 and 3 seldom close spontaneously [9, 10]. Both class 2 and 3 represent the clinical oblique type described by Blumberg,

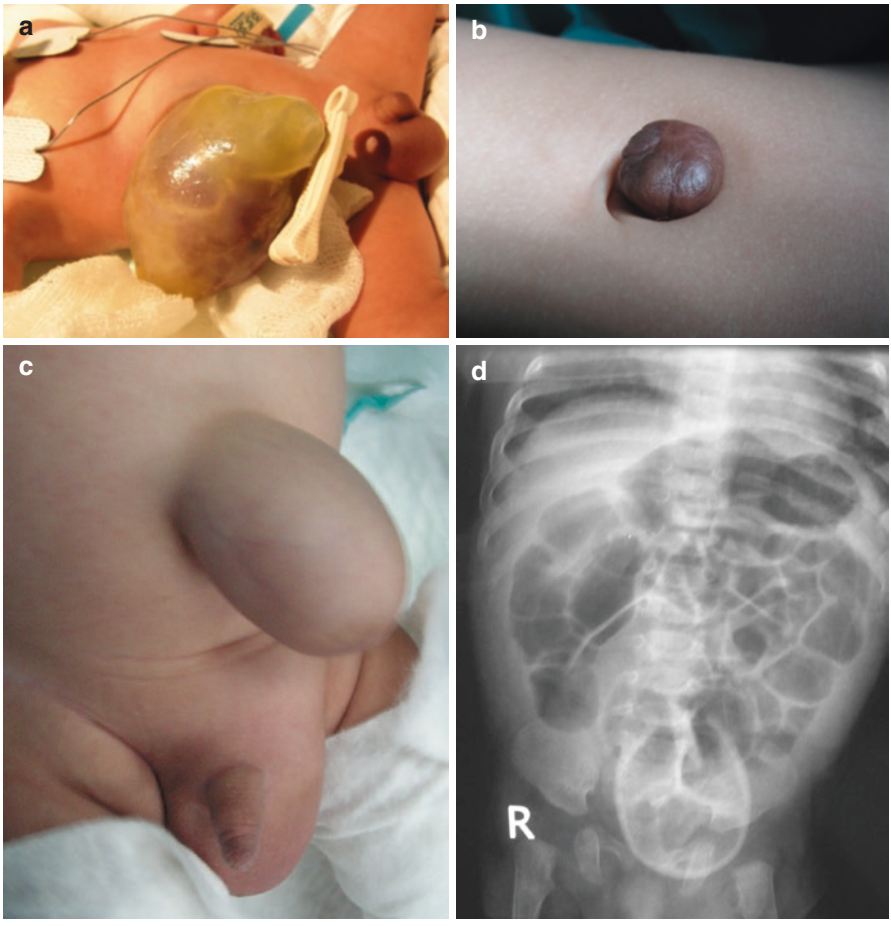

Fig. 7.1 Different pathologies that need umbilical reconstruction in children. (**a**) Exomphalos case in a boy. (**b**) Umbilical mass in an infant that proved to be teratoma. (**c**) Proboscoid umbilical hernia in a boy. (**d**) X-ray where the hernia is presented with white soft tissue shadow in the midline with intestinal loop with gas within the hernia sac (Courtesy of Prof. Sherif Shehata)

which is a large hernia with downward displacement of the umbilicus and appearing as descending from above (the proboscoid variety) [9]. Unsatisfactory postsurgical results may be a frustrating event for both patient and surgeon [11].

We aim to design a technique of umbilicoplasty for cases of proboscoid umbilical hernia in children that can be safe and easy with outcome resembling the normal-looking midline scar. In the meanwhile, the proposed umbilicoplasty technique needs to be simply done in the same session of umbilical hernia repair.

7.2 Technique

The idea of this technique was based on creating two half cones that, when invaginated and sutured together, would form an inverted cone, keeping the tubular structure of the normal umbilicus. This simple new technique is represented schematically by graph simulating the proboscoid skin in Fig. 7.2.

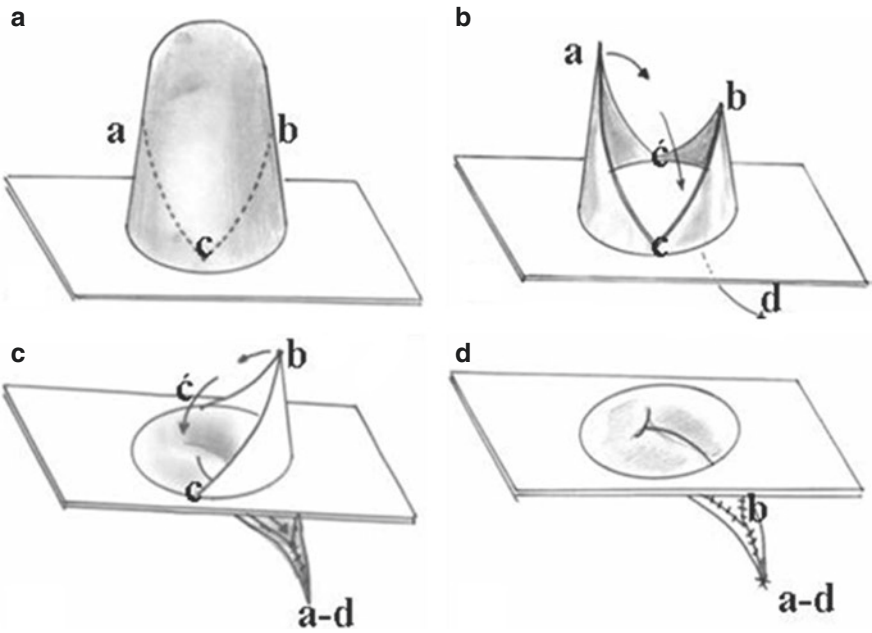

Fig. 7.2 Schematic of the technique. (**a**) Demarcation of the site of amputation of a big imaginary cone representing the protruding umbilical skin. (**b**) Excision of the big cone, leaving two small half cones, a short cephalic (0.5 cm) half cone [*b-cc´*] and a longer caudal (1 cm) half cone [*a-cc´*]. (**c**) Inversion of the caudal half cone after closure of its two limbs upon itself [*a-c* and *a-c´*] to almost half of their length to form most of the new umbilicus. The apex is anchored to the abdominal fascia [point *a-d*] after a classic hernia repair. (**d**) The cephalic half cone is inverted to complete the new cone where its apex [*b*] is sutured to the point at half of the length of *a-cc´* line representing the new umbilicus [12]

This technique that we proposed as described in 2000 and our experience in the first ten cases was published later in 2004 [12].

In order to understand the concept of the idea, we designed the glove model to convince the surgeons by our technique [12].

7.3 Operative Technique

Under general anesthesia, two stay sutures are applied to the apex of the protuberant umbilical skin, and a skin marker is used to draw the lines of skin incisions (Fig. 7.3). The protruding umbilical skin is excised sharply by two V-shaped cuts leaving two half cones, a short cephalic (0.5-cm length) and a long caudal one (1.0-cm length) (Fig. 7.3).

We sutured the caudal half cone from its apex till half of its length upon itself with interrupted sutures before fixing the tip to the underlying fascia (Fig. 7.2).

Inversion of the cephalic half cone then suturing it to the caudal cone will form the new umbilicus (Fig. 7.3). The caudal half cone is planned to be longer to constitute the apex of the new cone and to allow the pull of the inverted umbilicus to form the supraumbilical hood (Fig. 7.4). A classic herniotomy using a "vest-over-pants" technique could be easily performed through the excised skin.

For technical ease, after closure of the fascial defect, we anchor the caudal skin flap very deeply to the fascia (Fig. 7.2). Then each side is closed to itself until halfway up when the cephalic half-cone skin flap is inverted as the last step to complete the new umbilicus (Fig. 7.3). Only one suture line will be perpendicular to the umbilicus. Most of the incisions will be hidden within the newly fashioned umbilicus (Fig. 7.4).

This will help to get the best cosmetic result in the form of a rounded scar within the umbilicus. The final result of the technique postoperatively is clearly obvious (Figs. 7.4 and 7.5) [12].

7.4 Materials

Along the last 15 years, we have operated 24 cases of proboscoid umbilical hernia, with follow-up period ranged between 1 and 12 years. They were 14 boys and 10 girls where all have been operated between the age of 1 year and 6 years. All were operated by the same technique by one of two expert pediatric surgeons (Shehata S and ElDessouki N) under general anesthesia. In two occasions, a small Vicryl mesh was used to strengthen the repair.

The results were excellent in all cases with no infection and no ischemic changes encountered in the skin of the reconstructed umbilicus in any of the cases. Follow-up periods between 1 and 12 years with a mean follow-up of 5.2 years revealed a

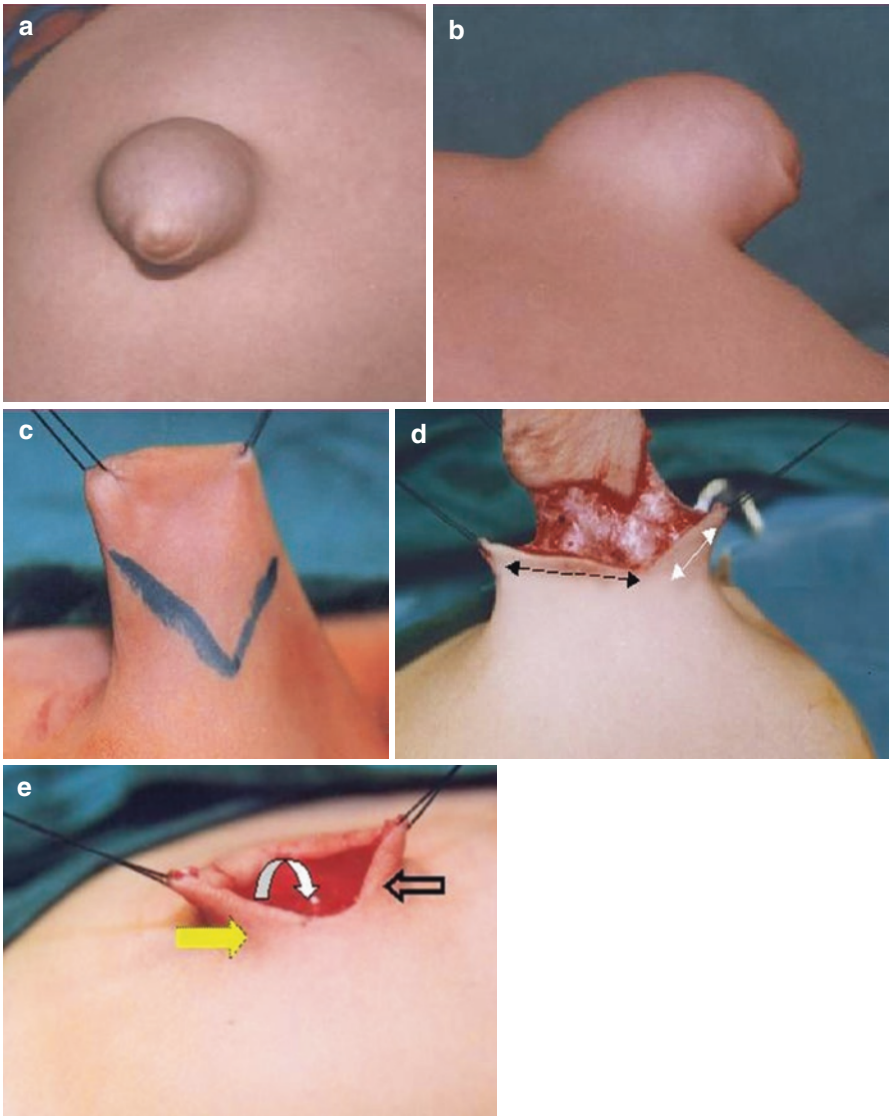

Fig. 7.3 Steps of the procedure. (**a**–**b**) Proboscoid umbilicus in a child with congenital umbilical hernia. (**c**) Proboscoid umbilicus showing two stay sutures at the apex of the redundant skin and the demarcated line of excision. (**d**) The two unequal half-cone skin flaps before hernia repair. The complete arrow denotes the inequality of the size of the flaps representing the cephalic half cone. The broken line arrow shows the longer caudal half-cone flap. (**e**) Excised redundant skin after hernia repair. The filled arrows denote the direction of inversion and pull of the caudal flap, while the unfilled arrow points to the cephalic flap [12]

cosmetically excellent shape of the umbilicus as seen in Fig. 7.5. Only two cases developed hypertrophy of the resulting scar. Small seroma reported once that resolved under conservative management.

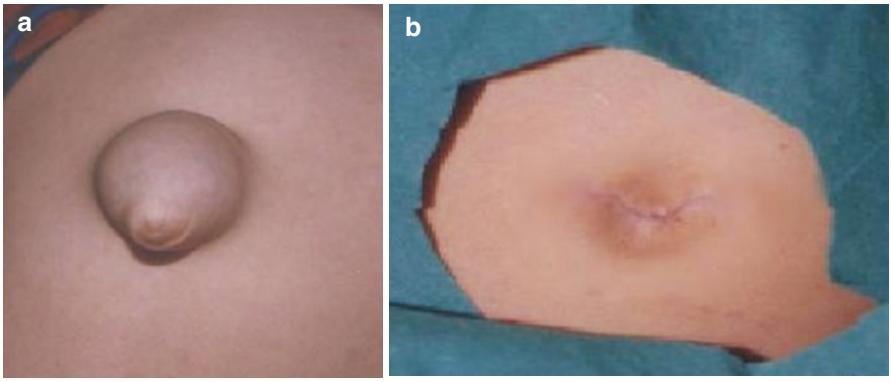

Fig. 7.4 Child with proboscoid umbilicus. (**a**) Preoperative. (**b**) Three months postoperative [12]

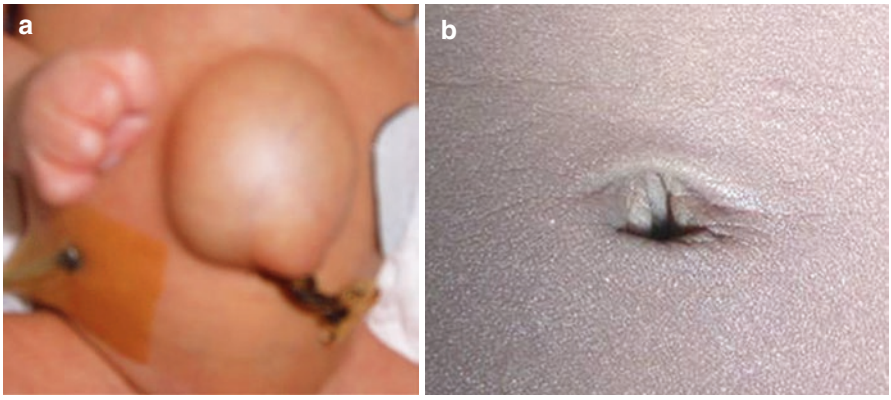

Fig. 7.5 Proboscoid umbilical hernia. (**a**) Preoperative in the neonatal period in a boy. (**b**) Six years postoperative after surgery at one year of age with excellent result following umbilical reconstruction by our technique (Courtesy of Prof. Sherif Shehata)

7.5 Discussion

The umbilicus is the only structure normally found in the smooth and featureless surface of the mid abdomen [13, 14]. The normal location of the umbilicus is the superior border of the iliac crest [13]. The surgeon's aim is to create an umbilicus of natural appearance, which consists of a ring, a tubular wall, a sulcus, and a bottom without any excess skin to preserve the aesthetic aspect of the umbilicus [13].

Although many techniques have been described for reconstruction of the protruding umbilicus in children with umbilical hernia, we present a simple new technique for umbilicoplasty. The ideal umbilicoplasty creates a permanent, rounded depression in the mid abdomen with minimum scarring. As a major aesthetic component of the abdominal wall and of beauty, the umbilicus is the only scar tissue

in the human body which normally remains after birth [15]. Simply in cases of umbilical hernia with excess skin, when technique did not involve raising of complex skin flaps will often result into loss of umbilical depression [16]. The upper margin should have a slightly hooded skinfold [17, 18]. Though many techniques described for umbilical reconstruction use various local flaps [11, 14, 17, 19, 20], this simple procedure utilizing the local tissue for fashioning the umbilicus proved to be efficient and satisfactory.

We give them only 1 year as an expectant trial to see if the defect gets smaller which is seldom to occur in this type of umbilical hernia (proboscoid type). If it fails, surgery is clearly indicated. As an integral part of repairing the fascial defect, it is worthy to perform an umbilicoplasty in the same setting with only one general anesthesia exposure. This idea is validated by the fact that there is seldom need prosthetic material for defect closure as compared to adults [21, 22]. Our experience showed the same as we need meshes in less than 10% of our series. Mateu and Hernandez [23] created a neo-umbilicus by creating three simple triangular flaps and suturing their apices after defatting the skin flaps to the muscular plane similar to Kirianoff technique of using a purse-string suture to reconstruct the inner walls of the neo-umbilicus [18].

It is vital that the apex of the new umbilicus is fixed securely down to the fascia [1]. The excess skin is discarded as described by many followed by closure of the fascial defect whatever the shape of skin incision, triangular or circular to make the new umbilicus [1, 16, 24]. Our idea to anchor the tip of the long caudal half cone after suturing its halfway upon itself to the short cephalic half cone as depicted in Fig. 7.2 is to simulate the elliptical vertical shape of normal umbilicus. These two half cones are fashioned, closed, and inverted to constitute the new umbilicus following a classic hernia repair. Similar to the same idea is the Benz incision concept as described where the tips of the three skin flaps are anchored to the caudal end of the fascia to retain the umbilicus concave curvature toward the caudal aspect as reported later [24].

Combining umbilicoplasty with hernia repair in this age group alleviates both parental worries and child suffering, which could be increased if umbilicoplasty is postponed to a separate session in preadolescence [8, 14, 20]. The disfigured umbilicus is an aesthetically and psychologically frustrating condition for patients [18]. It has recently become common for many people to want an aesthetically pleasing umbilicus because their umbilicus is visible in public when they wear cloths like at beaches or swimming pools [15, 25]. Wounds outside the umbilical ring, such as those occurring with the circum-umbilical or omega-shaped incision, typically result in scar formation [24]. The ideal umbilicus should have a natural prominent depth, minimal additional scars, and proper superior hooding [17]. Several studies have suggested various surgical techniques for umbilical reconstruction, such as using diversely shaped local flaps, a suture method, and even a cartilage graft [11, 15, 17, 18]. However, few reports have addressed the reconstruction of new umbilicus after proboscoid umbilical hernia in children [15].

Shinohara et al. [17] emphasized that an umbilicus with a natural appearance consists of a ring, a tubular wall, a sulcus, and a bottom without any excess skin that

would interfere with the aesthetic aspect of the umbilicus. Our technique provides a good solution for reconstruction of proboscoid umbilical hernia in children. An important advantage of this method is the ease of the design and execution of the excess skin, thus keeping the normal umbilical structure of the ring and tubular wall that produces a normal-appearing umbilicus as seen in Fig. 7.5. In the meanwhile, this new technique provides a good solution for reconstruction of the protruding umbilical skin.

The double half-cone flap umbilicoplasty technique is easy to learn and to perform. With this simple new technique, we can construct a normally appearing umbilicus with the following proved advantages: the technique is simple and easy to learn and perform even by junior surgeons, all incisions are hidden within the newly fashioned umbilicus, there is only one suture line with involving well-vascularized flaps, we use the umbilical skin with no need for local tissue flap and a minimal external scar at long-term follow-up, and we combine umbilicoplasty and hernia repair in the same sitting.

7.6 Conclusions

The double half-cone flap technique presented here is easy to learn and perform. By applying this new technique, satisfactory results can be obtained for pediatric patients despite the lack of abdominal fat in children. This technique could be used in other indications for umbilicoplasty with redundant skin as a completion to the proper repair of a hernia defect.

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Chapter 8
How to Reconstruct a Natural and Deep Umbilicus for All Kinds of Umbilical Deformities: Three Methods of Umbilicoplasty for Five Types of Deformities

Akiyoshi Kajikawa

8.1 Introduction

The purpose of umbilicoplasty is to create a deep and natural umbilical depression without conspicuous scars. A lot of umbilicoplasty methods have been reported [1–11]; however, most of the reports described only the design of flaps, and the conventional methods often result in unnaturally wide or shallow umbilical depression facing upward or downward with a little displacement. Although the umbilical deformities have many variations, no report has described categorical analysis and the selection of the proper umbilicoplasty method for each type. To resolve these problems, the author classified all kinds of umbilical deformities into five types and devised three methods of umbilicoplasty [12–15]. In this chapter, I introduce my classification of umbilical deformities and selection of the most suitable method for each type of umbilical deformity.

8.2 Classification of Umbilical Deformities

I classified all umbilical deformities into five types by the height and shape of protrusion [14, 15] (Fig. 8.1).

Type 0: *Umbilical Defect*

This type is the defect of the umbilicus after the abdominoplasty for the congenital defect of the abdominal wall, the abdominal wall hernia, the excision of abdominal

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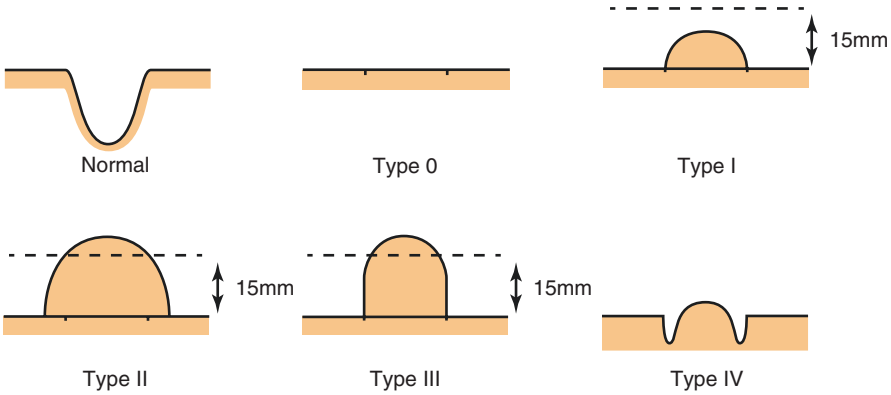

Fig. 8.1 Classification of umbilical deformities. The author classified umbilical deformities into five types by existence of the surplus skin for umbilicoplasty. *Type 0*, flat type, the defect of umbilicus; *type I*, small type, the low-grade (<15 mm) protrusion; *type II*, large type, the high-grade protrusion (>15 mm) with wide base; *type III*, tall and thin type, the high-grade protrusion (>15 mm) with narrow base; and *type IV*, protrusion in depression type, like a caldera volcano

wall tumor, the failure of umbilicoplasty, etc. Type 0 deformity has the perfectly flat abdomen and no surplus skin for umbilicoplasty at the center of the abdomen.

Type I: *Small Protrusion Type*

This type has a low-grade protrusion of the umbilicus, the height of which is less than approximately 15 mm (at 3–5 years old). This type is the most common umbilical deformity and has a little surplus skin for umbilicoplasty.

Type II: *Large Protrusion Type*

This type has a high-grade protrusion with a wide base. The height of the protrusion is more than approximately 15 mm (at 3–5 years old), and the diameter of the base is more than approximately 15 mm with a large umbilical hernia. This type usually has a large hernia orifice and much surplus skin for umbilicoplasty.

Type III: *Tall and Thin Protrusion Type*

This type has a high-grade protrusion with a narrow base. The height of the protrusion is more than approximately 15 mm (at 3–5 years old), and the diameter of the base is less than approximately 15 mm. This type has enough surplus skin for umbilicoplasty.

Type IV: *Small Protrusion in Depression Type*

This type has a small protrusion in a normal size umbilical depression. The deformity has the appearance of a caldera volcano. There is enough surplus skin for umbilicoplasty.

8.3 Surgical Technique

There are three designs for umbilicoplasty [12, 15]. The most suitable method among the following three surgical methods was adapted to each umbilical deformity in five types.

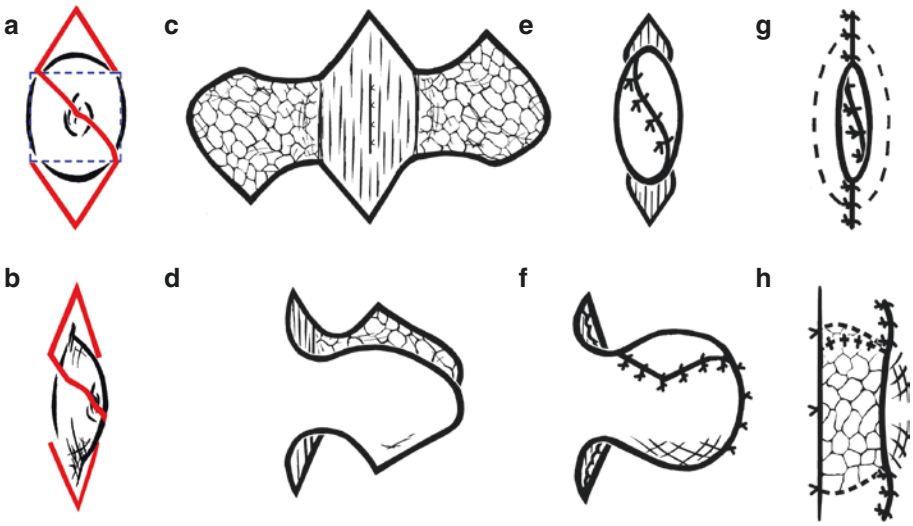

Fig. 8.2 Method 1. (**a**–**d**) A pair of long flaps with lateral bases is elevated from the cranial and caudal side of the umbilical position. (**e**, **f**) The skin pouch created with the flaps. (**g**, **h**) Turned inside out and sutured on the median line of the abdominal wall to create a vertically long depression. This method is better adapted for type 0 and I deformities

8.3.1 Method 1

The author has described this umbilicoplasty in Chap. 3 (a new umbilicoplasty for children), and it has a particular advantage for type 0 and I deformities, which do not have enough surplus skin for umbilicoplasty.

In method 1, first, a square is drafted initially at the required position of the umbilicus, and then a diagonal line is drawn. Next, equilateral triangles are drawn on the cranial and caudal sides of the square. Thus, an S-shaped skin incision line has been designed (Fig. 8.2). A pair of long flaps can be elevated, opposing obliquely and having their bases at the left and right sides of natural umbilical position. After closing the hernia orifice with absorbable sutures, both flaps are sutured together in the midline to make a skin pouch with rapid absorbable sutures. The pouch is turned inside out, and the median line of the dermal side is sutured on the median line of the abdominal wall with absorbable sutures at three points. Finally, the cranial and caudal donor sites are closed finely. A small amount of antibiotic petrolatum gauze is packed in the formed umbilical depression. Neither bolster sutures nor stents are needed to maintain the depression.

8.3.2 Method 2

This method suits the umbilicoplasty for type II, which has much surplus skin and does not require method 1.

In method 2, a pair of fan-style flaps is elevated on bilateral sidewalls of a large umbilical protrusion and excise excessive skin on the cranial and caudal side

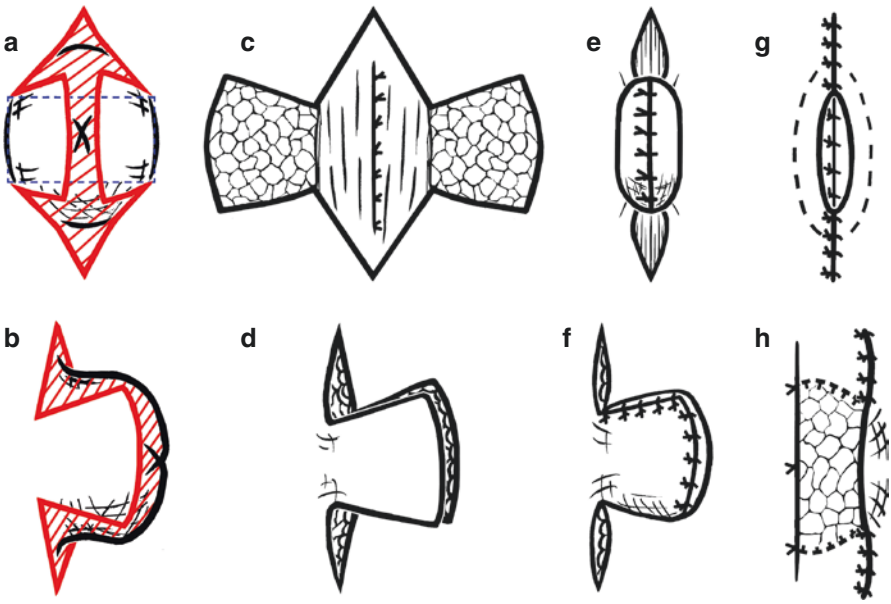

Fig. 8.3 Method 2. (**a**, **b**) A pair of fan-style flaps is elevated on bilateral sides of a large umbilical protrusion. (**c**, **d**) The excessive tissue on the cranial and caudal side of the protrusion is excised. (**e**, **f**) After closing the hernia orifice, the skin pouch is created with the flaps. (**g**, **h**) Turned inside out and sutured on the median line of the abdominal wall. This method is better adapted for type II deformity

(Fig. 8.3). After closing the hernia orifice, the fan-style flaps are sutured together to make a skin pouch with rapid absorbable sutures. The pouch is turned inside out and fixed on the median line of the abdominal wall in the same manner of method 1. The dressing is done as in method 1.

8.3.3 Method 3

This method is better adapted to the umbilicoplasty for type III and IV deformities, which have just size of tissue for umbilicoplasty.

In method 3, a pair of skin flaps is created by vertical straight-line incision of the protruding umbilicus with excision of the hernia sac and hard scar tissue under the umbilical skin (Fig. 8.4). After closing the hernia orifice, 3 untied rapid absorbable sutures are set on the median line of the abdominal wall and the center, cranial end, and caudal end of the flaps. Then, the flaps are sutured together with rapid absorbable sutures to make a skin pouch. The pouch is turned inside out and fixed on the median line of the abdominal wall by tying the 3 untied sutures to create a longitudinal depression facing forward. The dressing was done in the same manner of Method 1 and 2.

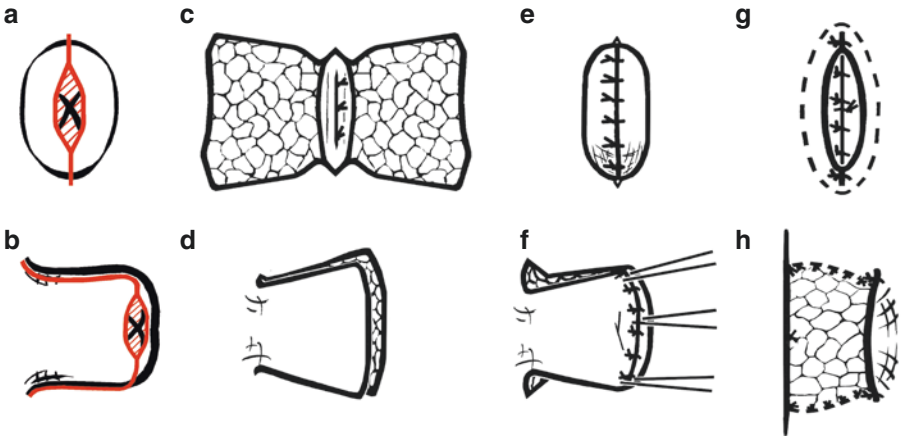

Fig. 8.4 Method 3. (**a**–**d**) A pair of skin flaps is created by vertical incision of the protruding umbilicus with excision of the hernia sac and the hard scar. (**e**, **f**) After closing the hernia orifice, the flaps are sutured together. (**g**, **h**) Turned inside out to be fixed on the median line of the abdominal wall. This method is better adapted for type III and IV deformities

8.4 Cases

8.4.1 Case 1 (Type 0, Method 1)

A 3-year-old girl had undergone an abdominoplasty for the congenital defect of the abdominal wall at another hospital 7 days after the birth. Although umbilicoplasty using the conventional method had been performed in the abdominoplasty, the abdomen had become perfectly flat with conspicuous scars and no umbilical depression on her first visit to our department (Fig. 8.5). The umbilical defect was diagnosed type 0 deformity, and the patient underwent umbilicoplasty using method 1 with excision of the conspicuous scars on the abdomen as much as possible. When elevating the flaps, a large weak site 30 mm in diameter was observed in the linea alba. After closing the hernia orifice rigidly, a skin pouch was created. The pouch is turned inside out and sutured on the median line of the abdominal wall. The vertically long and deep umbilical depression facing forward with inconspicuous scars was shown 2 years postoperatively.

8.4.2 Case 2 (Type I, Method 1)

A 3-year-old boy presented with a protruding umbilicus, which was round and 15 mm in diameter and 5 mm in height. A small hernia orifice of 5 mm in diameter was palpable in the umbilicus (Fig. 8.6). The small umbilical protrusion was

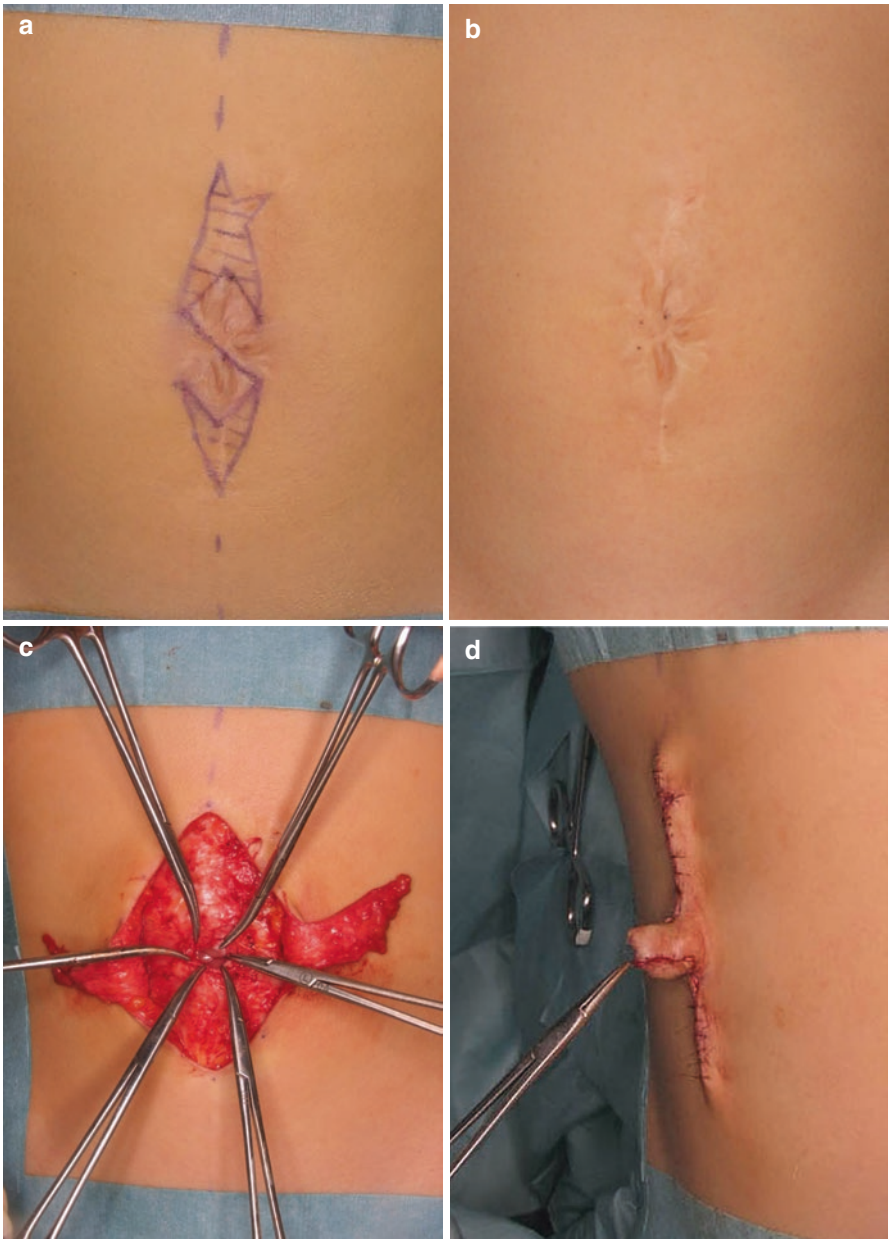

Fig. 8.5 Case 1 (*type 0*, *method 1*). (**a**) A 3-year-old girl showed the umbilical defect with conspicuous scars on the abdomen. (**b**) Method 1 with scar revision was designed. (**c**) A pair of flaps is elevated. (**d**) A skin pouch was created. (**e**) The pouch was turned inside out and fixed on the linea alba. (**f**) The natural and deep umbilicus with inconspicuous scar was shown 2 years postoperatively

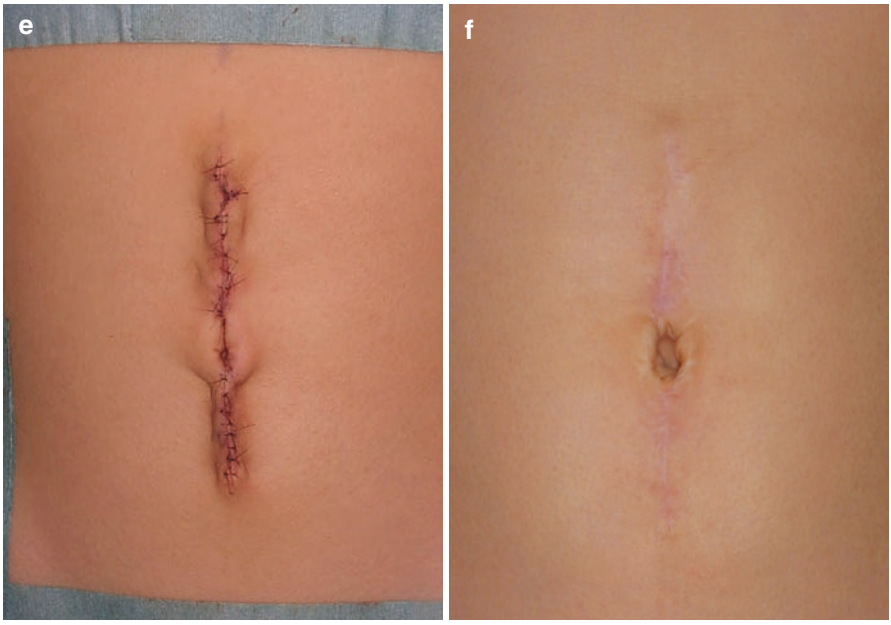

Fig. 8.5 (continued)

diagnosed type I deformity. The umbilicoplasty using method 1 was performed on the patient. A pair of long flaps was elevated, and hernia orifice was closed with the absorbable sutures. Both flaps are sutured together to make a skin pouch with rapid absorbable sutures. The pouch is turned inside out and sutured on the median line of the abdominal wall with absorbable sutures. The natural vertically long and deep umbilical depression facing forward without conspicuous scars was shown 2 years postoperatively.

8.4.3 Case 3 (Type II, Method 2)

A 3-year-old boy presented with a large umbilical protrusion, which was 30 mm in diameter and 25 mm in height with an umbilical hernia (Fig. 8.7). The large umbilical protrusion was diagnosed type II deformity. The patient underwent umbilicoplasty using method 2. The size of the fan-style flaps was 15 mm wide at the base and 20 mm wide at the top. The excessive skin on the cranial and caudal side was excised. After closing the hernia orifice, which was 20 mm in diameter, the fan-style flaps were sutured together to make a skin pouch with rapid absorbable sutures. The skin pouch is turned inside out and fixed on the median line of the abdominal wall to create a longitudinal deep depression. The natural appearance of the umbilicus without conspicuous scars was obtained 2 years postoperatively.

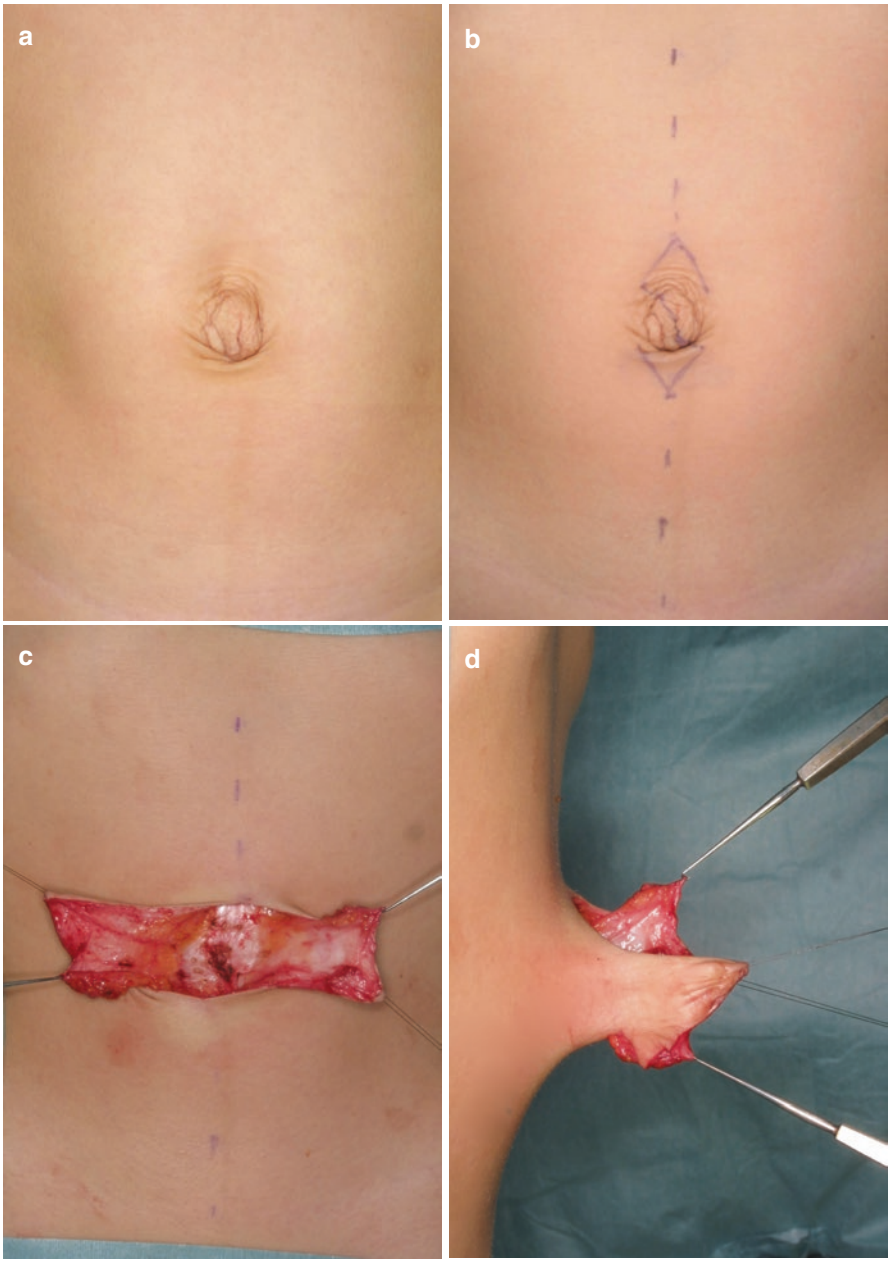

Fig. 8.6 Case 2 (*type I*, *method 1*). (**a**) A 3-year-old boy had a protruding umbilicus which was round and 15 mm in diameter and 5 mm in height. (**b**) Method 1 was performed. (**c**) A pair of long flaps was elevated. (**d**, **e**) Both flaps were sutured together to create a skin pouch. (**f**) The vertically long and deep umbilicus without conspicuous scar was obtained 2 years postoperatively

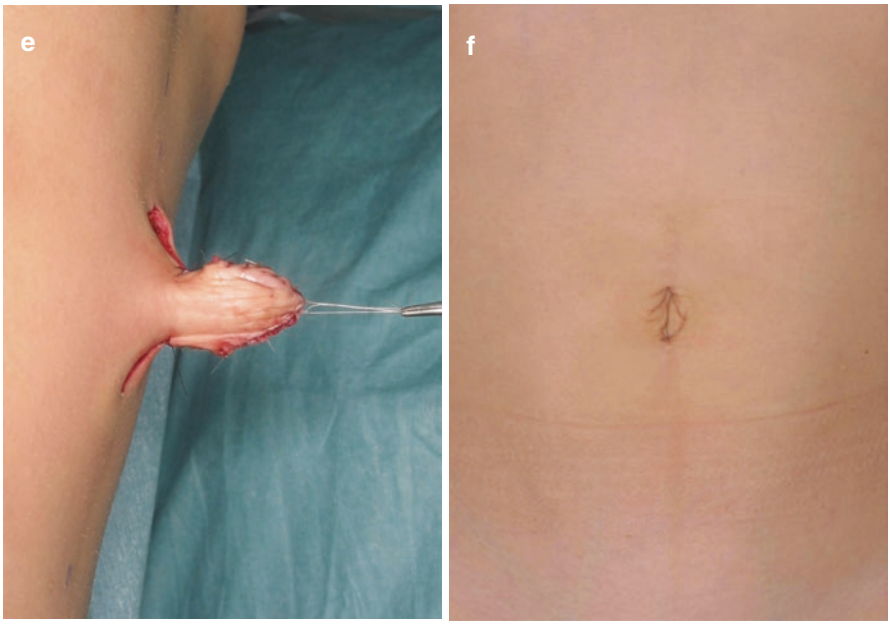

Fig. 8.6 (continued)

8.4.4 Case 4 (Type III, Method 3)

A 3-year-old boy presented with a protruding umbilicus, which was 15 mm in diameter and 20 mm in height. A hernia orifice of 5 mm in diameter was rigid (Fig. 8.8). The tall and thin umbilical protrusion was diagnosed as type III deformity. The umbilicoplasty using method 3 was performed on the patient. A pair of skin flaps 15 mm long are created by vertical straight-line incision of the protruding umbilicus with excision of the hernia sac, hard scar tissue, and excessive skin, and the hernia orifice was closed. Then, a skin pouch created with the flaps was turned inside out and fixed on the median line of the abdominal wall with rapid absorbable sutures to make a vertically long and deep depression. The natural umbilicus without visible scars was obtained 2 years postoperatively.

8.4.5 Case 5 (Type IV, Method 3)

A 3-year-old girl presented with a small umbilical protrusion in depression (Fig. 8.9). The deformity was diagnosed type IV deformity. The umbilicoplasty using method 3 was performed. After creating a pair of skin flaps by vertical straight-line incision of the protruding umbilicus, the hernia orifice was closed. Three untied rapid absorbable sutures are set on the median line of the abdominal wall and the center, cranial end, and caudal end of the flaps. Then, the flaps are

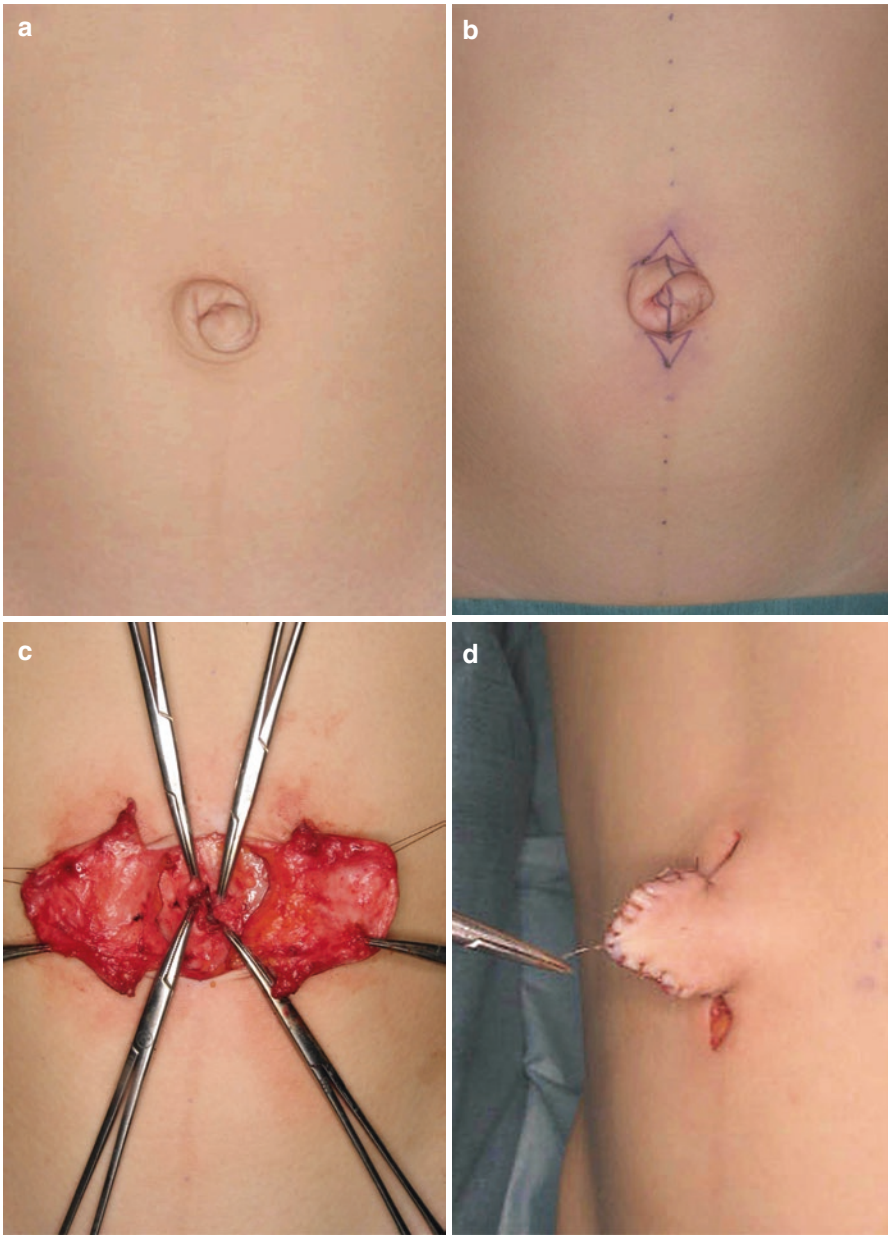

Fig. 8.7 Case 3 (*type II*, *method 2*). (**a**) A 3-year-old boy had a large protruding umbilicus which was 30 mm in diameter and 25 mm in height with a large hernia orifice. (**b**) Method 2 was designed. (**c**) Bilateral fan flaps were elevated with excising the excessive skin on the cranial and caudal side. (**d**) A skin pouch was created. (**e**) The pouch was turned inside out and fixed on the median line of the abdominal wall. (**f**) The natural umbilical depression was shown 2 years postoperatively

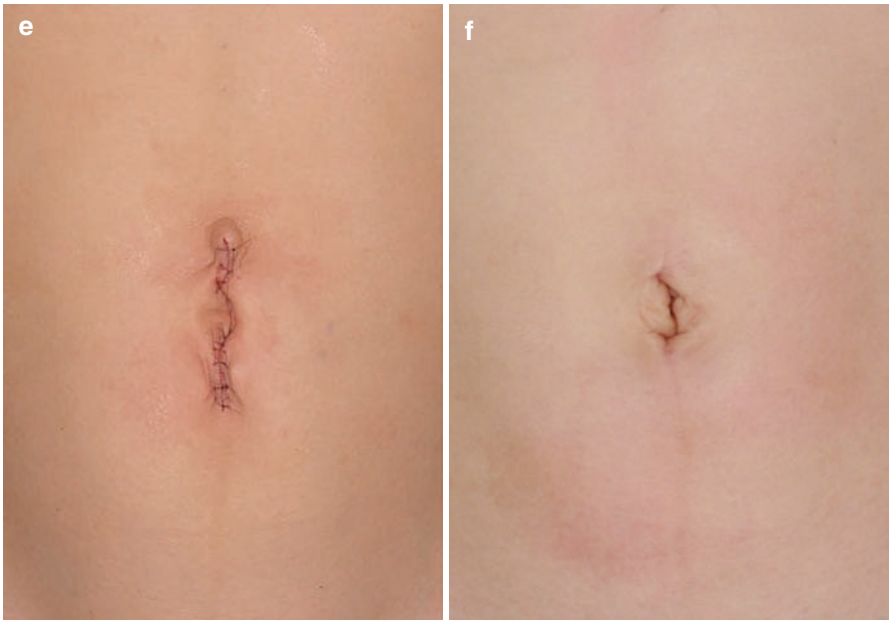

Fig. 8.7 (continued)

sutured together with rapid absorbable sutures to make a skin pouch. The pouch is turned inside out and sutured along the linea alba by tying the 3 untied sutures. The natural vertically long and deep umbilicus without visible scars was obtained 1 year postoperatively.

8.5 Discussion

The purpose of umbilicoplasty is to create a deep and natural cutaneous depression at the natural position. The normal umbilicus has natural size, natural shape, and natural direction. The normal umbilicus locates on the cranial tangential line of bilateral iliac crests and the median line of the abdominal wall. And the normal umbilicus faces simply forward, not upward or downward. However, the conventional umbilicoplasty methods often result in only scar lines with a wide and shallow depression. Some methods create a depression which is caudal or cranial shift facing upward or downward. To resolve these problems, I developed a new umbilicoplasty method with an S-shaped skin incision [12, 13]. Using this method, a longitudinal deep umbilical depression facing forward can be produced at the correct umbilical position without conspicuous scars. However, there are many variations of umbilical deformities, and some cases do not need this method. Therefore, we devised 2 more methods of umbilicoplasty to correct all kinds of umbilical deformities [14, 15].

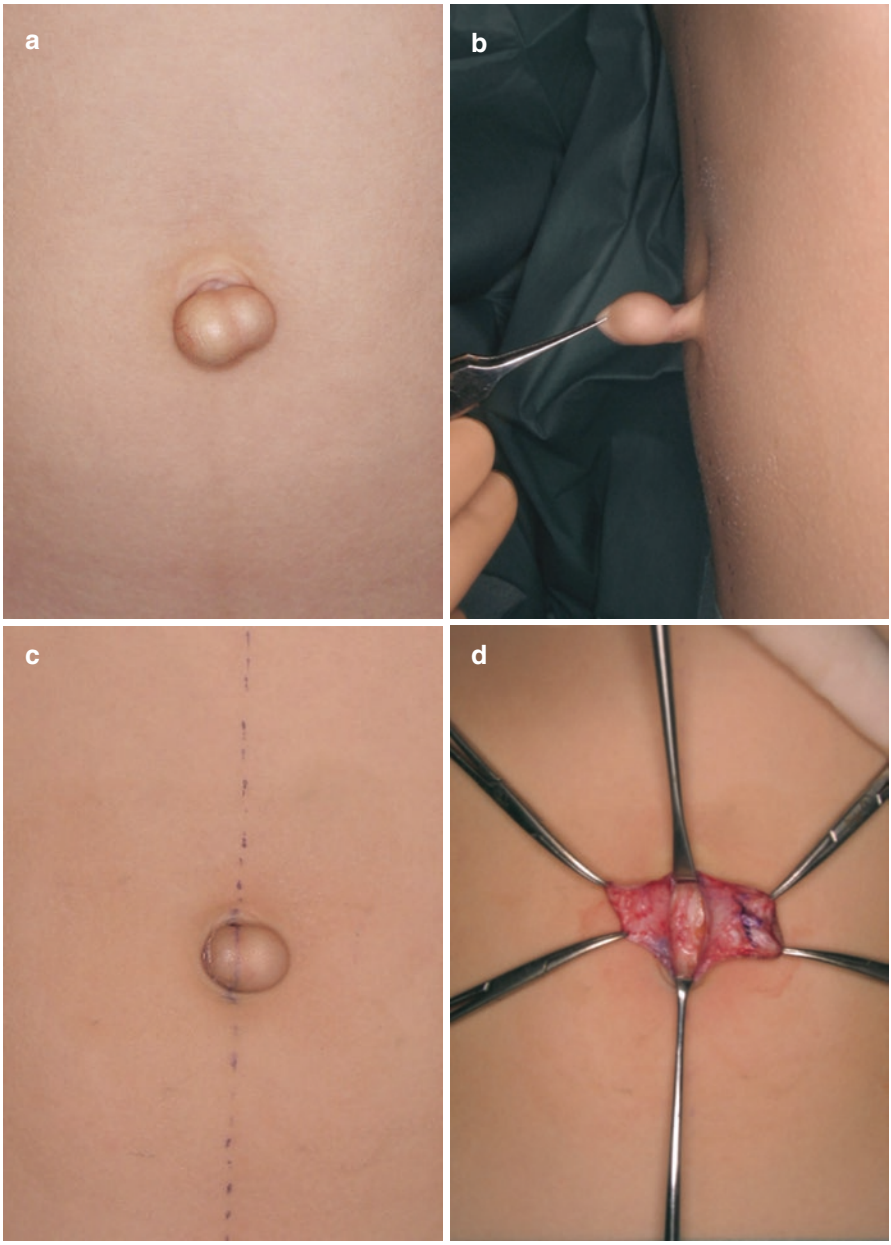

Fig. 8.8 Case 4 (*type III*, *method 3*). (**a**) A 3-year-old boy had a protruding umbilicus which was 15 mm in diameter and (**b**) 20 mm in height. (**c**) Method 3 was designed. (**d**) Bilateral flaps were elevated, and the hernia orifice was closed. (**e**) The flaps were sutured together and fixed on the median line of the abdominal wall longitudinally. (**f**) The natural umbilicus without visible scars was obtained 2 years postoperatively

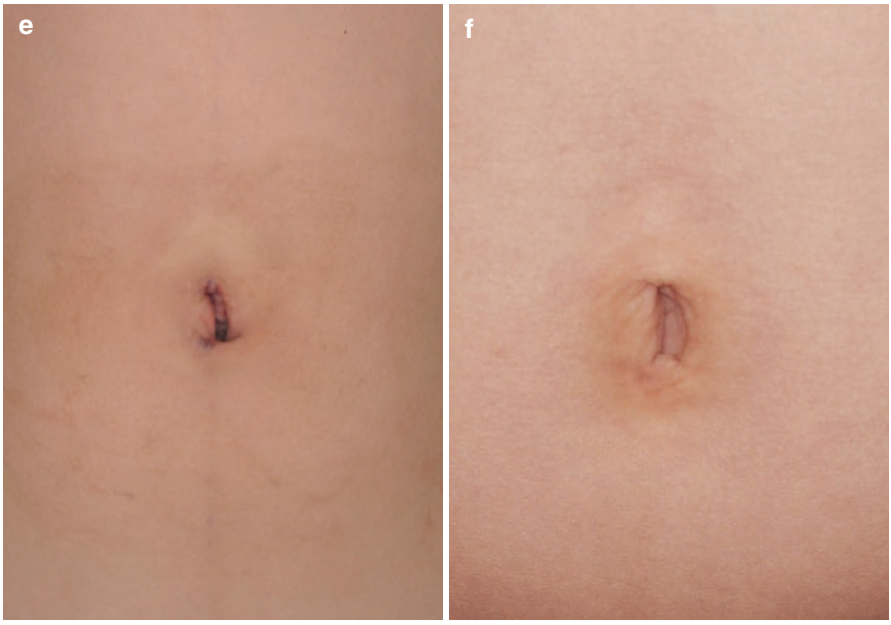

Fig. 8.8 (continued)

The author classified all umbilical deformities into 5 types and studied the best method for each type of umbilical deformity [15]. In this classification, the critical point is whether surplus skin to create the depression exists or not. The protruding umbilicus more than 15 mm in height makes it easy to create a deep umbilical depression. The "15 mm" was decided from the size of a normal umbilical depression. As the average diameter of a normal umbilical depression is approximately 10 to 15 mm in 3–5 years old, we should make the umbilical depression as a sphere of diameter more than 10 mm in the abdominal wall [13]. To create a skin sphere of 10 mm in diameter, 2 flaps approximately 15 mm (10 mm × π × 1/2) in length are needed. As the result, the "15 mm" is the breakpoint of enough or not enough tissue for successful umbilicoplasty. In adults, the length is corresponded approximately 20–25 mm.

Type 0 (Fig. 8.5) and type I (Fig. 8.6), which do not have enough surplus skin, need method 1. In this method, the skin closure of the cranial and caudal donor sites and sufficient tissue transferred to the lateral sides create a longitudinal deep umbilical depression [12]. Method 1 can create a good shape of umbilicus in all types of umbilical deformities, but leaves short visible scars. Type II, type III, and type IV deformity, which has enough surplus skin for umbilicoplasty, do not need method 1.

Method 2 is usually adapted to only type II (Fig. 8.7) deformity which has a large umbilical protrusion with excessive skin. It is easy to adjust the size of skin for

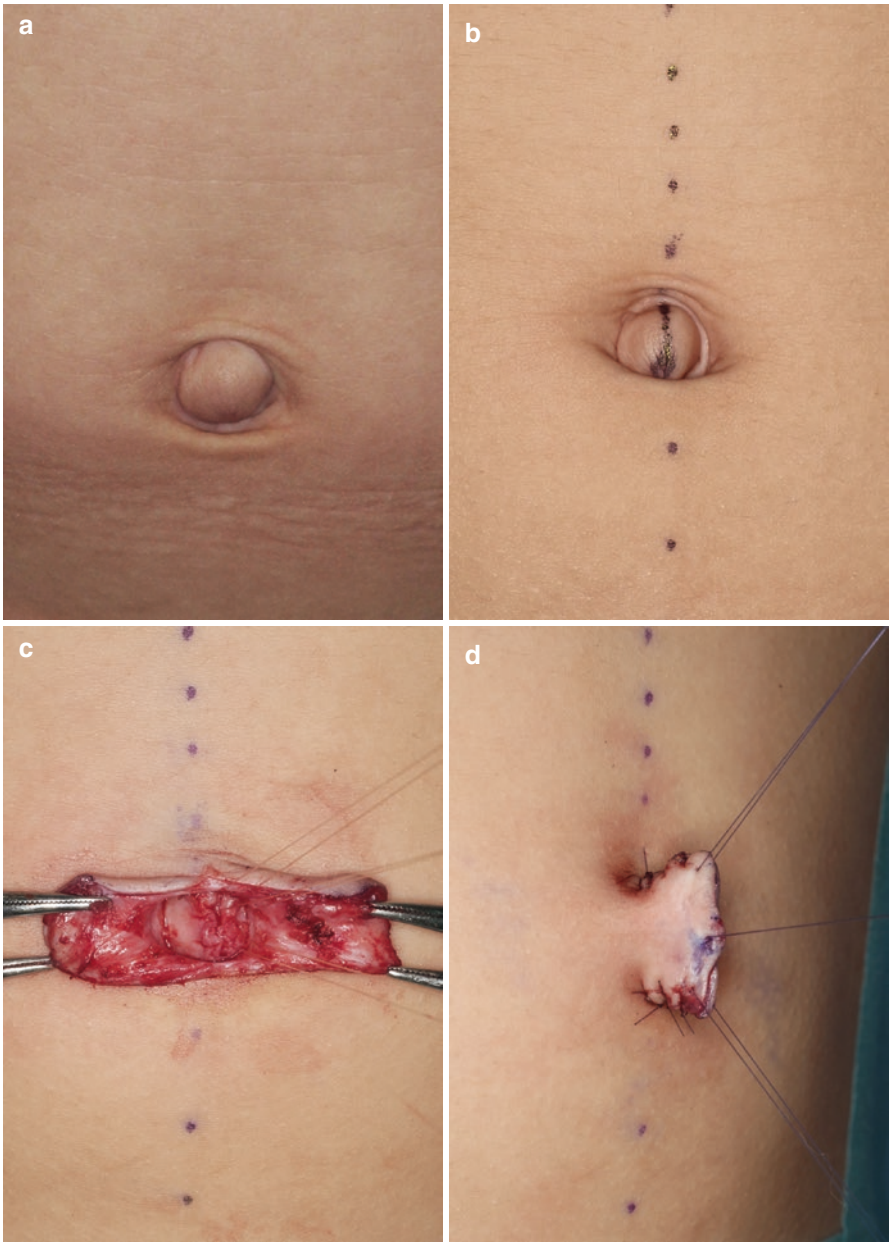

Fig. 8.9 Case 5 (*type IV*, *method 3*). (**a**) A 3-year-old girl had a small umbilical protrusion in depression. (**b**) Method 3 was performed. (**c**) A pair of skin flaps is elevated by dividing the protruding umbilicus, and the hernia orifice was closed. Three untied rapid absorbable sutures are set on the median line of the abdominal wall and the flaps. (**d**) The flaps are sutured together to make a skin pouch. (**e**) The pouch is turned inside out and fixed on the median line of the abdominal wall by tying the untied sutures. (**f**) The natural vertically long and deep umbilicus without visible scars was obtained 1 year postoperatively

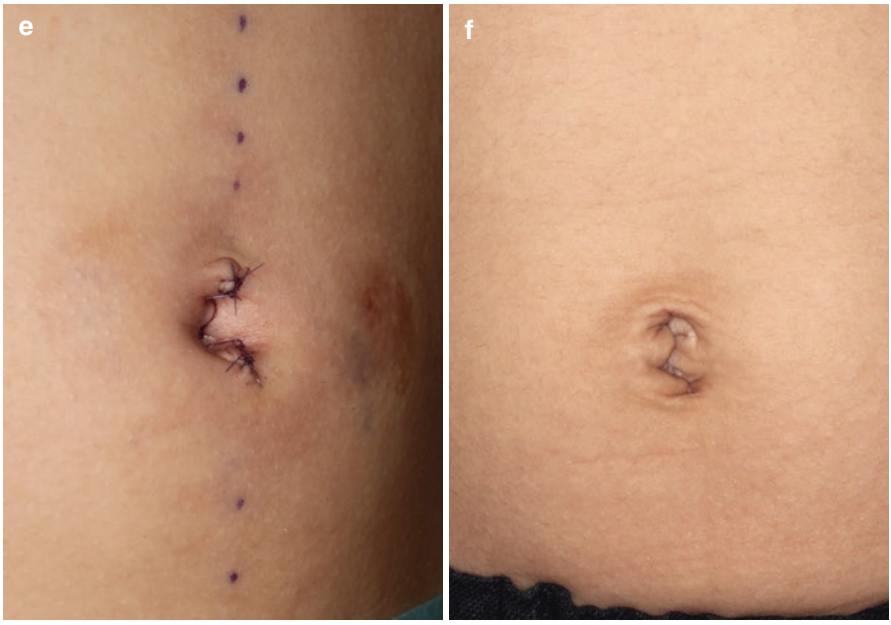

Fig. 8.9 (continued)

umbilicoplasty in method 2. The fan-shaped flaps create a stable umbilical depression with a narrow entrance and a large pocket. Method 2 also could be adapted to some cases of Type 0 with wide abdominal scars. In these cases, the fan-style flaps can be designed in the scarred area with excision of the cranial and caudal wide scar tissue as the scar revision. No circulatory deficit of the scar flap was observed in my experience.

Method 3 is a kind of suture fixation method. Of course there have been many suture fixation methods previously reported; however, skin flaps caudally based and fixed on the caudal abdominal wall often result in the creation of an unnaturally wide umbilical depression facing upward. Compared with these methods, in Method 3, elevating laterally based flaps and fixing flaps vertically long on the abdominal wall creates a natural, slightly vertical, and deep umbilical depression. Method 3 has a great advantage of making no visible scars at the outer umbilical edge. But this method can be only adapted to type III (Fig. 8.8) and IV (Fig. 8.9), not type 0, I, or II. Type III and IV have completely different shapes from each other, but they have the same characteristic of having the adequate tissue for umbilicoplasty. If you adapt method 3 to type 0 or I, the formed umbilicus will become shallow. If you adapt method 3 to type II, the formed umbilicus will become too large.

Although the three methods have different designs, they have the common strategy to elevate enough size of flaps based laterally and to create a vertically long and deep umbilical depression facing forward. Using the best choice among the three methods, it is easy to create a natural, deep umbilical depression without conspicuous scars in all types of umbilical deformities.

8.6 Conclusions

I classified all kinds of umbilical deformities into five types and devised three methods of umbilicoplasty. Method 1 with an S-shaped skin incision is adapted to type 0 and I, method 2 with fan-style flaps is adapted type II, and method 3 with dividing the umbilical protrusion is adapted type III and IV. Using the most suitable method, it is easy to create a natural, vertically long, and deep umbilical depression without conspicuous scars in all types of umbilical deformities.

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Chapter 9
Reconstruction of a Natural-Appearing Umbilicus Using a Local Flap

Natsuko Kakudo, Rina Hikiami, Masakatsu Hihara, and Kenji Kusumoto

9.1 Introduction

Umbilicoplasty is generally divided into two categories, which are procedures for treating umbilical hernia or navel protrusion and navel creation procedures that are required after surgery for abdominal wall abnormalities.

A protruding navel is frequently encountered in daily practice and is a state in which the umbilicus protrudes instead of being normally recessed. Congenital umbilical hernia causing a protruding navel in children closes spontaneously in 70 % by up to 1 year of age and by 2 years in 90 %. Therefore, we regard children over 2 years old with a persistent hernia or those in whom the navel protrudes even after closure of the hernia as candidates for surgical treatment. Various surgical procedures for umbilicoplasty have been reported [1–4], which provide radical treatment if an umbilical hernia is present, resect the subdermal scarring under the protruding navel as completely as possible, and create a deep umbilical fossa. In this chapter, we introduce our umbilicoplasty procedure using a local flap, which is conducted for uncomplicated navel protrusion, and a method of maintaining the navel recess after surgery.

After surgery for umbilical hernia, the navel has to be reconstructed, and there is usually vertical scarring in the abdominal midline. Also, unlike patients with a protruding navel, there is no excess tissue in the abdominal wall, but skin and subcutaneous tissue are required to create a navel and umbilical fossa. In a patient

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who lacked a navel and had extensive scarring after abdominal wall rupture, we previously created a subcutaneous local flap by conducting W-plasty at the same time as scar excision, successfully forming a deep navel [5]. We will introduce the technical points of our procedures here.

9.2 Technique

9.2.1 Umbilicoplasty Using a Local Flap for Protruding Navel

A 10-year-old girl had a congenital umbilical hernia, but the orifice of the hernia closed when she was around 2 years old. After follow-up, surgery was performed because the navel was protruding and the patient wished for cosmetic treatment (Fig. 9.1). First, a reverse U-shaped flap was created with a distal pedicle for the protruding navel and made a vertical incision in the upper part. Along the vertical incision, skin incisions were made to peel off and lift the flaps. Then the scar tissue was excised under the skin of the protruding navel as completely as possible and confirmed that the hernia orifice was closed. The left and right rectus sheaths were closely approximated to each other. In addition, the expanded rectus sheaths distally were peeled to create a space. After creating the recess of the navel by folding the flap of the lower pedicle distally and fixing it by suturing to the rectus sheath, we sutured the left and right flaps after trimming them. Then packing was fixed to the skin of the umbilical fossa, abdominal wall, and subumbilical region. The packing was removed after 2 weeks. We subsequently created a mold to maintain the umbilical fossa with Oyumaru (Daiso Japan, Hiroshima, Japan), a thermoplastic elastomer, which was used for 2 months after surgery. Oyumaru is a children's toy that becomes soft when dipped in hot water at 80 °C or more, making it possible to fashion into any shape. At 6 months after surgery, there was improvement in protrusion of the navel.

9.2.2 Umbilicoplasty Using a Subcutaneous Island Flap for Scarring After Umbilical Hernia Repair

An 11-year-old girl had undergone umbilical hernia repair shortly after birth. At her first visit to our hospital, she had a large radial scar measuring 4 cm × 8 cm in the umbilical region (Fig. 9.2). The scar had an irregular, uneven surface with a few small pits. The bilateral rectus abdominis muscles were atrophic and were separated in the midline. Umbilicoplasty and scar revision were planned. The ideal position of the navel was determined at the center of the scar. While the scar tissue around the anatomical position of the umbilicus was too rigid to use as a normal flap, a depressed part of the scar with a small pocket seemed available for reconstruction. The shape of the scar pocket was similar to the folds in the umbilicus. Before

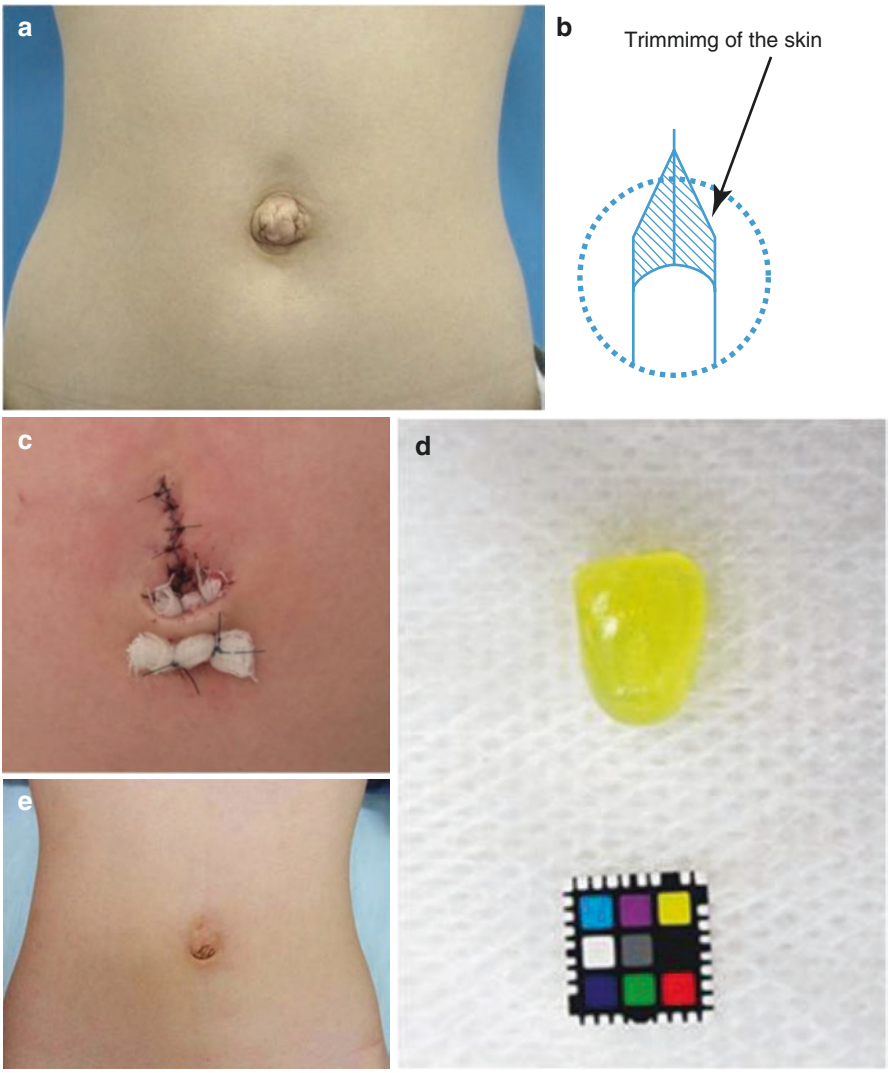

Fig. 9.1 (**a**) Preoperative umbilicus. (**b**) Design of the reverse U-shaped flap for protruding navel. (**c**) Immediately after surgery. Folding the reverse U-shaped flap and fixation of packing to the flap. (**d**) A mold made from Oyumaru (Daiso Japan, Hiroshima, Japan), which is a thermoplastic elastomer. (**e**) Postoperative umbilicus at 6 months

transfer of the island flap, the bilateral anterior sheaths of the rectus abdominis muscles were exposed and sutured together to strengthen the abdominal wall. Then a skin/subcutaneous island flap was designed with a sufficiently long pedicle for transfer to the ideal umbilical position, and the pivot point was set at a site above and lateral to the flap island (Fig. 9.3). Next, the island flap with its pocket was elevated and carefully moved to the correct position (Fig. 9.4).

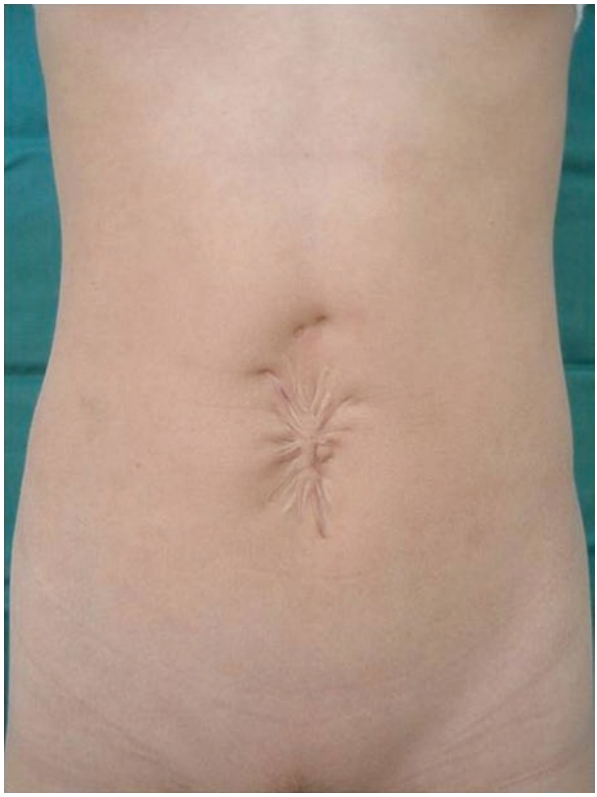

Fig. 9.2 Preoperative umbilicus (Reproduced with permission [5])

The island flap was rolled up to form a cone, and the apex of the cone was fixed to the abdominal wall, after resection of subcutaneous fat at the site of reconstruction to form a deep umbilicus. Anchor sutures were applied to the apex of the flap and 3 sites around the apex (4 sites in total), fixing the flap to the anterior sheath of rectus abdominis as well as forming wrinkles in the umbilical fossa to reproduce the natural shape of the navel. The anchor suture at the apex was used to position the flap and widen the inner cavity of the umbilical fossa.

The side walls of the umbilicus were subsequently reconstructed by tubing the surrounding skin, and the large scar on the abdominal wall was totally revised and approximated to a straight line by W-plasty (Fig. 9.4). The reconstructed umbilicus was continuously compressed with sponges for 6 months after surgery to maintain an adequate depth. Her postoperative course was uneventful. The reconstructed umbilicus remained concave and sufficiently deep due to continuous application of pressure.

We introduced umbilicoplasty using a triangular flap for navel protrusion. The umbilical fossa was maintained by compression using molded thermoplastic elastomer that could be fashioned to an individualized shape.

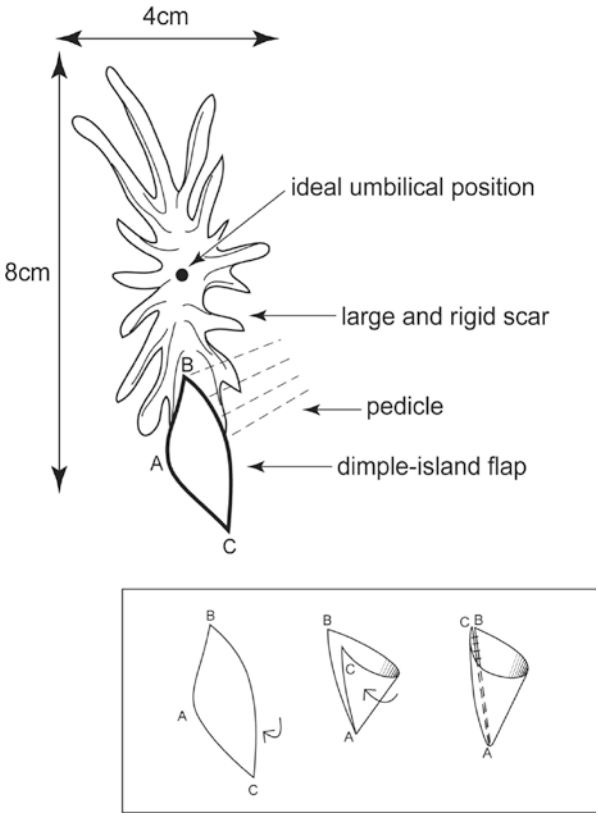

Fig. 9.3 Design of the island subcutaneous/skin flap. After the island flap was moved to the ideal position, it was folded into a cone (Reproduced with permission Kakudo et al. [5])

The other patient underwent umbilicoplasty using a subcutaneous island flap for scarring after umbilical hernia repair. The island flap was rolled into a conical shape, and the apex of the flap was fixed to the abdominal wall to form the umbilical fossa, after resection of subcutaneous fat at the site of reconstruction to form a deep umbilicus. The umbilicus is lost after umbilical hernia repair, and scarring is present, so revision of the scar tissue is necessary in addition to umbilicoplasty.

It is important to design a flap and surgical procedure that correspond to the umbilical deformity and/or defect, as well as taking the extent of scarring into account.

Fig. 9.4 (**a**) Elevating the distant island flap. (**b**) Immediately after surgery. (**c**) Umbilicus at one year after surgery (Reproduced with permission [5])

9.3 Conclusions

We introduced two umbilicoplasty procedures using triangular and subcutaneous island flaps, respectively. A thermoplastic elastomer mold was useful to maintain the umbilical fossa in one patient.

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Part IV
Benign Tumors

Chapter 10
Angiomyxoma: A Rare Tumor of the Umbilical Cord

Hale Göksever Çelik and Murat Celiloğlu

10.1 Introduction

Abnormalities of the umbilical cord are extremely rare. Differential diagnosis includes hematomas, varices, aneurysms, thrombosis, and tumors such as angiomyxoma or teratoma. Although both tumors of the umbilical cord are encountered rarely, angiomyxoma is the most common tumor of the umbilical cord.

Angiomyxoma has been associated with increased perinatal morbidity and mortality. Because of this, recognition and follow-up of this condition are very important.

10.2 Discussion and Technique

The umbilical cord and placenta have an important role in fetal health and development. Cord abnormalities can result in different perinatal complications such as intrauterine growth restriction, small for gestational age, stillbirth, and any cord accidents. Cord abnormalities related to morphology, coiling, placental insertion, number of vessels, diameter, and blood flow pattern can contribute to perinatal complications [1]. Abnormalities of the umbilical cord are extremely rare, but suspicion has a crucial role in diagnosis. Differential diagnosis includes hematomas, varices, aneurysms, thrombosis, and tumors such as angiomyxoma or teratoma. Although

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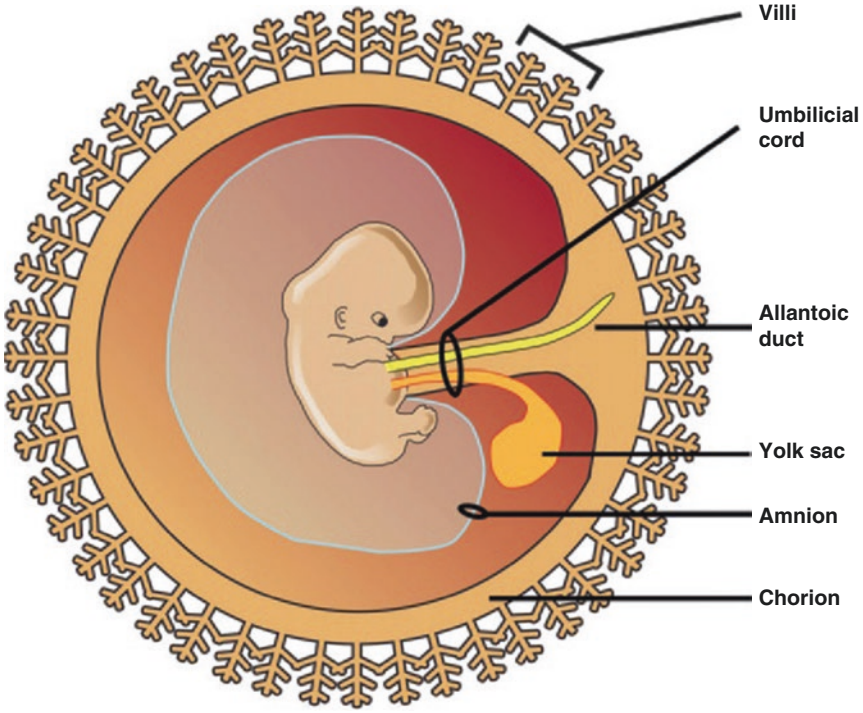

Fig. 10.1 Anatomy of fetus and umbilical cord

both tumors of the umbilical cord are encountered rarely, angiomyxoma is the most common tumor of the umbilical cord.

Umbilical cord starts to develop at approximately 7–8 weeks after conception. Between 12 and 16 weeks of gestation, the allantois or urachus develops as a second outpouching from the primitive gut and projects into the connecting stalk (Fig. 10.1) [2]. The blood vessels of the allantois develop into the two arteries and one vein of the umbilical cord, so umbilical arteries course lateral to the bladder and contiguous with the iliac arteries within the pelvis [3]. Angiomyxoma or hemangioma could arise from these allantoic or omphalomesenteric vessels [4].

Until 8 weeks of gestation, two umbilical arteries and two umbilical veins persist. Then the right umbilical vein regresses, so umbilical cord contains two umbilical artery and one umbilical vein. The umbilical cord vessels communicate with the villi of the placenta and facilitate gas and nutrient exchange.

The normal diameter of the umbilical cord is less than 2 cm. The umbilical cord grows until the third trimester to a length of 50–60 cm and up to 40 helical turns [5]. For normal development of the umbilical cord, there must be adequate amnion fluid and fetal activity.

The umbilical cord is visible at ultrasound by 42 days of gestation and is well established by 8–9 weeks of gestation [5]. Ultrasound image of a fetus between

Table 10.1 Umbilical cord abnormalities and associated pathologic conditions [2]

Type of abnormality	Associated pathologic conditions
Morphology	Coiling, increased thickness, thinning
Insertion	Marginal, furcate, velamentous insertions
Presentation	Vasa previa
In utero distortion	Cord knot, cord torsion, entanglement, nuchal cord
Vascular	Hematoma, varix, aneurysm, thrombosis, single umbilical artery, persistent right umbilical vein
Cord tumor	Hemangioma, teratoma

7 and 12 weeks of gestation shows normal physiologic midgut herniation as a focal echogenic bulge at the base of the umbilical cord. Then this herniated bowel undergoes a 270° turn and returns to the fetal abdomen.

For complete evaluation of the umbilical cord, gray-scale and color Doppler ultrasound is used. Cord abnormalities related with number of vessels, cord coiling, and cord thickness can be evaluated with these techniques. Especially in cases of any abnormalities related with fetus, umbilical cord, or placenta, Doppler evaluation of the umbilical cord blood flow is necessary.

Abnormalities of the umbilical cord are related to its morphology and structure, placental insertion, presentation, in utero distortion, vascularity, and primary tumors or masses (Table 10.1) [2].

Tumors of the umbilical cord are rare anomalies that can be detected prenatally by ultrasound examination. The clinical significance common to all anomalies of the umbilical cord is determined by their size, which can potentially cause vascular compromise and affect fetal growth. After birth, referral of the newborn to a pediatric surgery clinic for revision and correction is mandatory, but not an emergency, because there may be an abdominal wall defect or any other anomalies simultaneously [6]. Associated abnormalities can be exomphalos, umbilical hernia, exstrophy of the bladder, and myelomeningocele with hydrocephalus [7].

Teratomas are the only true neoplasms of the umbilical cord. They are developed from pluri or toti potent cells with diploid chromosome set. They are observed along the whole length of the umbilical cord. They have a polymorphic appearance, with both cystic and solid components. Because of its heterogeneous structure, an angiomyxoma with associated cystic degeneration of Wharton jelly can appear similar to a teratoma [4, 7].

Although both angiomyxoma and teratoma are encountered rarely, angiomyxoma is the most common tumor of the umbilical cord. This tumor has also been termed as myxangioma, hemangiofibromyxoma, myxsarcoma, chorioangioma, and hemangioma [8].

Angiomyxoma is recognized as an abnormal mass which is heterogeneous and composed of solid and cystic areas arising from umbilical cord on ultrasound examination (Figs. 10.2 and 10.3). Macroscopically, this tumor is observed as a mass which consists of solid and cystic components and edematous Wharton's jelly [6].

Fig. 10.2 Umbilical mass

Fig. 10.3 Umbilical cyst

On their microscopic examination, thin-walled capillaries are observed in myxoid stroma. In the vast majority of the cases, one of the umbilical arteries was involved, originating less commonly from veins or both. The tumor is located mostly toward the placental end than the fetal end of the cord [9].

Because of the rarity of the disease, data concerning morbidity, mortality, outcome, and prognosis of the angiomyxoma is limited. Clinical significance depends on impaired umbilical circulation resulting in intrauterine growth restriction and even fetal demise. Angiomyxoma has been associated with congenital anomalies, chromosomal abnormalities especially trisomy 13, intrauterine growth restriction, polyhydramnios, preterm labor, raised maternal serum alpha fetoprotein, severe fetal hemorrhage, and increased perinatal mortality, especially fetal demise. Because of these significant results, recognition and follow-up of this condition are very important.

Follow-up is an important question when this tumor is recognized. As mentioned before, the causal factor for fetal compromise has been accepted as altered umbilical circulation. This deterioration can result from mechanical compression, vascular

stenosis, or even torsion. Doppler flow studies especially systolic/diastolic ratio (S/D) in the umbilical cord segment before and after the tumor as well as within the solid component of the tumor have a significant role in antenatal period [10].

Follow-up is sufficient in most cases because of the location of the angiomyxoma which is located mostly toward the placental end than the fetal end of the cord. Treatment of this tumor has been necessary in antenatal period rarely. If polyhydramnios occurs as a result of the angiomyxoma, serial amniodrainage alone or in association with other techniques such as intratumoral injection of absolute alcohol or coil device or intrauterine blood transfusion can be performed or medical treatment such as indomethacin or digoxin can be prescribed to a mother in order to reduce amnion fluid [11–13]. Also endoscopy-guided ligation of a large feeding vessel and coagulation of the surface of the tumor with bipolar electrosurgery to ablate the remaining blood supply to the tumor can be applied [14]). The other method applied in antenatal period is coagulation of the superficial feeding vessels using a diode laser for permanent devascularization of the tumor [15]. The important thing before application of these techniques is counseling of the couple about possible results.

The umbilicus has a paramount aesthetical function for the abdomen, and its absence or its abnormality could contribute to the development of psychological disorders, especially in childhood. Umbilicoplasty assures a satisfactory anatomical and cosmetic result. For umbilical preservation and recreation, multiple techniques have been published to date for several indications especially in children with huge umbilical hernia or after omphalectomy [16–19]. But in literature, a case in which umbilicoplasty is applied for umbilical angiomyxoma has not defined yet. Because this tumor is located toward the placental end and appearance of the umbilicus is not altered, umbilicoplasty is not needed for this condition commonly.

10.3 Conclusions

Diagnosis and management of the umbilical cord tumors is very important. High perinatal morbidity and mortality can be encountered if it is not detected. Because of these significant results, suspicion and follow-up are lifesaving.

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Part V
Exstrophy

Chapter 11
Introduction to Abnormalities of the Umbilicus in the Infant

Melvin A. Shiffman

11.1 Introduction

There are many causes of umbilical abnormalities and loss in the pediatric age group. Large hernias [1–9] can be a problem as well as congenital disorders, infection, tumors, and trauma. It is important for the pediatric surgeon to know at least some of the methods for treating the abnormal or absent umbilicus.

11.2 Position of the Umbilicus

The normal position of the umbilicus in the infant is about 60 % of the distance from xipho-sternum and pubis [10, 11]. In the child, the umbilicus is a little lower than in the adult [12]. Once a child reaches puberty, the umbilicus is in the position of the adult at the approximate level of the iliac crests.

Puberty is the period or age at which a child's sexual and physical characteristics mature and full height is reached. Puberty begins in the female at age 8–11 and male at age 9–12 [13]. Adolescence is the period between puberty and adulthood.

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11.3 Bladder Exstrophy (Ectopia Vesicae)

This is a congenital anomaly that exists along the spectrum of the exstrophy-epispadias complex and most notably involves protrusion of the urinary bladder through a defect in the abdominal wall [14]. The usual presentation is:

1. A defect in the abdominal wall occupied by both the exstrophied bladder and a portion of the urethra
2. A flattened puborectal sling
3. Separation of the pubic symphysis
4. Shortening of the pubic rami
5. External rotation of the pelvis

Repair of exstrophy and reconstruction of the neoumbilicus have been reported [15–25].

11.4 Omphalocele (Exomphalos)

Omphalocele is herniation of some of the intra-abdominal contents through the open umbilical ring into the base of the umbilical cord. It involves the umbilical cord itself. The protrusion is covered by an avascular membrane consisting of peritoneum inside and amniotic membrane outside separated by a thin layer of Wharton jelly. With the defect is a type of abdominal wall defect in which the intestines, liver, and occasionally other organs remain outside of the abdomen in a sac because of a defect in the development of the muscles of the abdominal wall [26, 27].

Associated conditions include Wharton jelly; chromosomal abnormality; cardiac, macrosomia, cryptorchidism, and gastroesophageal reflux disease; and musculoskeletal and neural tube defects.

There are reports of reconstruction of a neoumbilicus in patients with omphalocele (exomphalos) [28–43].

11.5 Gastroschisis

Gastroschisis represents a congenital defect characterized by a defect in the anterior abdominal wall through which the abdominal contents freely protrude [44, 45]. There is no overlying sac, and the size of the defect is usually less than 4 cm (1.6 in). The abdominal wall defect is located at the junction of the umbilicus and normal skin and is almost always to the right of the umbilicus.

Associated conditions include intestinal atresia, small for gestational age, prematurity, gastroesophageal reflux disease, and cryptorchidism.

Neoumbilicoplasty has been reported in the treatment of gastroschisis [46–49].

11.6 Urachal Pathology

Failure for the lumen of the urachus to be filled in leaves a patent (open) urachus. The telltale sign is leakage of urine through the umbilicus. A patent urachus needs to be surgically removed. There are four anatomical causes:

1. Urachal cyst: there is no connection between the bladder and the umbilicus.
2. Urachal fistula: there is free communication between the bladder and umbilicus.
3. Urachal diverticulum [Vesicourachal diverticulum]: the bladder exhibits out-pouching [50].
4. Urachal sinus: the pouch opens toward the umbilicus [51].

Resection of urachal pathology and neoumbilicoplasty has been reported [52–57].

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Chapter 12
Construction of a Naturally Looking Inverted Umbilicus for Bladder Exstrophy

Valeria Solari and Raimondo Maximilian Cervellione

12.1 Introduction

An attractive umbilicus is a key aesthetic component of the abdominal wall. Its absence or disfigurement is cosmetically and psychologically distressing to the patient and his/her parents and challenging for the surgeon. In modern times, the umbilicus is regarded as a fitness sign in humans [1] and has an important role within plastic and reconstructive surgery. The complexity or the lack of a universally adequate procedure is demonstrated by the multiple surgical techniques available for reconstruction.

The umbilicus is connected to vestigial structures that become inert ligaments. The round ligament of the liver exerts a superior trajectory contractile force which is opposed to the median and medial umbilical ligaments [2]. The cosmetically appealing upper hooding of the umbilicus is the result of this superior force and gravity.

Several factors are important for an aesthetically pleasing umbilicus. Because of the wide range of normal variations, determination of what makes a normal umbilicus is difficult [3]. The normal position is commonly described as being near the midline with the horizontal level at the iliac crest [4]. In newborns and young children, it is slightly at a lower level due to a different developed pelvic region [5]. Generally a T-shaped or hooded oval belly button is found attractive [6, 7].

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12.2 Anatomy in Bladder Exstrophy

In bladder exstrophy (BE), the umbilical cord when it separates does not leave a normally looking umbilicus and an umbilico-neoplasty; a de novo creation is required.

In BE, the umbilical cord is attached to the upper border of the exstrophic bladder plate and is typically located more caudally than in normal infants. This indicates that a simple cranial reposition of the cord is not feasible as previously suggested [8] and the reconstruction of a totally absent umbilicus is needed for good cosmesis.

Since the development of BE repair, a few umbilicoplasty procedures have been described; however, no single method has been satisfactory often leaving a flat or a very long scar with poor long-term result [8–12].

We describe a simple surgical technique that has allowed the reconstruction of a more naturally looking inverted umbilicus with a normal-looking superior hooding and minimal scarring [13]. The procedure has been the procedure of choice at our institution because of its good to excellent long-term results after the initial exstrophy reconstruction or at the time of additional reconstruction for patients who had other type of umbilicoplasty during the newborn period.

12.3 Operative Technique

At the apex of vertical midline wound, the skin and superficial fascia are elevated off the anterior rectus sheath for 3–5 cm above the apex of the skin incision (Fig. 12.1). When the bladder plate is small, the incision can be extended to place the umbilicus in a more physiological cranial position. The most superior apex of the wound is sutured to the linea alba at as high point as possible, thereby inverting the skin and fixing it to the sheath. Two 1.0×0.5 cm skin flaps based superiorly are cut from the margin of the inverted skin. The flaps are rotated medial and sutured to the linea alba to form the base of the new umbilicus. The superficial fascia inferior to the umbilicus is opposed to create fullness of the lower umbilical lip, and the skin edges are approximated. The cosmetic result was excellent and durable (Figs. 12.2, 12.3, and 12.4).

In general, the authors advocate this method for umbilical neo-reconstruction in BE as this is rather simple and quick and has a consistent good cosmetic result (by both surgeons and patients/parents). Additionally, this method avoids the frequent complication of necrosis when using a flap technique.

From 2007 to 2014, 44 babies with classic bladder exstrophy had their umbilicus reconstructed adopting the “Manchester umbilicoplasty.” None of the patients had dehiscence of the reconstruction. The follow-up of the patients demonstrated a durable result which represents a significant improvement compared to the technique previously used which usually left a flat scar rather than an umbilicus.

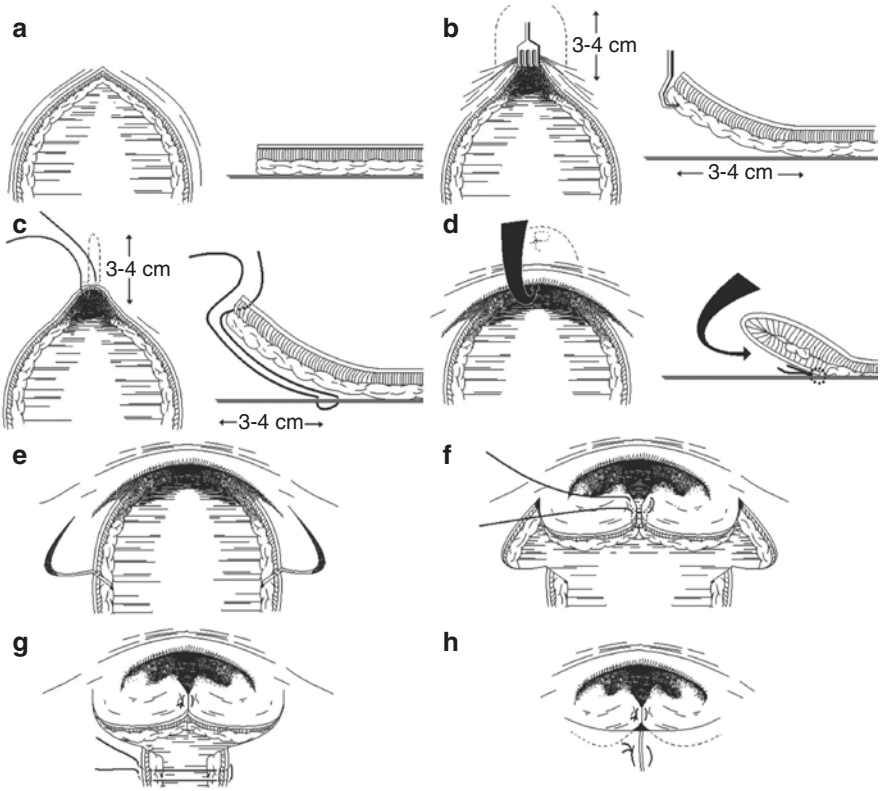

Fig. 12.1 (**a**–**h**) Main surgical steps in inverted umbilical reconstruction

Fig. 12.2 Immediately after the reconstruction

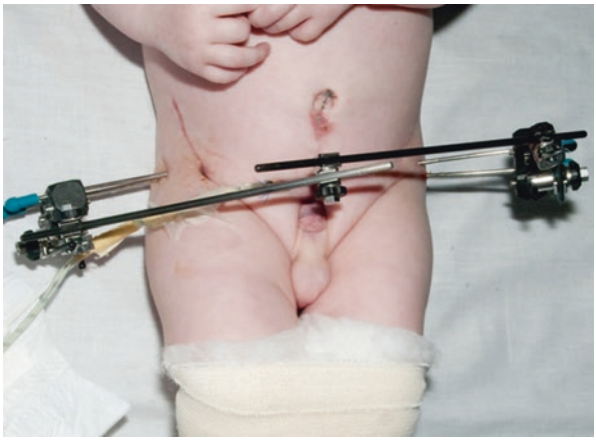

Fig. 12.3 Three weeks after the reconstruction

Fig. 12.4 Two years after the reconstruction

12.4 Discussion

Delayed BE closure leaves an abnormal-looking umbilicus, and the cosmetic sequelae are significant and deforming. Unlike the many umbilical reconstruction reported in the literature, the management of an absent navel in BE requires a different surgical approach that takes in consideration the specific anatomy and the growing patient for good long-term results. Several umbilical reconstructions for BE resulted often in a disruption of the natural contours and appearance. In the pediatric population, it has been particularly difficult to obtain sufficient depth due to a lack of skin laxity resulting in a flat scar. Numerous techniques documented in the literature include the reconstruction of a new umbilicus in BE with a flap and the use of the new navel as a site for temporary urinary diversion.

In 1986, Hanna [8] described preservation and reposition of the umbilicus during primary BE surgery. Our experience with this approach is that it leaves a flattened umbilicus with a poor patient satisfaction. Feyaerts et al. [9] proposed the

kangaroo pouch technique for umbilical reconstruction. In this technique, the umbilical depth is maintained permanently without the need for stent placement in the postoperative period. However, this method is indicated only for secondary delayed reconstruction of the umbilicus and does not produce the protuberant round periphery of the natural inverted umbilicus. Sumfest and Mithcell [10] described the only technique that creates a protruded periphery. Their technique is especially indicated when a urinary catheterizable stoma is required. Additionally the new umbilicus is located lateral to the midline, and the technique is described only in young children without reports in newborns. Barroso et al. [11] described a method of umbilical reconstruction in conjunction with a Mitrofanoff procedure. Their functional umbilicus does not have a protruding periphery and leaves a flat and unnatural-looking navel. The gold standard procedure for umbilical reconstruction in BE has been described by Hanna and Ansong [12]; this is the only report on a larger series of patients with long-term results. This procedure requires the use of a postoperative stent for inward umbilical projection, and the lips do not protrude as in a normal navel. Additionally, the results are dependent of the thickness of the subcutaneous fat.

Recently, Featherstone and Cuckow [14] described the spiral rotational flap that uses a tabularized skin flap with a wide width-to-length ratio. This procedure utilizes the incision for the primary closure of the bladder, and the flap is rotated and sutured spirally around the ureteric stents.

12.5 Conclusions

The authors' technique is safe, easy to perform, and complication-free and results in an adequately sized umbilicus. Importantly, this method can be performed in a flat abdominal wall without any remaining umbilical tissue yielding a nice superior hooding with a minimal external scar. Overall we recommend this procedure in BE patients as it provides a good to excellent umbilical reconstruction in the vast majority of the patients after both initial exstrophy reconstruction and after revision umbilicoplasty.

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Chapter 13
Tubularized Trapezoid Flap Neoumbilicoplasty: Simple Technique for Umbilical Reconstruction in Bladder Exstrophy

Shiv N. Kureel, Archika Gupta, and Apala Priyadarshini

13.1 Introduction

Surgery of exstrophy-epispadias itself is challenging and demands complete awareness of surgical anatomy [1, 2] and acquaintance with details of all the techniques of reconstruction with precision of surgical craftsmanship [3–6]. Satisfaction of successful reconstruction of the bladder, urethra, and sphincters, restoration of the pelvic ring, epispadias repair, and repair of abdominal wall defect remains incomplete and eclipsed if finished reconstruction is associated with flat anterior abdominal wall without the umbilicus (Fig. 13.1). Surgeons have attempted many techniques to reconstruct the umbilicus with reconstruction of exstrophy [7–14]. A very simple practice of exiting all the catheters through the proposed site of the umbilicus subsequently leaves merely a spot of scar without giving the look of the umbilicus (Fig. 13.1). The other elaborate techniques of umbilicoplasty are complex [7–9, 11, 12, 14] and may not be adopted and reproduced by all surgeons involved in exstrophy reconstruction. The technique of tubularized trapezoid flap neoumbilicoplasty is not only simple and easily reproducible but, if used with reconstruction of exstrophy, the technique rather than imposing additional exercise actually facilitates the main procedure of bladder plate mobilization [15]. After raising the flap since the very beginning, access to the linea alba is obtained through which preperitoneal plane is entered. No major loss is encountered even if dehiscence of umbilicoplasty repair occurs because redo umbilical repair is feasible at the same site with the same technique after 6 months.

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Fig. 13.1 Showing exstrophy reconstruction without umbilicoplasty

13.2 Technique

13.2.1 Indications

Tubularized trapezoid flap neoumbilicoplasty can be combined with surgery of bladder reconstruction either as a part of staged procedure of modern staged reconstruction of exstrophy (MSRE) [3] or with complete penile disassembly [4] or with the single-stage total reconstruction with innervation preserving sphincteroplasty (SSTR-IPS) [6]. It can also be done in cases of redo exstrophy repair.

13.2.2 Marking of Incision

Proposed level of the umbilicus is mapped by drawing a transtubercular transverse line on anterior abdominal wall. The point of crossing the midline becomes the future site of the neoumbilicus, and the base of trapezoid flap corresponds to the transtubercular line. At the level of transtubercular line over the midline, the skin is gently pinched up between the index finger and thumb to get a rough estimate of loose skin available to decide about the width of umbilicoplasty flap which is marked on both sides of the midline. Keeping the ratio of 3:1 between the width and length, the trapezoid flap is marked at the midline as shown in Fig. 13.2. Distal to the trapezoid flap midline incision line is marked up to the margin of the bladder plate.

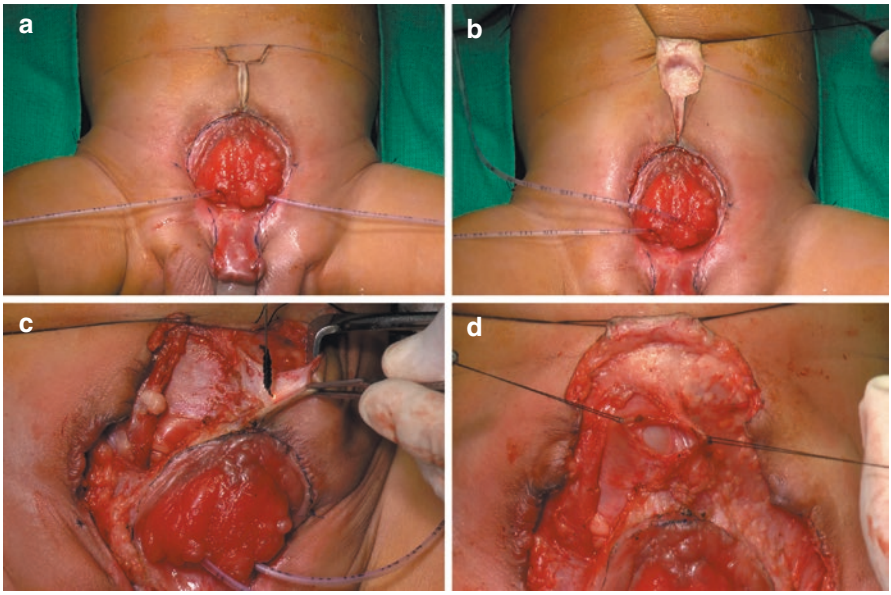

Fig. 13.2 (**a**) Marking of trapezoid-shaped incision for umbilicoplasty keeping the ratio of width and length to 3:1 and base of the flap corresponding to the transtubercular line. (**b**) Raising of trapezoid flap off the linea alba in the plane deep to the Scarpa's fascia maintaining its random pattern vascularity. (**c**) Dissection done in prefascial plane by remaining just on anterior rectus sheath for vesico-cutaneous disconnection. (**d**) Access to preperitoneal plane facilitating bladder plate mobilization off the bifurcated recti

13.2.3 Procedure

With fine needle tip cautery, keeping the intensity to minimum sufficient to cut the skin with a blend of coagulation, the skin is incised along the trapezoid flap margin and midline up to the bladder plate. The trapezoid flap held in stay sutures is dissected off the linea alba keeping the plane of dissection on the anterior rectus sheath and lifting the Scarpa's fascia and subcutaneous fat with the trapezoid flap to maintain its random pattern vascularity (Fig. 13.2). The exposure obtained by lifting the trapezoid umbilicoplasty flap and supravesical linea alba is used for prefascial (just on anterior rectus sheath) dissection to affect vesico-cutaneous disconnection for bladder plate mobilization (Fig. 13.2).

Superior to the bladder plate, the linea alba is exposed which tends to bifurcate following deviation of the rectus as we approach toward the bladder plate. By incising the linea alba off the midline, but medial to the edge of recti, preperitoneal plane is entered which is easily insinuated with a pack of moist gauze tip up to the pubic bone, and it facilitates disconnection of the bladder plate off the bifurcated recti (Fig. 13.2). After reconstruction of the bladder and approximation of the linea alba, the lower abdominal skin crease is aligned. The trapezoid umbilicoplasty flap is tubularized over vesicostomy catheter drain using an interrupted absorbable 5–0

polyglactin suture. Interrupted suture approximating the base of trapezoid flap is kept stronger using 2–0 polyglactin suture to provide additional support against dehiscence (Fig. 13.3).

As a preventive measure to prevent dehiscence, the disparity between caliber of vesicostomy catheter and width of the flap has to be prevented as premeditated plan.

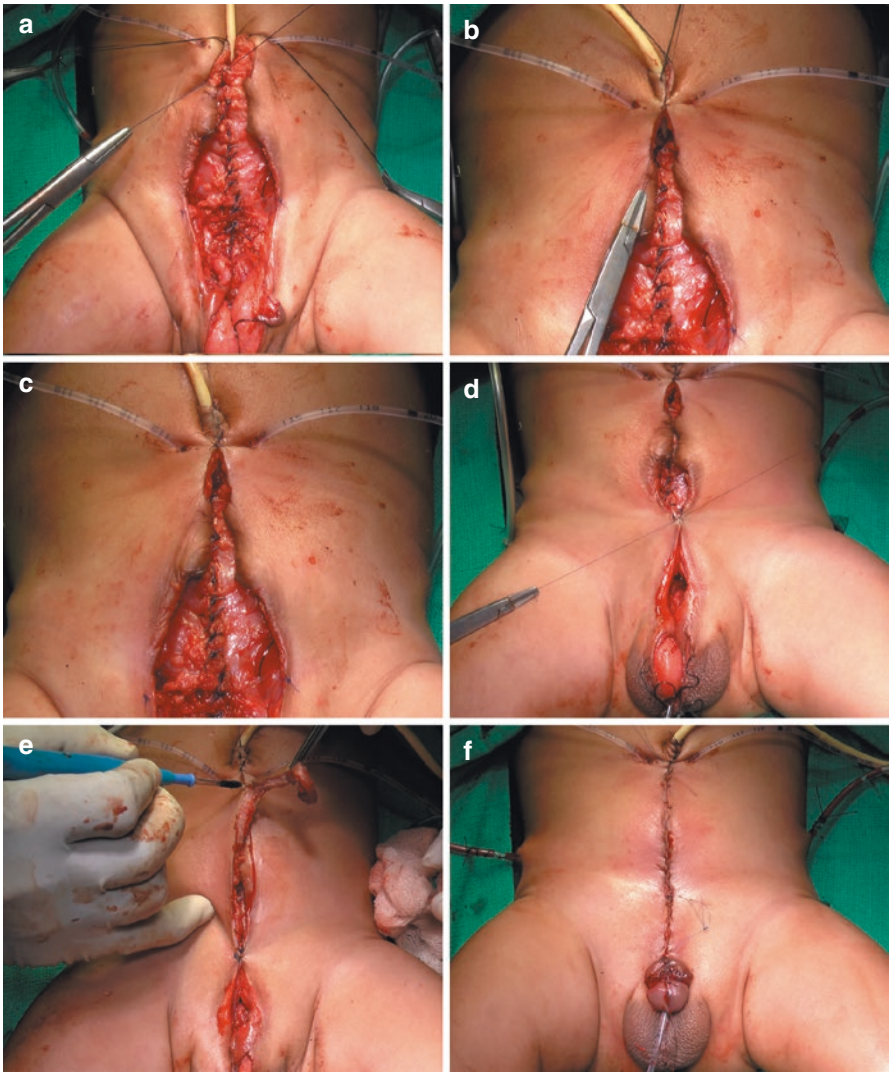

Fig. 13.3 (**a**) Linea alba approximation around vesicostomy catheter. (**b**) Approximation of the base of trapezoid flap with absorbable polyglactin suture. (**c**) Tubularization of the flap completed with absorbable polyglactin suture for umbilicoplasty. (**d**) Approximation of the lower abdominal skin crease. (**e**) Excision of excess skin for midline skin and subcutaneous tissue approximation. (**f**) Completed repair with well-reconstructed tubularized trapezoid flap umbilicoplasty

If the width of the flap is short and catheter is thick, tubularization under tension is likely to fail inviting dehiscence.

13.2.4 Postoperative Care

No special postoperative care or compression dressing is needed. Dressing to ensure proper fixation of vesicostomy catheter exiting through the trapezoid flap to prevent traction on suture line is a very important measure to prevent umbilicoplasty dehiscence. At our center, vesicostomy catheter is removed at 21 days which leaves umbilicoplasty tube as similar to the stump of the umbilical cord. After 6 weeks with further healing, the umbilical button is automatically formed (Fig. 13.4).

Fig. 13.4 (**a–d**) Near normal look of neoumbilicus after 6–12 weeks of healing of reconstructed tubularized trapezoid flap umbilicoplasty

13.3 Discussion

The technique of tubularization of trapezoid flap over the vesicostomy catheter without making any attempt to create dimple or fascial anchoring was conceptualized by the author in 2002, and experience with 36 patients (23 boys and 13 girls) was published in 2009 [15]. Today with experience of 131 patients of exstrophy (105 boys and 26 girls), the strength and weakness of the technique have become more evident. The greatest strength of the technique has been its simplicity and easy reproducibility. The most significant weakness of the technique is that dehiscence and automatic returning back to natural position is almost certain if certain precautions are not taken (Fig. 13.5). These precautions are (1) the creation of precise width of flap with prefascial mobilization of lateral abdominal wall skin with subcutaneous fat and Scarpa's fascia to ensure tension-free midline closure with tension-free approximation of the base of flap as the beginning point of tubularization, (2) use of stronger approximating suture at the base of flap which is the point of greatest tension, (3) use of adequate caliber vesicostomy catheter for tubularization of flap taking precaution not to use a large caliber catheter, and (4) raising flap with inclusion of subcutaneous fat and Scarpa's fascia for the maintenance of random pattern vascularity. Our database shows that despite taking these precautions, there is 10 %

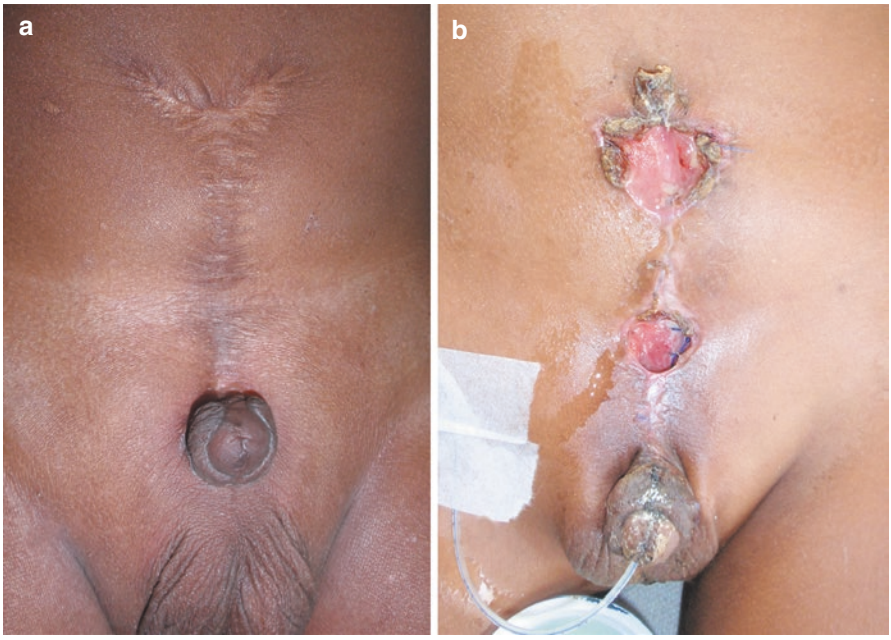

Fig. 13.5 (**a**) Dehiscence. (**b**) Automatic returning back of tubularized trapezoid flap umbilicoplasty to natural position

dehiscence rate of umbilicoplasty flap. But the saving grace is that nothing is lost except that revision umbilicoplasty is planned after 6 months. Revision umbilicoplasty done in seven patients so far has not failed. We make no attempt to anchor it to underlying fascia or create a dimple. It automatically forms. We have not used this technique as Mitrofanoff channel in cases of augmentation cystoplasty. The use of neoumbilicus for concealment of Mitrofanoff stoma has been reported [16, 17].

13.4 Conclusion

The technique of tubularized trapezoid flap neoumbilicoplasty is a useful tool in the armamentarium of a reconstructive surgeon to create aesthetically satisfactory neoumbilicus with the reconstruction of exstrophy-epispadias. It can be adopted for its simplicity and reproducibility without significant complications.

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Chapter 14
Umbilicoplasty for Bladder Exstrophy

Moneer K. Hanna

14.1 Introduction

The umbilicus is a functionless depressed scar, but it is the only scar which has natural aesthetic importance. It marks the waistline and serves to complete the harmony of the curved lines above and below and represents an important visual landmark. The absence or deformity of the navel may be associated with poor self-image. In patients born with bladder exstrophy, the umbilicus is attached to the upper margin of the bladder, and reconstructive surgery of the urinary tract often removes the navel. The importance of achieving urinary continence and preservation of renal function in patients born with bladder exstrophic anomalies resulted in concentration of attention on the urinary tract. Regardless of whether staged functional reconstruction or urinary diversion is chosen, the genital tract and abdominal wall must be reconstructed. Long-term follow-up revealed that many of these patients suffered from poor self-image, as the aesthetic aspects of the genitalia and lower abdomen acquire greater importance during adolescence and adulthood [1, 2]

14.2 Technique

Herein is a surgical method which is simple yet successful for reconstruction of the umbilicus first reported in 1984 [3]. The technique was based on the surgical principle of eventual tubularization of a skin strip when buried in the subcutaneous space acting as a backing for a suprapubic cystotomy tube and ureteral stents placed

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during bladder repair. Early on the umbilical position was marked at the above level of iliac crests. The newborn umbilical stump was excised, and then a V-shaped flap with a base of approximately 2 cm was raised, sutured to the rectus sheath, and buried subcutaneously. The cystotomy and ureteral drainage tubes exited anterior to the skin flap. Eventually the skin flap became a tube around the cystotomy drainage catheter, and the cicatrix formed the umbilical dimple. This method necessitated constant packing and dressing with iodoform gauze for 4–6 weeks.

Subsequently, the technique evolved into tubularization of a U-shaped skin flap 2–3 cm wide and 2 cm long depending on the patient size, rather than the buried skin strip method. A rubber tube is placed inside as a stent for 2 weeks to maintain inward neo-umbilical projection (Fig. 14.1). This technique allows healing by primary intention and is preferred to the former method in which healing is by secondary intent. In neonatal repair of bladder exstrophy, the skin tube houses the drainage tubes (Fig. 14.2).

Revision umbilicoplasty involves reoperation using the same technique; however, daily maintenance for 4 weeks with a Q-tip applicator is recommended.

Between January 1980 and December 2015, the author has operated on 178 patients born with epispadias, bladder exstrophy, and cloacal exstrophy. In cases of primary repair, the above surgical techniques were utilized in all. In secondary repair of the urinary tract for correction of urinary incontinence and in secondary repair of the genitalia, creation of a neo-umbilicus was almost always incorporated in the design of the surgical incision and approach.

Pinto [4] reviewed the records of this author of 69 children who underwent umbilical reconstruction between 1980 and 1999. Thirty-five patients had primary reconstruction, the majority of whom were newborns was performed. Thirty-four older children and young adults had had their initial repair elsewhere and were subsequently referred for secondary surgery, including bladder augmentation, continent diversion, genitoplasty, etc. Neoumbilicoplasty was done in all of the former and in 30 of the latter 34 cases.

Early results were available in all 69 patients, and long-term follow-up of more than 1 year was available in 48. As described by the surgeon, early results were excellent or good in 62 of 65 patients who had had their reconstruction by us, while the results in the other four who underwent umbilicoplasty elsewhere were satisfactory. In the three cases deemed unsatisfactory, the neo-umbilicus appeared flat and had lost depth. Of the 48 patients in whom long-term results were available at the time of review, 43 had an excellent or good outcome, 2 required revision to correct an off-center umbilicus, and 3 underwent repeat umbilicoplasty for correction of an umbilicus that lost depth (Fig. 14.3). The best cosmetic results were achieved in patients with a relatively thick layer of subcutaneous fat (Figs. 14.4 and 14.5). In thin children with little subcutaneous fat, the umbilicus may lose some depth, resulting in suboptimal cosmesis. Nevertheless, patients and parents were generally pleased with the umbilical appearance even when the surgeon was not. Since that

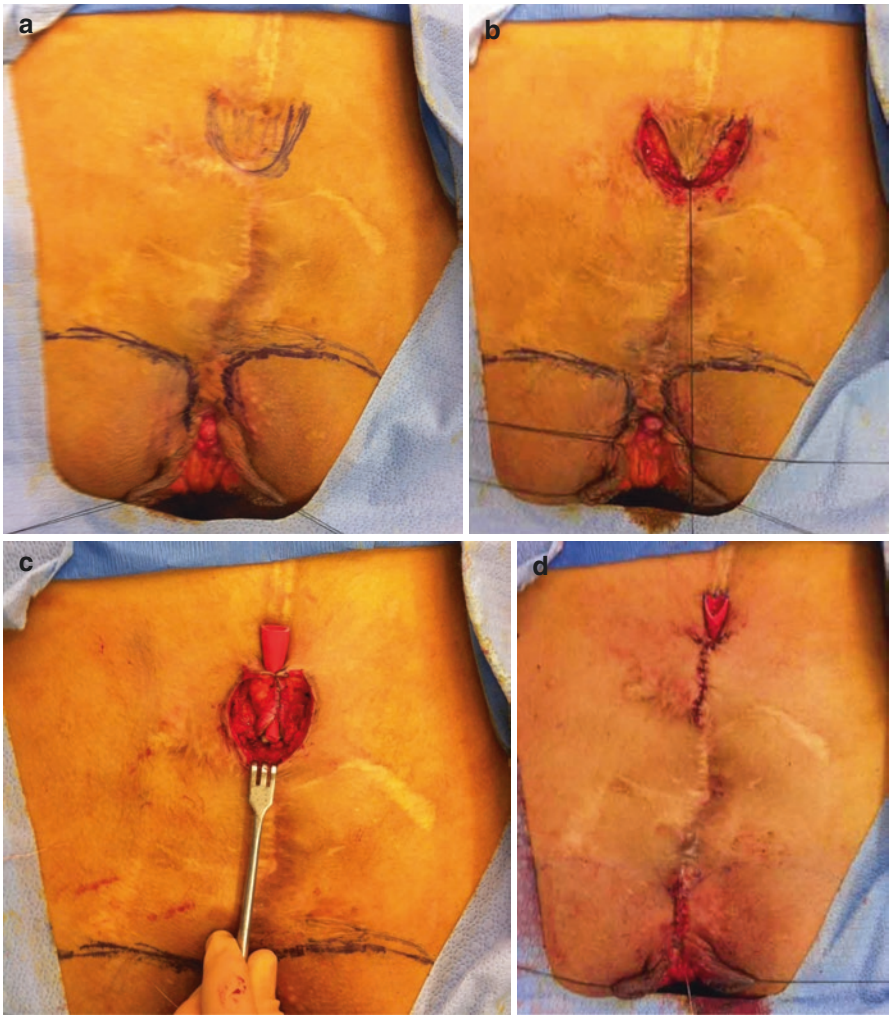

Fig. 14.1 A 16-year-old with bladder exstrophy had multiple unsuccessful surgeries referred for continent urinary diversion, genitoplasty, puboplasty, and umbilicoplasty. (**a**) Marking a U-shaped flap above the level of iliac crests. (**b**) Skin flap is raised. (**c**) The flap is tubularized around a stent. (**d**) Apex of the skin tube is sutured to the rectus sheath. (**e**) Completed umbilicoplasty and contouring of the mons pubis

review, I have noted the durability of the reported surgical technique, and it seems to have stood the test of time (30 years) in cases who continued their follow-up. Furthermore, I used the same technique in cases of abdominoplasty for prune belly syndrome and patients who had repair of omphalocele with successful outcome.

Fig. 14.2 (**a**) Newborn male with bladder exstrophy. (**b**) Completed repair and the tubed U-shaped flap housed the urinary drainage tubes. (**c**) 6 weeks postoperatively

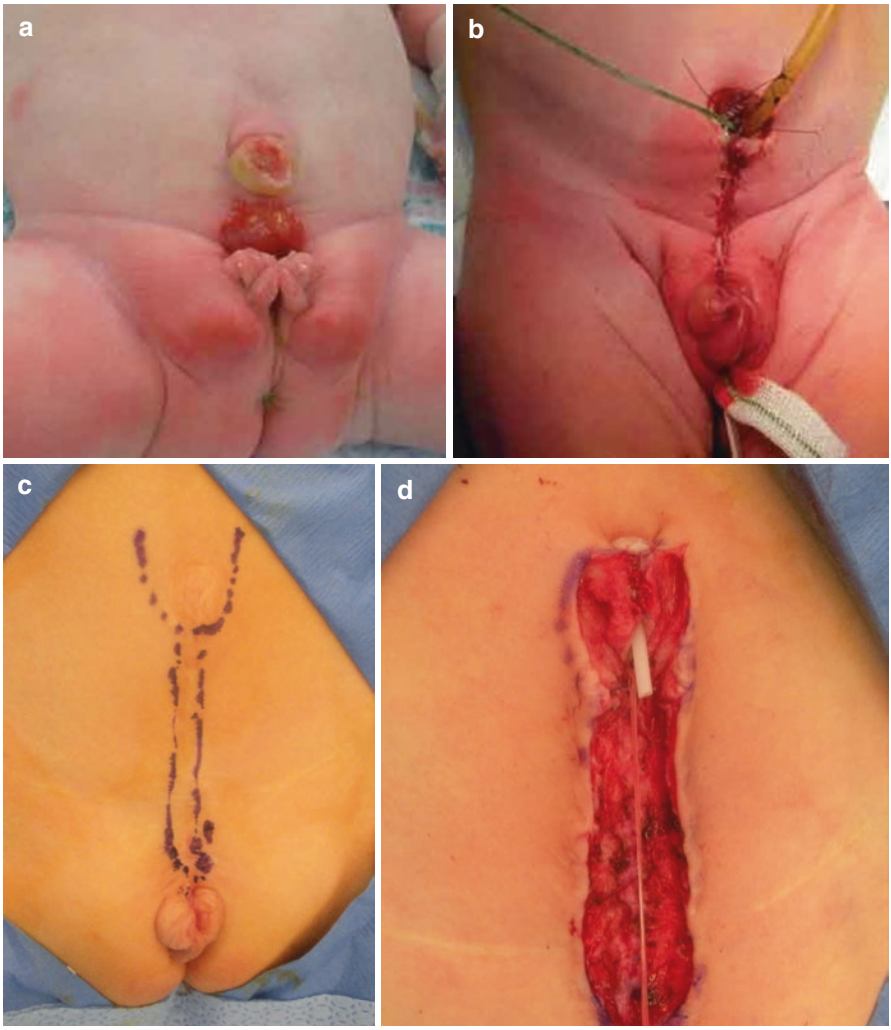

Fig. 14.3 (**a**) Newborn female with bladder exstrophy. (**b**) Following reconstruction of the bladder, urethra, abdominal wall, and umbilicoplasty. (**c**) 3 years postoperative, the umbilicus is flat and lost its depth. (**d**) Repeat umbilicoplasty using a stent

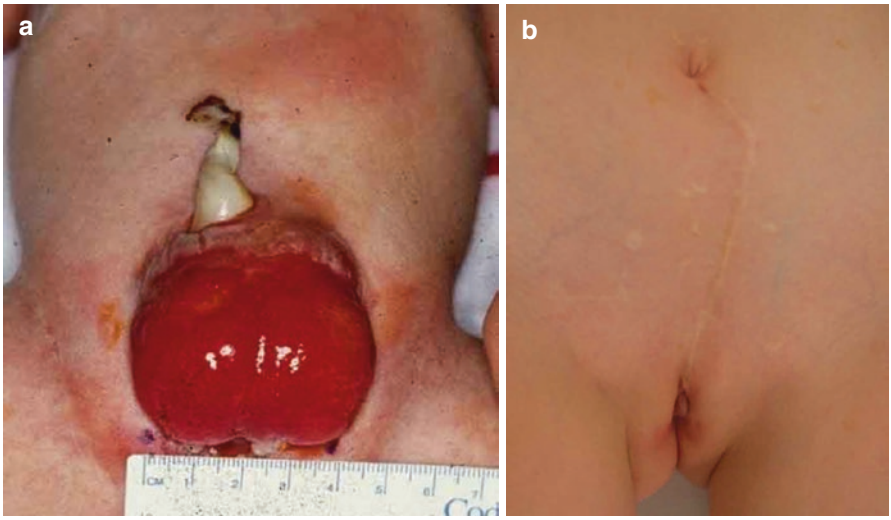

Fig. 14.4 (**a**) Newborn female with bladder exstrophy. (**b**) 11 years post-umbilicoplasty

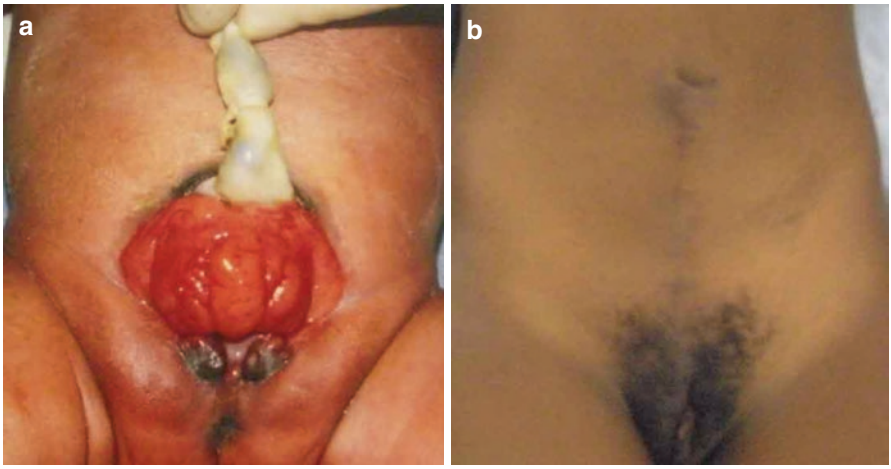

Fig. 14.5 (**a**) Newborn female with bladder exstrophy. (**b**) 18 years post-staged reconstruction including augmentation of the bladder with cecum and repair of the abdominal wall and mons pubis (puboplasty), genitoplasty (fusion of bifid clitoris), and umbilicoplasty

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Part VI
Gastroschisis (Omphalocele)

Chapter 15
Anatomical Localization of the Umbilicus and Omphaloplasty Techniques

Stefan Danilla and Ekaterina Troncoso

15.1 Introduction

The umbilicus is a natural scar where the umbilical cord was placed during the fetal period. It is essential for the natural look of the abdomen and for the contour of the body, since it helps to define the abdominal sulcus. The absence or misplace of the umbilicus may lead to an unnatural appearance, and it may be associated with emotional changes [1]; therefore it is very important for the plastic surgeon to correctly position the neoumbilicus when performing body contouring procedures or when the surgeon must create a new umbilicus.

15.2 Embryology

By the end of third week of the development, the embryo is attached to the placenta via a connecting stalk. During the fifth week of the embryologic development, the junction between the ectoderm and the amnios (known as the primitive umbilical ring) contains the allantois, two umbilical arteries and one vein, the vitelline duct, and a canal which connects the intra- and extraembryonic coelomic cavities. By the tenth week, the gastrointestinal tract has developed and protrudes through the umbilical ring to form a physiologically normal herniation into the umbilical cord. Normally these loops of bowel retract by the end of the third month. The allantois

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and the vitelline duct obliterate leaving only the umbilical vessels surrounded by Wharton's jelly in the umbilical cord [2, 3].

At birth the umbilical cord is ligated, and between the fifth and fifteenth day after the birth, it falls leaving a scar, that is the umbilicus.

15.3 Blood Supply of the Umbilicus

The blood supply of the umbilicus comes from the subdermal plexus, from three different sources. The principal supply is from branches originated in the right and left deep inferior epigastric arteries that ascend between the rectus muscle and the posterior rectus sheath on their way to the umbilicus. The additional flow is from the *ligamentum teres* and the median umbilical ligament [4, 5]. The venous drainage flows upward to the thoracoepigastric and lateral thoracic veins and downward to the great saphenous vein. Subcutaneous veins near the umbilical anastomosis with the portal system by branches along the *ligamentum teres*, generate portocaval anastomosis at this level [4]. The lymphatic drainage flows into the axillary nodes and superficial inguinal nodes.

15.4 Anatomical Localization of the Umbilicus

Classical anatomical texts describe the umbilicus at the midline, between the third and the fourth lumbar vertebrae [1, 4, 6]. This description is not useful in clinical settings; therefore, many authors have attempted to describe the right position of the umbilicus using the umbilical pedicle, the waistline, the xipho-sternum, the pubic tubercle, and the iliac crests as landmarks.

In the horizontal plane, the anatomical texts and first publications on abdominoplasty position the umbilicus in the midline, judged by the pubis and xipho-sternum. The findings of Rohrich et al. [7] suggest that in the normal position of the umbilicus according to 116 standardized photographs of female patients, in which 114 of the cases were included, the umbilicus was located lateral to the midline. Our findings suggest that it is more common for the umbilicus to be located in a slightly right position, then in a left position, and then in the midline. This finding is important to assess to the patient prior to surgery.

In the vertical plane, there has been more controversy. Vernon described the new position of the umbilicus when performing a lipectomy, simply upward in the midline [1]. Trying to achieve a more accurate description, Dubou [8] measured the location of the umbilicus in 100 randomly selected nonobese subjects and discovered that the umbilicus transects, in 96% of the subjects, a line drawn from the highest level of the crest of one ilium to the other.

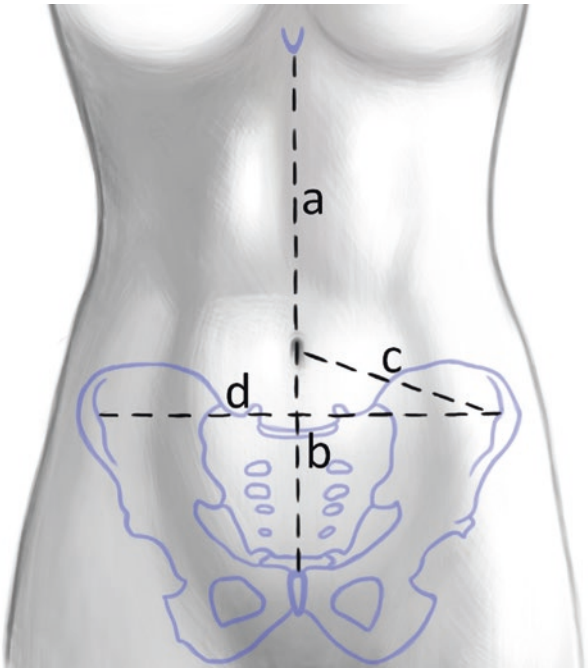

Fig. 15.1 (**a**) Distance between the xipho-sternum and the umbilicus. (**b**) Distance between the umbilicus and the pubic symphysis. (**c**) Distance between the anterior superior iliac spine and the umbilicus. (**d**) Inter–anterior superior iliac spine distance

An Indian study included 75 female young healthy volunteers, nulligravid and nulliparous, without history of abdominal operations, and measured the distances between the abdomen landmarks (Fig. 15.1). They found that the distance between the xipho-sternum and the umbilicus (a) – distance between the umbilicus and the pubic symphysis (b) – had a relation of 1.6:1. The distance between the umbilicus and the anterior superior iliac spine (c) – the distance between both the anterior superior iliac spines – had a ratio of 0.6:1 (d). And the distance between the umbilicus and the anterior superior iliac spine (c) – distance between the umbilicus and the pubic symphysis – had a ratio of 0.9:1 (b) [9].

Furthermore, our group using this data found that the distance between the xipho-sternum and the umbilicus can be very accurately predicted by the following equation:

$Xu = -2.32 + 0.91\ Xp - 0.07H$ (Fig. 15.2)

where Xu is the distance between the xipho-sternum and the umbilicus, Xp is the distance between the xipho-sternum and the pubic symphysis, and H is the patient height, all measured in centimeters [10].

When performing an abdominoplasty, Hoyos [11] recommended that the position of the neoumbilicus is slightly higher for a better appearance, since it would be further apart from the abdominoplasty scar.

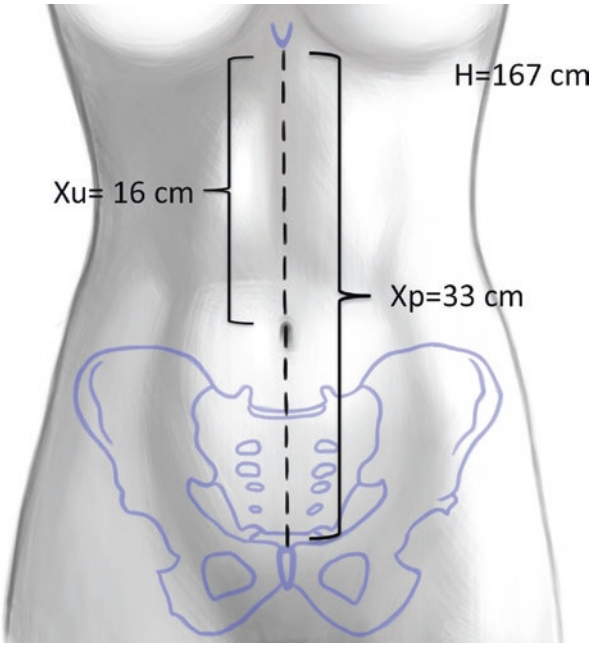

Fig. 15.2 Xu is the distance between the xipho-sternum and the umbilicus, Xp is the distance between the xipho-sternum and the pubic symphysis, and H is the patient height, all measured in centimeters [10]

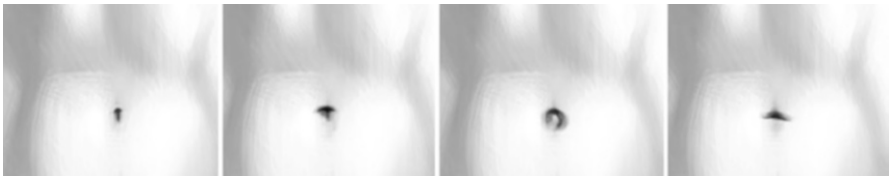

Fig. 15.3 Different shapes of the umbilicus. (*Left*) The most aesthetically pleasing umbilicus is small and T in shape and possesses a small superior hood

15.5 Aesthetics of the Umbilicus

The appearance of the umbilicus alters with age, abdominal fat, weight fluctuations, pregnancies, hernias, and abdominal surgeries [12]. In the standing position, it has a minor inferior inclination and a small superior hood that changes position because of gravity [12]. Its average dimension is between 1.5 and 2 cm long, and 1.16 cm of mean depth [9]. All layers of the abdominal wall are fused at the umbilicus, and subcutaneous fat that accumulates around the margins causes the umbilicus to appear depressed. Many authors have tried to describe the ideal female umbilicus [12–15]. Craig et al. [12] conducted a study to ascertain the characteristics of an appealing umbilicus in 147 photographs of women between 18 and 62 years old. According to their findings, the most aesthetically pleasing umbilicus is small and T or vertical in shape and possesses a small superior hood or shelf (Fig. 15.3).

15.6 Umbilical Transposition in Abdominoplasty (Figs. 15.4, 15.5, 15.6, 15.7, 15.8, and 15.9)

Many techniques are described in the literature to perform an umbilicoplasty [1, 13–16]. Most authors have tried to emulate an appealing and natural-looking neoumbilicus by designing it with a long shape and superior hood. We present our preferred technique for umbilical transposition during abdominoplasty.

Before finishing the abdominoplasty closure, a Pitanguy marker is used to mark in the skin the exact position of the umbilicus. A figure of two asymmetrical ellipses is drawn, the inner ellipse is exactly the same size of the umbilical stalk (at this stage beneath the flap), usually 1.5 × 1 cm. The outer ellipse is approximately 4 × 3 cm. The overall shape of the drawing is similar to an avocado. The inner ellipse is cut with a no. 15 blade, and care is taken to bevel the edge of the knife outward, so the defect created will make a trapdoor contraction, hiding the scar. The skin and a cuff of fat tissue are removed, only to Scarpa's fascia; the fat tissue beneath the Scarpa's fascia is preserved. With a sharp scissor, the dermis is detached from the underlying fat tissue, in all the ellipse marked by the outer drawing.

The fat tissue is transected and the umbilicus stalk is sutured to the dermis of the inner circle using 4–0 absorbable monofilament (Monocryl). The authors prefer Gillies horizontal dermal sutures to continuous sutures, even with 6–0 monofiliment, that can leave "railway scars" and cause patient dissatisfaction with the aesthetic result.

Paraffin gauze dressings are used and left in place for 1 week. The sutures are left to fall off, usually between 3 and 4 weeks.

Long-term results show a natural umbilicus in most cases.

15.7 Neo-umbilicoplasty (Fig. 15.10)

In patients without umbilicus, such a sequela of omphalocele or surgery for umbilical hernia, a neo-umbilicoplasty, the same technique is used; the only difference is that as there is no umbilical stalk, in the inner circle, it is sutured with 5–0 Prolene

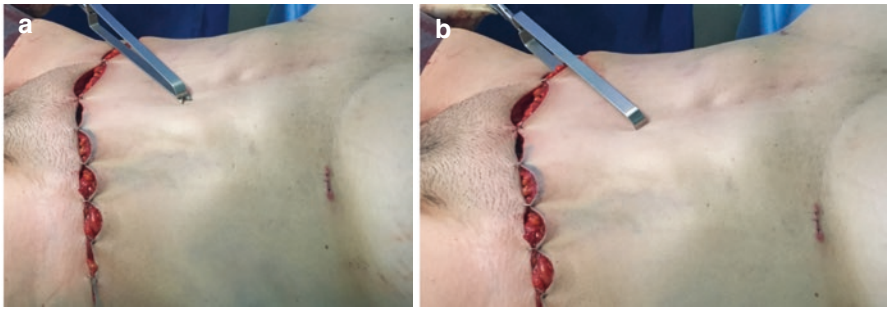

Fig. 15.4 (**a**–**b**) Position of the umbilicus with Pitanguy's marker

Fig. 15.5 Marking two asymmetrical ellipses, the inner ellipse is exactly the same size as the umbilical stalk

Fig. 15.6 Removal of the skin and cuff of fat tissue

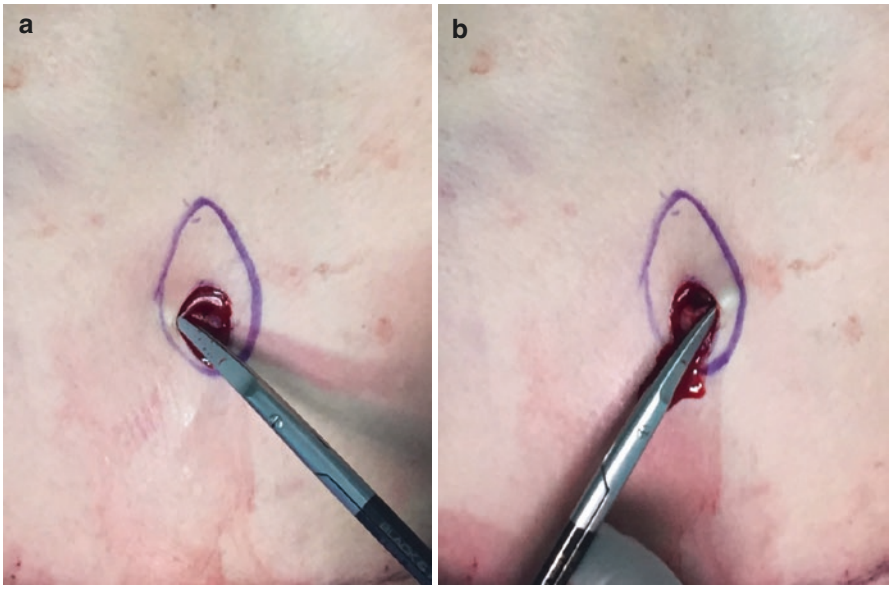

Fig. 15.7 (**a**–**b**) Detaching of dermis from the underlying fat tissue

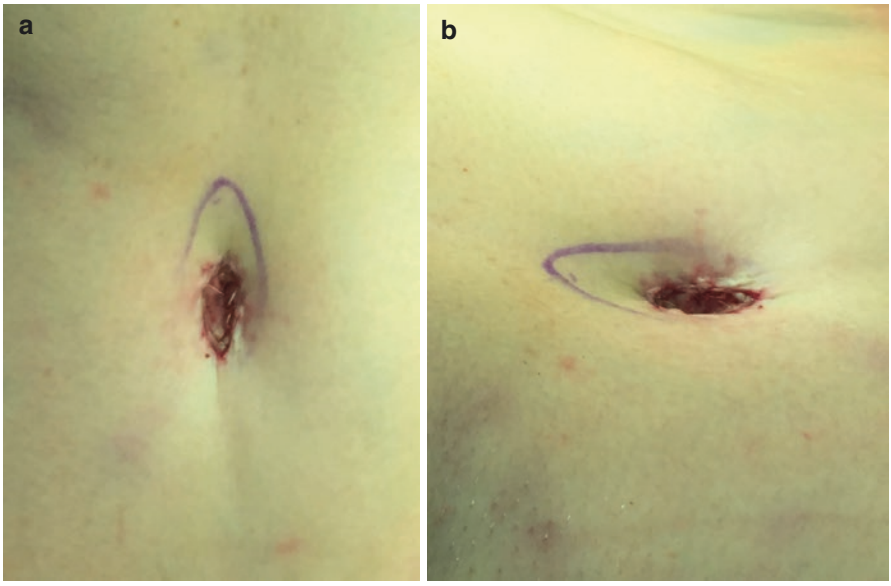

Fig. 15.8 (**a**–**b**) Suture of the umbilicus stalk to the dermis

Fig. 15.9 Long-term results

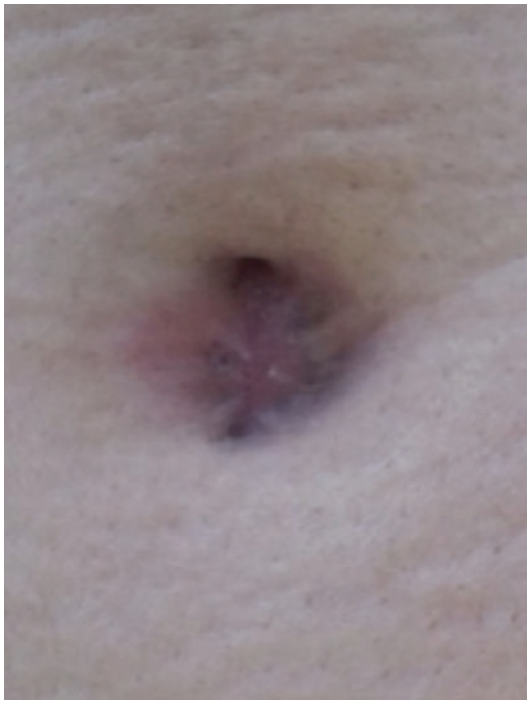

Fig. 15.10 Results of neo-umbilicoplasty

directly to the rectus abdominis fascia, leaving an open-wound small area that usually epithelializes in 3–4 weeks ending in a natural-looking umbilicus.

15.8 Conclusions

The umbilicus is an important landmark in the abdomen, and the ideal position is at midline in the vertical axis and at the level of iliac crest in the horizontal plane. Several techniques for umbilicoplasty are described in the literature; in the author's experience, the presented technique gives natural results, and it is easy to perform in most patients.

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Chapter 16
Umbilicoplasty for Gastroschisis

Adrian Bianchi

16.1 Introduction

Gastroschisis (Fig. 16.1) is the end result of a failure of migration of the midgut from the yolk sac into the fetal abdomen at 8–10-weeks' gestation. The diagnosis is easily made in early pregnancy by antenatal ultrasound; however, there is no effective management until after birth. There are no associated anomalies, and the children are otherwise normal but are often born prematurely at a weight of around 2–2.5 kg.

At birth these children have a small volume peritoneal space with a large proportion of thickened edematous intestine, but not the liver or spleen, extruding externally through an expanded umbilical port. The narrow mesenteric base presents a serious risk of volvulus with loss of part or all of the superior mesenteric vascular territory so that a small bowel atresia is not uncommon. There is no actual tissue deficit in the abdominal wall despite a wide umbilical port commonly expanded to a 1.5–3.5 cm diameter, with the splayed umbilical cord attached at its left margin.

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Fig. 16.1 Child with gastroschisis within hours of birth

16.2 Concepts

The "normal" umbilicus varies with race, age, and body configuration (Fig. 16.2). Normal aesthetics is relevant to body image and self-esteem, and particularly to the growing child and adolescent, the presence of a peer acceptable aesthetic umbilicus is of major psychological relevance. Umbilicoplasty for gastroschisis uses the natural spontaneous fascial contracture that occurs during postnatal umbilical cord resolution and leads to a normally placed aesthetic umbilicus at the midline and a scarless abdominal wall.

16.3 Postnatal Surgical Management

The thickened bowel is reduced into the peritoneal space immediately manually or over several hours or days with the aid of a temporary silastic silo and gravity.

Spaced tacking sutures are placed between the peritoneal triangle at the base of the umbilical cord (Fig. 16.3) and the rectus fascia, avoiding the skin, thereby using the umbilical cord as a cap for the wide umbilical port [1] in the manner of a bottle top hinged to the left (Fig. 16.4). The umbilicus is then left to dry out and

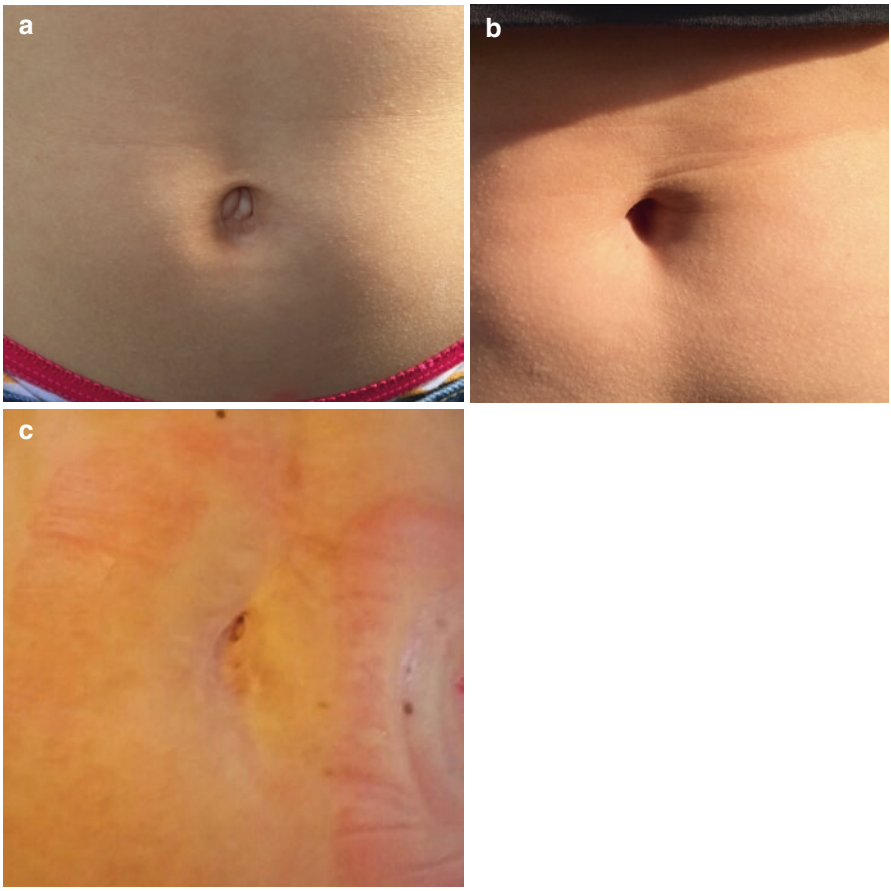

Fig. 16.2 Normal umbilicus: (**a**) At 8 years of age, (**b**) at 10 years of age, (**c**) at 14 years of age

contract down normally (Fig. 16.5). Unless absolutely necessary, the umbilical port should not be extended but allowed to reduce spontaneously, and no prosthetic materials are necessary for closure. Transverse or midline apposition of the margins of the umbilical port is contraindicated since it displaces the umbilicus to the left of the midline or downward and adds an unnecessary permanent abdominal scar.

When bowel atresia is present, initial management is to return the intact residual bowel to the peritoneal space, with closure by umbilical cord "bottle-top" capping to allow aesthetic natural maturation of the umbilicus. Some 3 weeks later and once the thickened bowel has resolved, the atresia can be routinely managed at laparotomy through a skin crease supra-umbilical incision [2, 3] or a Pfannenstiel incision that hides the surgical scars within natural skin creases and preserves abdominal wall aesthetics.

Fig. 16.3 Splayed cord with peritoneal triangle to the left of the umbilical port

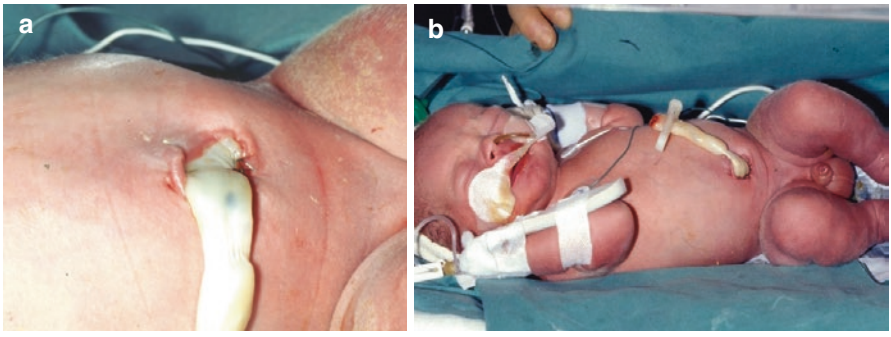

Fig. 16.4 (**a**, **b**) Umbilical cord "bottle-top" capping for umbilical port closure

A tight umbilical port that is too narrow to allow bowel return or that is causing compromise to the mesentery will require release with a limited but adequate right transverse incision and possible placement of a temporary silastic silo for gravity reduction.

If relevant, an additional Pfannenstiel incision gives good access for careful placement of the bowel within the peritoneal space. Umbilical cord "bottle-top" closure ensures an aesthetic umbilicus (Fig. 16.6).

A necessary temporary stoma can be placed within the margins of the umbilical port, through which a definitive laparotomy can eventually be undertaken, taking

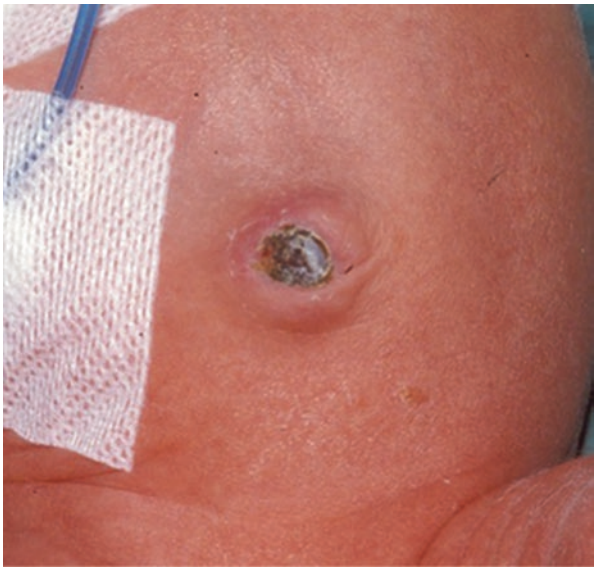

Fig. 16.5 Dried umbilical cord after umbilical cord capping

Fig. 16.6 12 months after right extension to a narrow umbilical port and closure by umbilical cord capping. Umbilicus shows a right indentation

down the stoma and achieving a similar abdominal closure with respect to the position and shape of the umbilicus (Fig. 16.7). The resulting umbilicus fits within the normal spectrum but may be less aesthetic and merit eventual surgical adjustment.

16.4 Follow-Up

Immediately following umbilical cord capping, and as the cord undergoes its natural resolution, the umbilicus may appear "wet." Occasional periumbilical cellulitis requires antibiotics, but generalized peritonitis has not been a problem and bowel

Fig. 16.7 Initial placement of a stoma at the umbilical port and subsequent laparotomy, leaving an acceptable but less aesthetic umbilicus

Fig. 16.8 6 months after reduction and umbilical cord capping

function becomes established within 7–15 days. There have been no instances of bowel extrusion or fistula.

During the early months following umbilical cord maturation, the umbilicus may be of slightly wider diameter but is flat and soft without a hernia sac (Fig. 16.8), and no corrective surgery is required. However, a persistent wide umbilicus (Fig. 16.9) in early adolescence has occasionally merited minor surgical reconstruction.

Long-term follow-up now at >20 years, of 32 children following umbilical cord "bottle-top" capping for umbilical port closure in gastroschisis, confirms the patient acceptability and aesthetic appearance of the umbilicus and the scarless abdominal wall (Fig. 16.10).

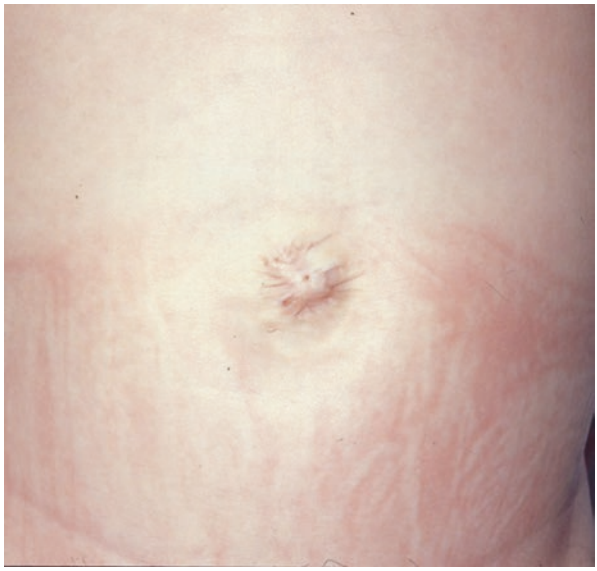

Fig. 16.9 Wide soft umbilicus, but no hernia, possibly meriting surgery

Fig. 16.10 14 years after bowel reduction and umbilical cord capping

16.5 Conclusions

The absence, displacement, and distortion of the umbilicus, like obvious abdominal scarring, cause significant psychological upset that presents as an unwillingness to expose the abdomen to peers and generates requests for surgical correction. Normal aesthetics (Fig. 16.2) is important to body image and to the patient's self-esteem and quality of life. Unnecessary iatrogenic distortion and scarring are no longer acceptable or excusable. Umbilicoplasty for gastroschisis, using the cord for capping the wide umbilical port and allowing closure by natural contracture, achieves a scarless

abdomen with a normally positioned and shaped umbilicus sufficiently pleasing for patients to willingly expose their umbilicus, even drawing attention to it by wearing an umbilical stud!

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Chapter 17
Umbilical Reconstruction After Gastroschisis Repair in the Infant

Alfredo Donnabella and Fernanda Parentoni Santos

17.1 Introduction

The umbilicus is the only scar in the human body that anyone wants to possess. Its absence causes significant change in the appearance of the abdomen, thus making it an essential part of its anatomy. Therefore in reconstruction, the umbilicus should have a good shape, an appropriate position, and a natural aspect, and it should not have stenosis or enlargement.

The umbilicus is described as a depressed scar surrounded by a natural fold of skin approximately 1.5–2.5 cm diameter [1, 2] in the adult. Its natural position in the infant is approximately 60 % of the way from the xiphosternum to the umbilicus [3, 4].

Craig et al. made an analysis regarding the most graceful form of the umbilicus. It should be small, with a T-shaped silhouette in depth, be rounded or oval, and be with a discrete fold of skin in its upper portion. A large umbilicus is extremely unaesthetic [1, 5].

The umbilicus is formed by a base (a dome), its corrugated part, and a groove or ring that surrounds it. Its upper portion, which surrounds the depressed portion, is called the impeller.

Congenital disorders of the umbilicus that result in umbilical loss include exstrophy, omphalocele, and gastroschisis. The abdominal wall reconstruction for closing

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the defect results in a midline scar. Neo-umbilicoplasty can be formed at the time of closure or at some later time depending on the extent of the congenital defect.

In order to have a reconstruction that is as close to the ideal as possible, it is mandatory that every anatomic unit of the element be suitably reconstructed. The key point for the umbilical reconstruction is creating a base where the neo-umbilicus will emerge with the elevation of its edges. This base should be rounded and fixed to the aponeurosis of the rectus abdominis. The umbilicus must have a good depth so as to achieve a quite natural look in the reconstruction. Ng [6] has developed a technique for the primary neo-omphaloplasty in the classic abdominoplasty that gives the umbilicus a good shape and manages to have some depth to it. This technique's great trump is the nonremoval of the fat in the site of the neo-omphaloplasty. In keeping the fat, the edges of the neo-umbilicus are elevated, getting some depth therein. The removal of the fat around the neo-umbilicus is a huge mistake and should be avoided. With the removal of the fat, the structure that would give sustenance to the lateral wall of the neo-umbilicus is lost.

17.2 Technique

The authors use a modification of the technique proposed by Franco and Medeiros [7] in which the anatomical units such as the dome, umbilical groove, and impeller are reconstructed step by step.

In order to reconstruct the umbilicus, be it for the total lack of it (in the cases of congenital disorder, hernias, destruction by the previous scar, bad formations, tumors, or infections) or for aesthetic reasons, it uses two rectangular and parallel flaps that are sutured together and fixed to the aponeurosis of the rectus abdominis. These flaps should measure 1.5 cm height by 2.0 cm width. The flaps should transition with the skin in a curvilinear path. Also, the curvilinear form should be observed in its distal portion (Fig. 17.1).

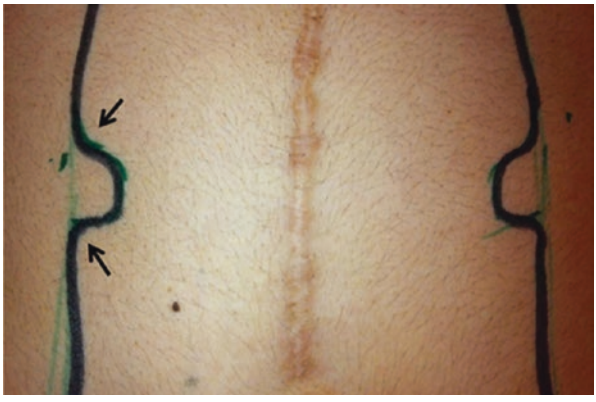

Fig. 17.1 The flaps transition with the skin in a curvilinear path and not in an angle

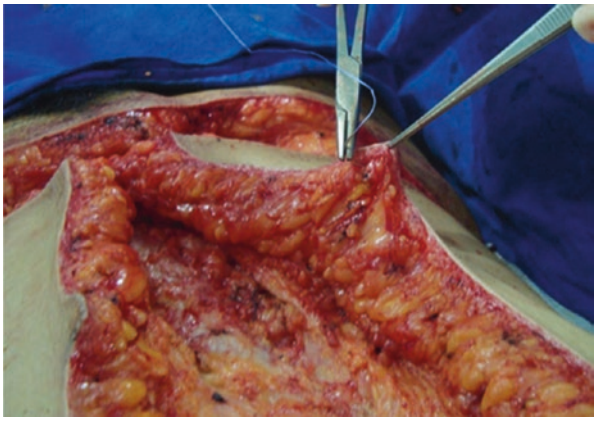

Fig. 17.2 Fixing the neo-umbilicus using the Vicryl®2.0 (polyglactin)

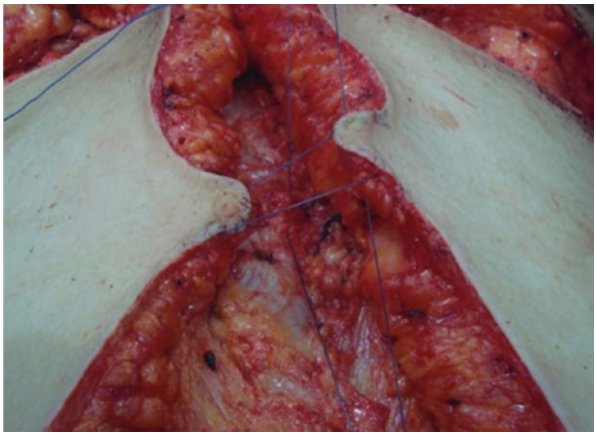

Fig. 17.3 Fixing the neo-umbilicus to the aponeurosis of the rectus abdominis

The flaps fixation is made with two parallel sutures that bring together the dermis of the flap from one side and the dermis of the flap of the opposite side, reaching also the aponeurosis in the median line. This way, the union of both flaps can be attached by lightly compressing their distal border (Fig. 17.2, 17.3, and 17.4).

With the fixation of both flaps, by compressing their distal border, we can achieve to form the dome or the base of the neo-umbilicus in the aponeurosis. Due to the fact that the dermis from the flap is included at the suture, there is a folding in the flaps, which creates the aspect of the navel groove (Fig. 17.4).

Then, the fat tissue around the umbilicus is approximated with new sutures using Vicryl®1 (polyglactin) and a 4 cm needle. We should use this big needle so as to include as much fat tissue as possible (Fig. 17.5).

It is necessary to take care of not putting too much pressure in those sutures, to avoid liponecrosis and the risk of losing this resource. The procedure is concluded

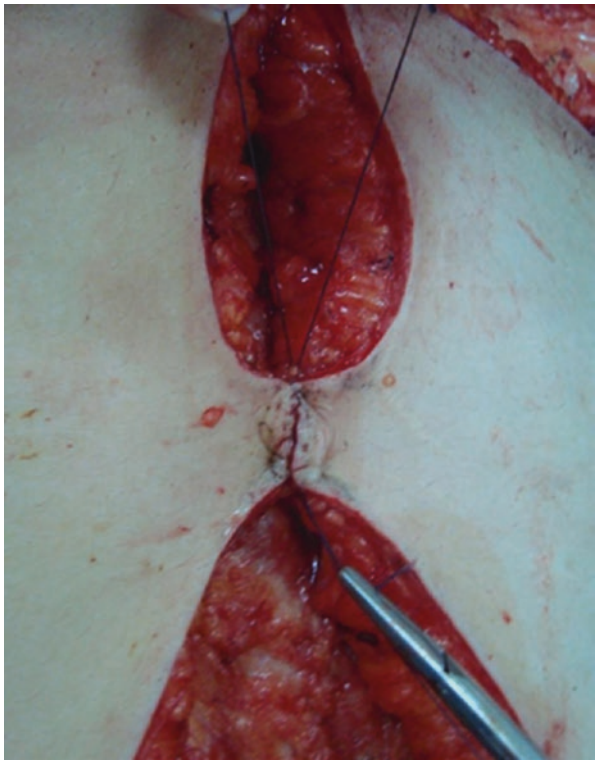

Fig. 17.4 Forming the base of the neo-umbilicus

with the skin suture (Fig. 17.6). Since the flaps are short, a curvature around the skin in the neo-umbilicus is formed, creating the impeller.

17.3 Discussion

The formation of all anatomical units is achieved: the dome, the groove, and the impeller, besides an adequate depth of the neo-umbilicus. We call attention to the fact that the formation of the base of the neo-umbilicus (dome) is of fundamental importance to a satisfactory reconstruction of the neo-umbilicus. There were no cases of umbilical stenosis, due to the fact that there was no round scar around the neo-umbilicus. In this way, the stigma of an operated umbilicus is also avoided. Usually, no hypertrophic or keloid scars were observed, although pathological

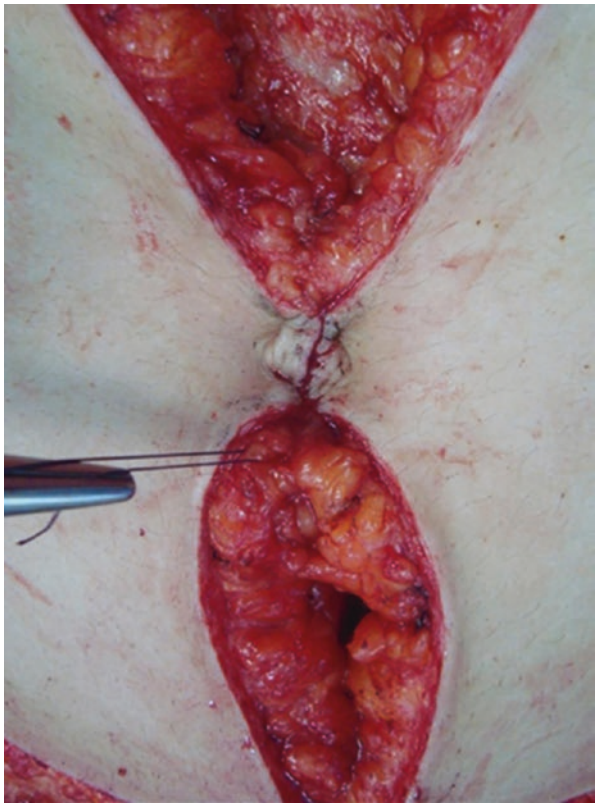

Fig. 17.5 Approximation of the adjacent fat tissue

scaring may occur in the vertical scar above or below the umbilicus. In time, it is expected that a ptosis will occur in the cranial portion of the neo-umbilicus, creating a discrete fold, which gives a more natural aspect to the final reconstruction. By keeping the flaps between 1.5 and 2.0 cm, the result is a small and harmonic umbilicus.

With the approximation of the adjacent fat tissue to the neo-umbilicus, an elevation of the boards is achieved which gives the neo-umbilicus the necessary depth. This approximation of the surrounding fat tissue is essential to define the profundity of the neo-umbilicus. Since it is impossible to make the dome deeper than the aponeurosis, the solution is to elevate the tissues around the neo-umbilicus in order to have the appropriate depth. The tissue available for that maneuver is the adipose tissue. It should be handled with delicacy because of the real risk of tissue lesion (Fig. 17.7).

Fig. 17.6 Final aspect of the neo-umbilicus

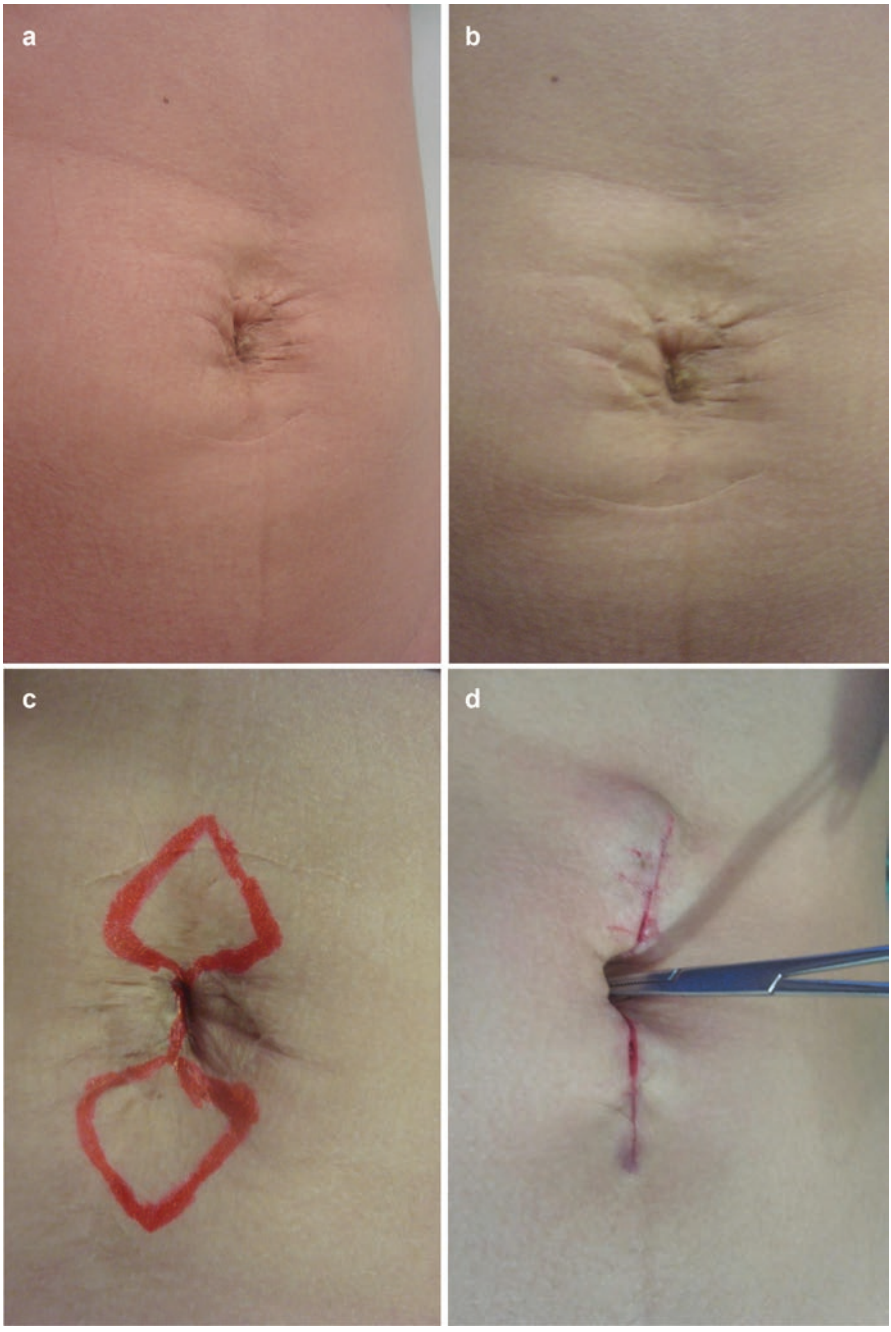

Fig. 17.7 (**a–b**) Omphalocele. This patient was operated on three times and does not have a good aspect of the umbilicus. (**c–d**) Omphalocele. Perioperative aspect. (**e–f**) Omphalocele. Postoperative

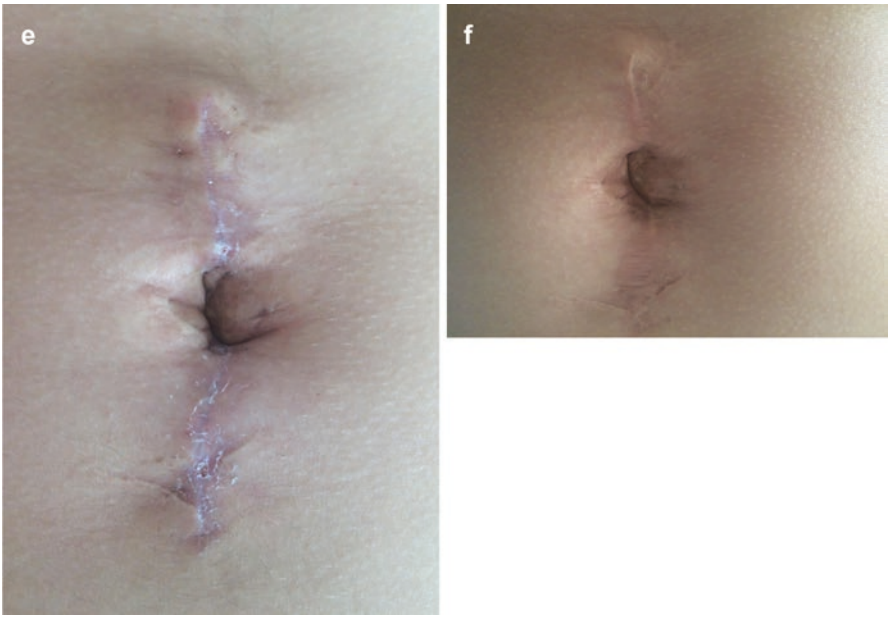

Fig. 17.7 (continued)

17.4 Conclusions

The technique for the reconstruction of the umbilicus presented here, accounting for the anatomical units, provides a very natural look, and in time an excess of skin on the upper part occurs, giving a more graceful appearance to it. The resultant umbilicus exhibits appropriate features of depth and size. The technique avoids the appearance of operated umbilical scar and secondary stenosis because it does not show a circular scar, and the incision position is in the midline of the neo-umbilicus.

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Part VII
Urachal Pathology

Chapter 18
One-Stage Umbilicus Reconstruction After Resection of Urachal Cyst

Makoto Omori

18.1 Introduction

The urachus is the embryological remnant of the urogenital sinus and allantois. Involution of the urachus usually occurs before birth, resulting in the median umbilical ligament. Urachal cyst is the most common urachal anomaly, reportedly occurring in approximately 1/5000 births [1, 2]. Such cysts are not always symptomatic, but once infection occurs, it tends to recur repeatedly and becomes difficult to treat. Urachal carcinoma sometimes arises from urachal cysts and shows poor prognosis [3], so complete resection of the cyst and surrounding inflammatory tissues is required. The umbilicus is an important esthetic feature in the middle of the abdominal wall, and loss of this structure may represent a source of psychological distress. Reconstruction of a new umbilicus after loss of the umbilicus can thus be important. However, immediate reconstruction of a new umbilicus after umbilicus loss accompanied by large tissue defect is challenging for reconstructive surgeons, and few reports have described umbilical reconstruction under such conditions.

Herein presented is a simple and easy method for umbilical reconstruction following total resection of an urachal cyst.

18.2 Technique

After total resection of the urachal cyst, the abdominal defect is sutured in a cranial-to-caudal direction. Next, two triangular flaps are designed just caudal to the umbilical defect, which is usually circular. Each triangular-shaped flap with a base-to-side

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ratio of about 1:2.5 is raised on the fascia of the rectus abdominis muscle. The width of the flap pedicle is designed corresponding to almost 1/4 of a quadrant (Fig. 18.1). After adequate thinning of the flap, each flap is rotated 180° and sutured to the other, forming one large triangular flap (Fig. 18.1). Next, three anchor sutures are placed on the fascia about 3–4 cm below the umbilicus. Each single end of the anchor thread is sutured to the skin flap. This anchor suture technique was first described by Park et al. [4]. Next, the needle is threaded with both ends of the suture and passed through the abdominal wall to anchor the skin flap to the fascia. The flap is then sutured to the edge of the umbilical defect with a 5-0 absorbable suture. The cranial side of the defect is closed in the V–Y fashion in order to make the new umbilicus elliptical in the cranial-to-caudal direction. Finally, the remaining untied 3-0 nylon sutures are tied off to create a reconstructed umbilical fossa of sufficient depth. The dog ears of the flap are hung at the opening of the new umbilicus, forming the anterior wall of the new umbilicus.

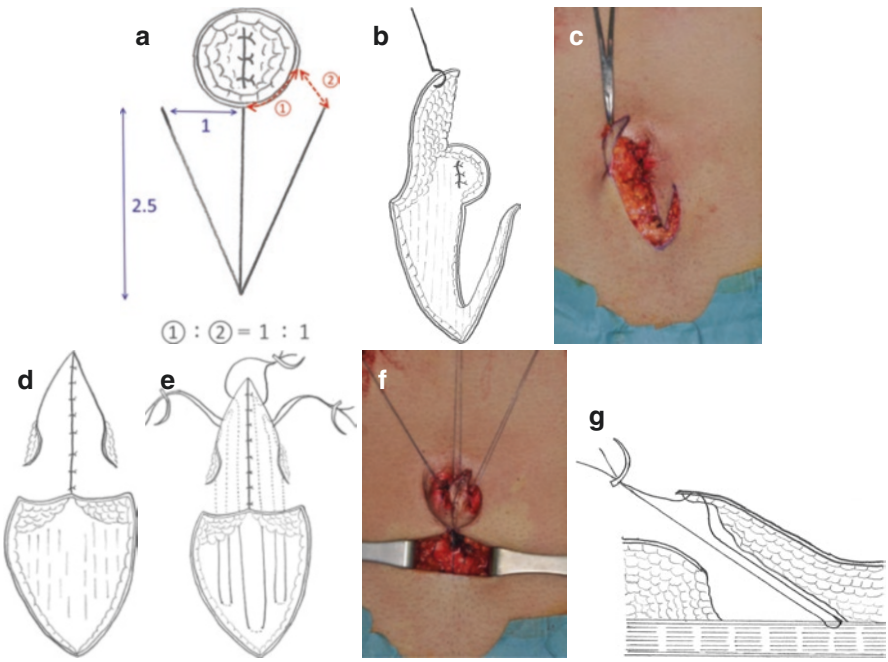

Fig. 18.1 Schema of the surgical procedure. (**a**) Design of triangular flaps. (**b**, **c**) Triangular flaps are raised on the fascia of the rectus abdominis. (**d**) Each flap is rotated and sutured to the other. (**e**, **f**) Preparation of anchor sutures. (**g**) Sagittal view of the neoumbilicus. (**h**, **i**, **j**) The needle is threaded with both ends of the suture and passed through the abdominal wall to anchor the skin flap to the fascia. The flap is then sutured to the edge of the umbilical defect. The cranial side of the defect is closed in the V–Y fashion to make the new umbilicus elliptical in a cranial-to-caudal direction. (**k**, **l**, **m**) Postoperative view. Each end of the anchor suture is buried in the subcutaneous fat similar to the buried suture technique used in double eyelid blepharoplasty. The dog ears of the flap are hung at the opening of the new umbilicus, forming the anterior wall that creates the illusion of deep umbilical fossa. All figures are reprinted from Omori et al. [20]

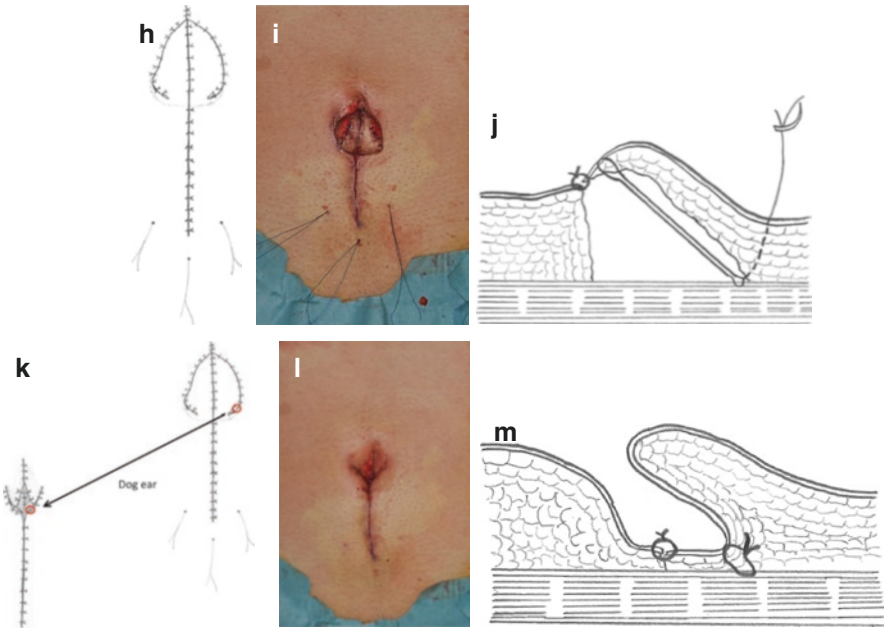

Fig. 18.1 (continued)

18.3 Discussion

Excision of the urachus has traditionally been performed via a midline infraumbilical incision, but laparoscopic removal has become more frequent in the last decade [1, 2, 5]. The benefits of a laparoscopic approach include reductions in postoperative pain and duration of hospitalization and improved cosmesis. In any case, because of the potential for malignant degeneration of the urachus, complete excision is essential and results in umbilical loss along with a large tissue defect. Reconstructing a new umbilicus after wide umbilical resection is challenging for reconstructive surgeons, because more tissue is required to reconstruct a new umbilicus compared to secondary umbilical reconstruction.

The ideal shape of the umbilicus is considered to be deep and elliptical in the cranial-to-caudal direction, with the outlet of the umbilical fossa turned slightly upward [4–8]. Many umbilical reconstruction techniques have been reported, using methods such as free skin grafts [9], skin flaps [7, 8, 10–15], and others [16].

Umbilical reconstruction with a skin graft is an effective method that leaves a minimal scar. However, creation of a natural-looking umbilical wrinkle is difficult. Moreover, an umbilicus reconstructed with a skin graft tends to become shallower over time, due to the inevitable shrinkage of grafted skin. We therefore thought that umbilical reconstruction with skin flaps would yield a better outcome than skin grafts.

Many flap techniques have been developed, ranging from islanded abdominal flap [6, 8, 12], superior-based single triangular flap [7], transverse flaps [10, 13, 15], and inferior-based vertical flap [11, 14] to the combination of skin flap and cartilage graft [16]. However, all of the techniques described above represent secondary reconstructions designed on an intact abdominal surface. The relatively few techniques for one-stage umbilical reconstruction that have been described include the "Iris" technique [17], purse-string technique [18], and "Celtic cross" technique [19]. Each of these techniques involves advancing neighboring skin to cover the umbilical defect and placing anchor sutures in the middle of the umbilical fossa to create the umbilical depression. In comparison with those methods, our approach is able to place the bottom of the umbilicus more caudally in the umbilical fossa. To enhance the depth of the neoumbilicus, it is important to place the entrance and bottom of the new umbilicus at different sites. With the author's technique, it is easy to provide sufficient umbilical depth in a caudal direction by folding the lower part of the flaps.

The importance of the anchor suture has been discussed in detail elsewhere. The anchor suture technique described by Park et al. [4] is strong enough to maintain sufficient depth of the new umbilicus for a long time. This method allows the anchor sutures to be tied at the end of the operation. By monitoring the final appearance of the umbilicus, fine adjustment of the anchor sutures is possible.

Many authors have pointed out that creating a natural wrinkle in the new umbilicus is important for creating a natural-looking umbilicus [8, 11, 15]. With the author's method, the dog ears of the rotated flaps (Fig. 18.1) that protrude slightly on opening of the new umbilicus provide a natural wrinkle and three-dimensional form to the new umbilicus.

Flap size should be strictly estimated to avoid a constricted umbilicus (Fig. 18.2). The flap size required is easily calculated geometrically in our method. Moreover, if a conventional infraumbilical midline incision is used for urachal cyst resection, an immediate umbilical reconstruction can be performed without any additional incision (Fig. 18.3).

18.4 Conclusions

The author has presented a new method for one-stage umbilicus reconstruction after umbilical resection. No major complications have yet been encountered. The technique is simple and easy, allowing a natural-looking umbilicus with sufficient depth to be fashioned. Total excision of the urachal cyst can be achieved through the same incision used for flap elevation, without any additional incision.

Fig. 18.2 Case 1. A 32-year-old man who underwent complete excision of the umbilicus using a laparoscopic approach. (**a**) Preoperative. The circled area is to be resected. (**b**) Defect of the umbilicus and design of the triangular flaps. (**c**) Each flap is rotated 180° and sutured to the other, and three buried sutures are made. (**d**) Immediately postoperative. (**e**) Thirty-one months postoperatively. All figures are reprinted from Omori et al. [20])

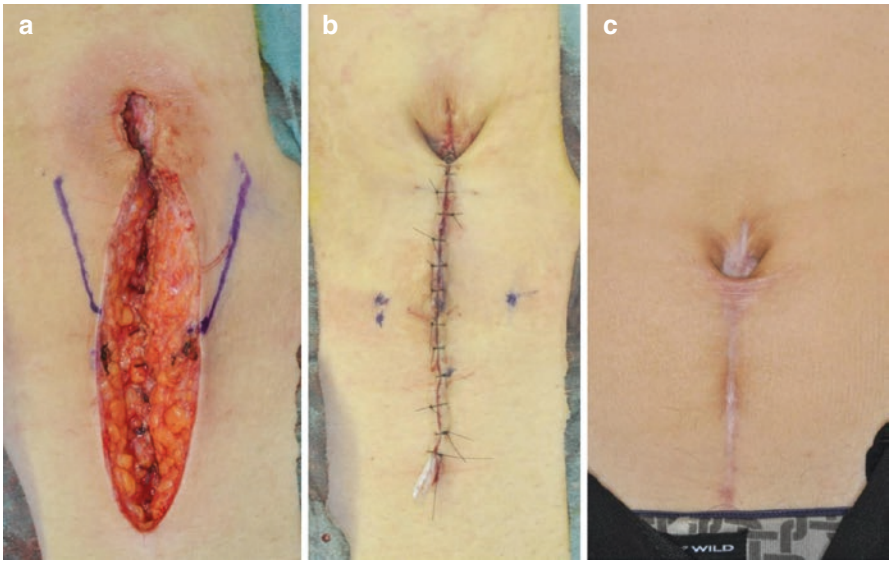

Fig. 18.3 Case 2. A 37-year-old man who underwent excision of the umbilicus using a conventional transcutaneous approach. (**a**) Intraoperative. Design of the triangular flaps. (**b**) Immediately postoperative. (**c**) Seven months postoperatively. Umbilical reconstruction can be performed without any additional incisions

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Chapter 19
Umbilicoplasty with a New Three-Step Technique in a Case of a Patent Urachus

Philine Loertzer, Inga-Marie Schaefer, Rolf-Herrmann Ringert, and Hagen Loertzer

19.1 Introduction

On account of the central position within the body, the umbilicus means much more than a simple fetal remnant. This becomes particularly evident when malformations or secondary destruction of the umbilicus occurs and surgical intervention is required. Beyond the restored function of the umbilicus to "seal off" the abdominal wall toward the outer environment and to avoid urinary discharge and recurrent infections, cosmetic aspects become crucial, especially in women [1]. Therefore, the concept of "umbilicoplasty" was created to emphasize the cosmetic function of the beyond and focuses on aesthetic aspects of reconstructive surgery. Some criteria have to be accomplished to create an aesthetically satisfying and functional umbilicus. For instance, a protruding umbilicus is regarded "unattractive and undesirable" by some patients [2]. Therefore, one's aim is to form an inverted umbilicus by resection of the umbilical scarification [2]. Second, a "scarless" and "natural-appearing umbilicus" with a "longitudinal deep depression" [3–5] is another goal to achieve [6, 7]. In an analysis of 147 female participants, the authors concluded that the T- or

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vertically shaped umbilicus with superior hood or shelf is a desirable goal in umbilical reconstruction since it scored the highest in aesthetic appeal [1].

We herein present a new technique for surgical reconstruction of the umbilicus in a 6-week-old girl with patent urachus.

19.2 Patients and Methods

19.2.1 Case Report

At 38 weeks gestation, a mature 3,455 g and 50 cm tall girl was delivered by caesarian section for a 50 × 8 cm sized giant umbilical cord. Postnatal clinical, laboratory, and pathological examinations lead to the diagnosis of an open patent urachus with urinary leakage into the umbilical cord and subsequent development of a giant edema. The child's development was appropriate, though, and no further malformations were observed. A visible connection between the dome of the urinary bladder and the umbilicus was not detectable in sonographic controls. Hence, the umbilical cord was clamped, but urinary discharge persisted, and the stump failed to detach as the patient was discharged. Therefore, at 6 weeks age, the child underwent surgical repair of the patent urachus with subsequent aesthetic and functional umbilicoplasty.

19.2.2 Operative Procedure

Operative steps began with circular skin incision around the umbilicus and preparation of the urachal stump. Following this, the incision was elongated 3 cm caudal from the umbilicus, and the abdominal cavity opened. The urachus was separated from the inner abdominal wall toward the dome of the urinary bladder and the urachus lifted upward (Fig. 19.1). After this, the structure including the accompanying lateral plica umbilicalis was excised close to the urinary bladder without a cuff. Subsequently, the primary closure of the urinary bladder was carried out, and the urinary bladder was plunged inside. Afterward, the peritoneum and transversalis fascia were closed and the longitudinal median skin incision was adjusted. The Y-shaped wound was closed by mobilizing the subcutaneous tissue of the central flap so that the skin could be folded and fixed as cranial as possible "upside-up" down onto the transversalis fascia. A free, 1 cm crescent-shaped edge of the skin was left, and a medial impression was created. Without skin incision, the small bottom was formed by the deeply fixed skin. Then, redundant skin on the left and right was resected and finally sutured directly to the crescent-shaped margin of the deeply fixed middle flap to create the new umbilicus. Finally, closure of the abdominal wall in layers with intracutaneous skin suture using single sutures followed. The final

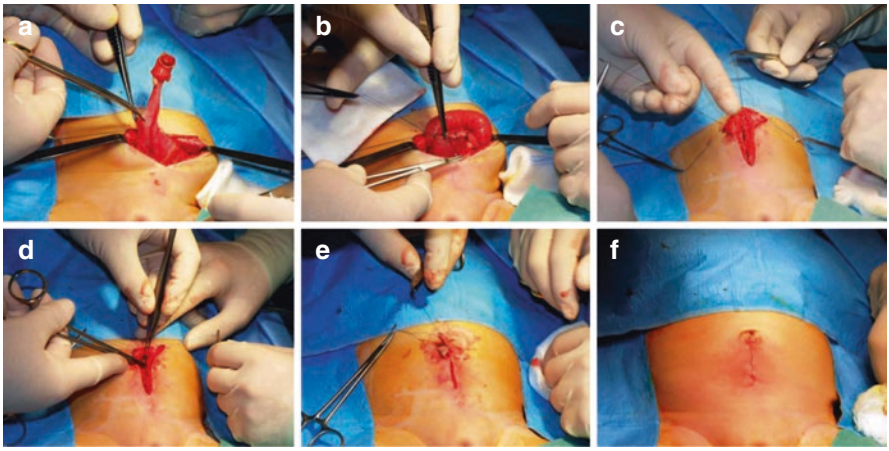

Fig. 19.1 (**a–f**) The urachus is separated from the inner abdominal wall toward the dome of the urinary bladder and the urachus lifted upward

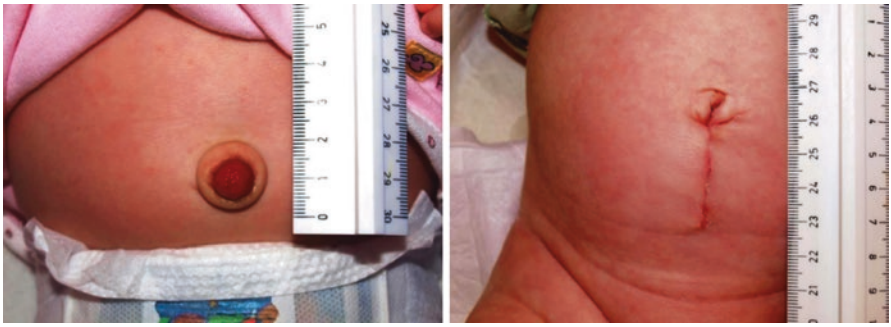

Fig. 19.2 (*Left*) Marking around urachus. (*Right*) Two weeks after surgery revealed a cosmetically pleasing shape of the umbilicus and complete restoration of urinary continence

result was a naturally looking, inverted, and symmetric umbilicus with an incipient longitudinal deep depression and small incision.

19.2.3 Results

There were no postoperative complications. Primary wound healing was appropriate with neither infectious nor ischemic complications, and only minimal scar formation was encountered in the skin of the reconstructed umbilicus. Follow-up controls 2 weeks after surgery revealed a cosmetically pleasing shape of the umbilicus and complete restoration of urinary continence (Fig. 19.2).

Gross and histopathological examination of the resected 5 × 1.5 cm sized specimen showed a tubular central structure lined by transitional epithelium and surrounded by fibrotic tissue and smooth muscle bundles. Physiological involution of the umbilical arteries to form the lateral plica umbilicalis had already taken place.

19.3 Discussion

Several techniques for either new construction or reconstruction of the umbilicus have been invented, developed, and modified during the past 30 years.

Indications for umbilicoplasty include congenital abdominal wall defects [8] such as gastroschisis, omphalocele, cloacal exstrophy, or exstrophy-epispadias complex [9–13], in which case the umbilicus is completely missing, or secondary destruction of the umbilicus due to umbilical hernia [7], laparotomy, abdominoplasty [14], or inflammatory and neoplastic diseases [15]. The former demand a completely new construction, whereas the latter necessitate a *re*construction of the umbilicus. The same applies to a patent urachus with persistent urinary leakage from an already existent umbilicus which requires surgical repair and the reconstruction of the umbilicus.

Persistent urachal remnants can present at any age and with various clinical manifestations [16, 17]. Most common congenital urachal malformations present as urachal cysts and urachal sinus and are frequently accompanied with urinary discharge from the umbilicus [18]. Diagnostics may not always detect an open connection from umbilicus to urinary bladder with transabdominal sonography. If urinary discharge persists after clamping of the umbilical cord, a patent urachus may be suspected clinically, and complete surgical removal of the urachus is mandatory to avoid acute as well as chronic complications [18]. Chronic complications include incontinence and recurrent infections and more seldom the finding of an adenocarcinoma of the bladder which may arise in the adult from a persistent vesicourachal diverticulum located at the dome of the urinary bladder [18]. The surgical approach implies open preparation and complete resection of the urachus from the urinary bladder with or without a cuff, depending on luminal size [15], and primary closure of the bladder dome. In the present case, umbilicoplasty had to follow the resection of the urachus, and a longitudinal abdominal skin incision was already present.

As no proper instructions exist, yet, to determine optimal preferred method or time for surgical reconstruction of a patent urachus, the procedure still depends on the practical skills, experience, and aesthetic sense of the surgeon. Therefore, we developed a new technique to meet the abovementioned goals of aesthetic and functional umbilicoplasty and provide a successful method for cases of a patent urachus requiring surgical repair. Our technique is derived from two methods, developed by Hanna and Ansong in 1984 [11] and Cervellione et al. [13] in 2008

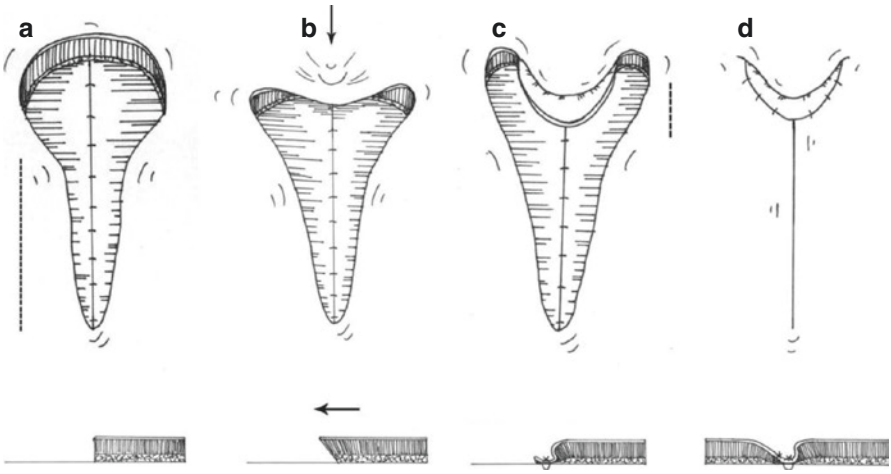

Fig. 19.3 (**a–d**) The longitudinal incision between former umbilicus and urinary bladder that had been necessary to completely remove the urachus

for umbilicoplasty in bladder exstrophy. The first authors used a Y-shaped incision, in the central converge of which the new umbilicus was created by fixing the middle upper skin strip buried in the subcutaneous space, followed by the two lateral flaps which were similarly fixed deep down to create an inverted umbilicus [11]. The second group mobilized the skin of the most superior apex of the wound and inverted it to fix it inside out to the linea alba as high possible to create a rim with a deep inversion. Subsequently, they cut two lateral skin flaps from the margin of the inverted skin, rotated the medial and sutured them to the linea alba to form the base of the new umbilicus [13]. Thus, the bottom of the umbilicus was formed by a longitudinal skin scar. The abovementioned techniques were modified to meet our constellation of a patent urachus.

Initial point of our reconstruction technique was the longitudinal incision between former umbilicus and urinary bladder that had been necessary to completely remove the urachus (Fig. 19.3). We first mobilized the middle upper skin flap from subcutaneous tissue and folded the skin and fixed it "upside up" as high a point as possible deep down onto the transversalis fascia. A free margin of 1 cm skin was left, extending as a crescent from the left to the right side. Subsequently, the caudal median abdominal incision was closed subcutaneously. The redundant skin lateral to the inverted superior skin flap was resected and sutured directly to the C-shaped free edge of skin. Thereby, the new umbilicus was formed, with the advantage of a bottom consistent of skin instead of an incision, thus providing better wound healing and less ischemic complications. Additionally, a superior deep depression due to the folding and subsequent fixation of the superior skin deeply onto the transversalis fascia was achieved.

19.4 Conclusions

The presented new three-step technique for umbilicoplasty in a patent urachus is easy to perform, lacks major complications, and achieves excellent cosmetic results.

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