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REVIEW BODY CONTOURING

Umbilical Reconstruction Techniques: A Literature Review

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Abstract

Background There are many instances in which sacrificing the umbilicus is unavoidable. Umbilical reconstruction (umbiliconeoplasty) is an important surgical procedure to complete the abdomen's reconstruction and to give again a pleasant cosmetic appearance.

Objectives To provide a complete overview of all surgical techniques for umbiliconeoplasty described in the literature.

Methods PubMed database was queried using 'umbilical and reconstruction', 'umbilicus and reconstruction', 'navel and reconstruction', 'umbiliconeoplasty', 'neo-omphaloplasty' or 'umbilicaneoplasty' to select the papers dealing with the reconstruction of the umbilicus.

Results Sixty different techniques for the reconstruction of the missing umbilicus were described in 77 papers. Local skin flaps and the purse-string suture technique were the most frequently described techniques. The Three flaps technique, the Four flaps technique and the 2 Lateral rectangular pedicle lateral flaps technique were the most popular local flap techniques. Indications ranged from congenital pediatric defects to reconstruction during abdominoplasty.

Conclusions Several surgical techniques were described for umbilicus reconstruction. While there is not a universal algorithm for the choice of the technique, the surgeon may decide which technique to use based on other surgeons' experiences reports.

Level of Evidence III This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Umbilical reconstruction · Umbiliconeoplasty · Neo-omphaloplasty · Neoumbilicoplasty

Introduction

The umbilicus is our first scar, the last remnant of our life in utero [1, 2]. There are many instances in which sacrificing the umbilicus is unavoidable: abdominoplasty performed simultaneously with umbilical or ventral hernia repair, transverse rectus abdominus myocutaneous (TRAM) and deep inferior epigastric perforator (DIEP) breast reconstruction [3], surgical removal of cutaneous mole or cancer localized to the navel and congenital conditions, such as bladder exstrophy or omphalocele. In particular, Ricci et al. [3] observed umbilical stalk necrosis to occur in 3.2% of patients after abdominal-based microsurgical breast reconstruction. The importance of the umbilicus in abdominal harmony leads plastic surgeons to place particular attention on its anatomic features during

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Table 1 Studies describing umbilicus reconstruction techniques

Authors	Year	Location	Number of pts	Age, sex	Surgical Technique	Cause of umbilicus loss
McMillan et al. [35]	1955	USA	NR	NR	Bilateral advancement flap	Abdominal hernia repair
Tange and Miyake [30]	1969	Japan	1	3 years, M	Transposition flap	Umbilical hernia
Onizuka et al. [31]	1970	Japan	NR	NR	Transposition flap	Exomphalos repair
					V–Y flap	
Borges et al. [36]	1975	USA	2	NR	Paramedian flaps	Umbilical herniorrhaphy
Kirianoff et al. [14]	1978	USA	1	24 years, F	Three flaps technique (Fig. 1)	Hernia repair
Sabatier et al. [37]	1978	France	1	NR	Two lateral rectangular pedicle skin flaps (Fig. 3)	Any loss of umbilicus
Jamra et al. [38]	1979	Lebanon	1	36 years, F	Double V–Y procedure	Umbilical herniorrhaphy
Apfelberg et al. [39]	1979	USA	2	34 years, F	Circular flap	Abdominoplasty, ventral hernia repair
				27 years, F	Superiorly-based skin flap	
Ricketts and Luck [40]	1983	USA	NR	NR	Four flaps technique (Fig. 4)	Omphalocele
Cone et al. [7]	1983	USA	NR	NR	Purse-string technique	Herniorrhaphy
Hanna and Ansong [32]	1984	USA	8	3–28 years, Sex NR	V–Y flap	Bladder exstrophy
Reyna et al. [15]	1987	USA	NR	NR	Three flaps technique (Fig. 1)	Proboscid hernia
Matsuo et al. [81]	1990	Japan	1	2 years, M	Local flap with cartilage graft	Omphalocele
Itoh et al. [41]	1992	Japan	9	40 years, F	Cone-shaped triangular flap	Endometriosis of umbilicus, exomphalos, foreign body granuloma after laparotomy, omphalocele
				28 years, M		
				17 years, F		
				19 years, M		
				18 years, F		
				40 years, F		
				34 years, F		
				13 years, M	Cone-shaped rhombic flap	
				21 years, F		
Miller et al. [42]	1993	USA	1	31 years, F	*Iris* technique	Melanoma
Sumfest and Mitchell [43]	1994	USA	12	3–16 years (mean: 10 years), Sex NR	Tongue-like flap	Bladder exstrophy
Marconi et al. [23]	1995	Italy	1	NR	Island flap	Herniorrhaphy
Sugawara et al. [44]	1995	Japan	5	16 years, F	Triangular conical flap	Exomphalos
				17 years, F		
				NR		
				NR		
				NR		
Onishi et al. [45]	1995	Japan	3	3–32 years, Sex NR	Lunch box–type method	Omphalocele and abdominal wall tumor surgical removal

Table 1 continued

Authors	Year	Location	Number of pts	Age, sex	Surgical Technique	Cause of umbilicus loss
Breuninger et al. [46]	1996	Germany	7	25–59 years, Sex NR	Two opposing trapezoidal skin flaps	Melanoma
Pardo Mateu and Chamorro Hernandez [82]	1997	Spain	5	NR	Three flaps technique (Fig. 1) + Purse-string suture	Reconstruction of a nonexistent umbilicus
Yotsuyanagi et al. [47]	1998	Japan	1	7 years, M	Two twisted flaps with 1 pedicle	Umbilical cord hernia repair
Park et al. [48]	1999	Japan	8	3–15 years (mean: 8 years), 4 M, 4F	Elliptical skin flap	Omphalocele and gastroschisis
Franco and Franco [16]	1999	Brazil	NR	NR	Three flaps technique, modified from Kirianoff [14] (Fig. 1)	Repair of umbilical hernias, incisional hernias, correction of bladder exstrophy
Shinohara et al. [49]	2000	Japan	2	4 years, M 5 years, F	Inverted C–V flap (Fig. 5)	Omphalocele
Feyaerts et al. [33]	2001	France	4	10–20 years, Sex NR	Kangaroo pouch technique	Bladder exstrophy
Abenavoli et al. [79]	2001	Italy	1	54 years, F	*Tortellino* shaped graft	Adverse effect of abdominal surgery
Schoeller et al. [8]	2002	Austria	1	25 years, F	Purse-string technique	Endometriosis
Bartisch et al. [9]	2003	USA	3	28 years, F 38 years, F 65 years, F	Purse-string technique (Fig. 2)	Urachal cyst repair
Masuda et al. [50]	2003	Japan	2	4 years, M 5 years, M	Reverse fan-shaped flap	Operation for gastroschisis, surgical correction for an umbilical cord hernia at birth
Iida et al. [17]	2003	Japan	2	4 years, F 2 years, M	Three flaps technique, as described by Kirianoff [14] (Fig. 1)	Umbilical hypogenesis
Tamir et al. [51]	2004	Israel	2 (twins)	2.5 years, M 2.5 years, M	*Lazy-M* and omega Flaps	Large umbilical hernia
Sankalé et al. [52]	2004	France	77	2 months-15 years (mean: 3 years), 31F, 46 M	Lateral left plasty *Horseshoe* plasty Umbilical graft	Umbilical hernia Umbilical hernia "Monstrous" umbilical hernia
Korachi et al. [53]	2004	UK	1	10 years, F	Defatted area of skin folded	Umbilical hernia
Kaneko and Tsuda [54]	2004	Japan	204	2 months-12 years (mean: 1.7 years), 109 M, 95 F	Four flaps technique, as described by Ricketts and Luck [40] (Fig. 4)	Umbilical hernia, omphalocele, omphalomesenteric duct, urachal abscess, umbilical granuloma
Ozbek and Ozcan [55]	2005	Turkey	1	NR	Modified *unfolded cylinder* technique	Horizontal abdominoplasty
Pfulg et al. [56]	2005	Switzerland	2	NR	Triangular skin flap	Absent or destroyed umbilicus
Franco et al. [57]	2006	Brazil	7	NR	Two lateral rectangular pedicle flaps, as described by Sabatier et al. [37] (Fig. 3)	Midline scar
Kakudo et al. [22]	2006	Japan	1	11 years, F	Island flap	Umbilical cord hernia
Kokuba et al. [58]	2006	Brazil	7	NR	Two semicircular defatted skin flaps	Umbilical endometriosis
Sevin et al. [59]	2006	Turkey	1	NR	Bilobed flap	Umbilicus necrosis after abdominoplasty

Table 1 continued

Authors	Year	Location	Number of pts	Age, sex	Surgical Technique	Cause of umbilicus loss
Uraloğlu et al. [60]	2006	Turkey	1	65 years, F	Modified C–V flap technique	Abdominoplasty
Rogliani et al. [61]	2007	Italy	3	20–60 years, Sex NR	Maltese cross technique	Dermolipectomy complicated with umbilical hernias
Cervellione et al. [62]	2008	UK	18	5 days-7 years, Sex NR	Inverted umbilical reconstruction	Bladder exstrophy and cloacal exstrophy
Kureel et al. [63]	2009	India	36	2 days–16 years, Sex NR	Tubularized trapezoid flap	Bladder exstrophy
Barbosa et al. [64]	2009	Brazil	2	45 years, F	Double triangular flap and trapezoid flap	Horizontal abdominoplasty and vertical laparotomy
				25 years, F	Inverted C flap	
De La Cruz et al. [65]	2009	USA	2	27 years, M	Celtic cross technique	Umbilical cysts
				30 years, M		
Hazani et al. [80]	2009	USA	5	NR	Transposition flap with skin graft	Umbilical hernia repair, abdominoplasty with sacrifice of umbilicus, and breast reconstruction with sacrifice of umbilicus
Watanabe et al. [66]	2009	Japan	5	3–14 years (mean: 7 years), 1 M, 4 F	Rabbit head–shaped scar flap (Fig. 6)	Omphalocele or gastroschisis
Rodó Salas et al. [34]	2010	Spain	4	6–16 years, Sex NR	Kangaroo pouch technique	Vesical exstrophy
Malebranche et al. [10]	2010	Canada	1	35 years, F	Purse string technique	Umbilical endometriosis
Takasu et al. [18]	2010	Japan	149	3 months–10 years (median: 2.5 years), 74 M, 75 F	Three-flaps technique, as described by Kirianoff [14] (Fig. 1)	Umbilical hernia
Zaccagna et al. [67]	2011	Italy	1	60 years, F	Superior polygonal skin flap	Melanoma
Dessy et al. [68]	2011	Italy	10	25–65 years (median: 45 years), 2 M, 8 F	Double opposing Y technique	In 5 cases, the outcome of previous abdominal surgeries, and in 5 cases, the repair of a ventral hernia
Kajikawa et al. [24–26]	2012	Japan	63	1–48 years, 33 M, 30 F	3 different local flaps: Method 1 with a S-shaped skin incision, Method 2 with fan-style flaps, and Method 3 with dividing the umbilical protrusion	Abdominoplasty or abdominal wall surgery with sacrifice of umbilicus
Arai et al. [69]	2012	Japan	1	26–67 years, F	Modified 2 twisted flaps technique [47]	Benign and malignant tumor located on umbilicus
Cló et al. [70]	2012	Brazil	306	24–56 years, F	Four flaps technique (Fig. 4)	Abdominoplasty
Omori et al. [71]	2013	Japan	6	24–56 years (mean: 33.8 years), Sex NR	Two triangular rotation flaps	Urachal cyst
Navysany et al. [11]	2013	Germany	1	10 years, M	Purse string technique	Melanoma
Lee et al. [72]	2013	Korea	1	1 days–6 years, Sex NR	Inverted C–V flap	Omphalocele
Gera et al. [73]	2013	Australia	6	2 years, F	Double purse string technique	Exomphalos minor, large umbilical hernia
Bongini et al. [12]	2015	Italy	1	2 years, F	Purse string technique	Complicated congenital urachal sinus

Table 1 continued

Authors	Year	Location	Number of pts	Age, sex	Surgical Technique	Cause of umbilicus loss
Lee et al. [74]	2015	Korea	NR	NR	Four flaps technique, as described by Ricketts and Luck [40] (Fig. 4)	Absence of umbilicus
Featherstone and Cuckow [75]	2015	UK	47	Age NR, 31 M, 16F	Spiral rotational flap (Fig. 7)	Bladder exstrophy
Şentürk et al. [76]	2016	Turkey	6	NR	The dome procedure (Fig. 8)	Abdominal wall surgery with amputation of umbilicus
Costa-Silva et al. [21]	2017	Portugal	1	81 years, F	Island pedicle flap	Melanoma
Moio et al. [13]	2017	Italy	1	24 years, F	Purse-string technique	Endometriosis
Kim et al. [19]	2017	Japan	16	16–46 years (median: 25 years), 11 M, 5 F	Three-flaps technique, as described by Kirianoff [14] (Fig. 1)	Urachal remnants
da Silva Júnior and de Sousa [29]	2017	Brazil	108	25–67 years, Sex NR	Scarless neo-umbilicoplasty Lateral horn flaps	Abdominoplasty
Vallim et al. [28]	2017	Brazil	19	NR	Lateral flaps, as described by Sabatier et al. [37] and Franco et al. [57] (Fig. 3)	Abdominoplasty with *anchor-like* skin excision
Ricci et al. [3]	2017	USA	NR	NR	Four flaps technique, as described by Lee [74] and by Ricketts and Luck [40] (Fig. 4)	Abdominal-based microsurgical breast reconstruction
DelMauro et al. [20]	2018	USA	13	mean: 45 years, Sex NR	Island flap	Reliable results and favorable aesthetic outcomes
Purnell et al. [77]	2018	USA	> 50	NR	Pumpkin-teeth advancement flap	Abdominoplasty or abdominal wall surgery with sacrifice of umbilicus
Michel et al. [78]	2018	France	12	Gestational age: 30–39 wk (median: 36.5 wk), Sex NR	Z omphaloplasty (ZORRO)	Omphalocele
Mendes et al. [27]	2018	Brazil	110	Age NR, 12 M, 98 F	Two lateral skin flaps, as described by Sabatier et al. [37] and Franco et al. [57] (Fig. 3)	Vertical abdominoplasty

F female, *M* male, *NR* not reported, *UK* United Kingdom, *USA* United States of America

Table 2 Umbilicus reconstruction techniques

Flap		Graft		Flap and graft combined	
	Number of papers		Number of papers		Number of papers
Three flaps technique [14–19, 82] (Fig. 1)	7	Umbilical graft [52]	1	Transposition flap with skin graft [80]	1
Purse-string technique [7–13] (Fig. 2)	7	*Tortellino* shaped graft [79]	1	Local flap with cartilage graft [81]	1
2 lateral rectangular skin flaps [27, 28, 37, 57] (Fig. 3)	4				
Four flaps technique [3, 40, 54, 70, 74] (Fig. 4)	5				
Island flap [20–23]	4				
Local flap [24–26]	3				
Transposition flap [30, 31]	2				
V–Y flap [31, 32]	2				
Kangaroo pouch technique [33, 34]	2				
Other techniques[a]	48				

Total number of techniques: 61. More than 1 technique was described in 7 papers

[a]Includes the following techniques: bilateral advancement flap [35], rotation of 2 small paramedian flaps [36], 2 lateral rectangular pedicle skin flaps [37], double V–Y procedure [38], circular flap [39], superiorly-based skin flap [39], cone-shaped triangular flap [41], cone-shaped rhombic flap [41], *iris* technique [42], tongue-like flap [43], triangular conical flap [44], lunch box–type method [45], 2 opposing trapezoidal skin flaps [46], 2 twisted flaps with 1 pedicle [47], elliptical skin flap [48], inverted C–V flap (Fig. 5) [49], reverse fan-shaped flap [50], *lazy-M* and omega flaps [51], lateral left plasty [52], *horseshoe* plasty [52], defatted area of skin folded onto itself to create an umbilical depression [53], modified 'unfolded cylinder' technique [55], triangular skin flap [56], two semicircular defatted skin flaps [58], bilobed flap [59], modified c–v flap [60], maltese cross technique [61], inverted umbilical reconstruction [62], tubularized trapezoid flap [63], double triangular flap and trapezoid flap [64], inverted C flap [64], celtic cross technique [65], rabbit head–shaped scar flap (Fig. 6) [66], superior polygonal skin flap [67], double opposing Y technique [68], modified 2 twisted flaps technique [69], X-shaped incision that creates 4 V-shaped flaps [70], 2 triangular rotation flaps [71], modified inverted C–V flap with conjoint flaps [72], double purse string technique [73], spiral rotational flap (Fig. 7) [75], dome procedure (Fig. 8) [76], scarless neo-umbilicoplasty [29], bilateral square *pumpkin-teeth* advancement [77], Z omphaloplasty (ZORRO) [78], local lateral horn flaps rotated in opposite directions [29]

reconstruction. It is appropriate to clarify the terminology, as follows. The terms umbiliconeoplasty, neo-omphaloplasty, and *neoumbilicoplasty* refer to the creation of a navel (umbilical reconstruction) where it does not exist, whereas the terms *umbilicoplasty*, *omphaloplasty*, and *umbilicaplasty* refer to the transposition of the umbilicus (umbilical reinsertion) during abdominoplasty or other abdominal surgeries [4–6]. The aim of this review is to provide a complete overview of all existing surgical umbiliconeoplasty techniques.

Methods

PubMed database was queried using 'umbilical and reconstruction', 'umbilicus and reconstruction', 'navel and reconstruction', 'umbiliconeoplasty', 'neo-omphaloplasty' or 'neoumbilicoplasty' to select the papers dealing with the reconstruction of the umbilicus. Only the studies in which the performed surgical technique was clearly described were included. Studies on umbilical reinsertion in abdominoplasty or during other surgeries were excluded. The database search was conducted from January 2019 to March 2019 by the first author (A.S.).

Results

We found 77 papers from 1955 to 2018 (Tables 1 and 2). Sixty different techniques for the reconstruction of a missing umbilicus were described: 56 flap [7–78], 2 graft [52, 79], and 2 combined flap and graft techniques were described [80, 81]. Eight representative techniques out of them have been selected by the first author (A.S.) based on frequency of description in the literature and clinical significance and have been illustrated in Figs. 1, 2, 3, 4, 5, 6, 7, and 8. Local skin flap was the most frequently performed technique. Three flaps technique (Fig. 1) was described in 7 papers [14–19, 82], and purse-string suture technique (Fig. 2) in 7 [8–12, 21, 73].

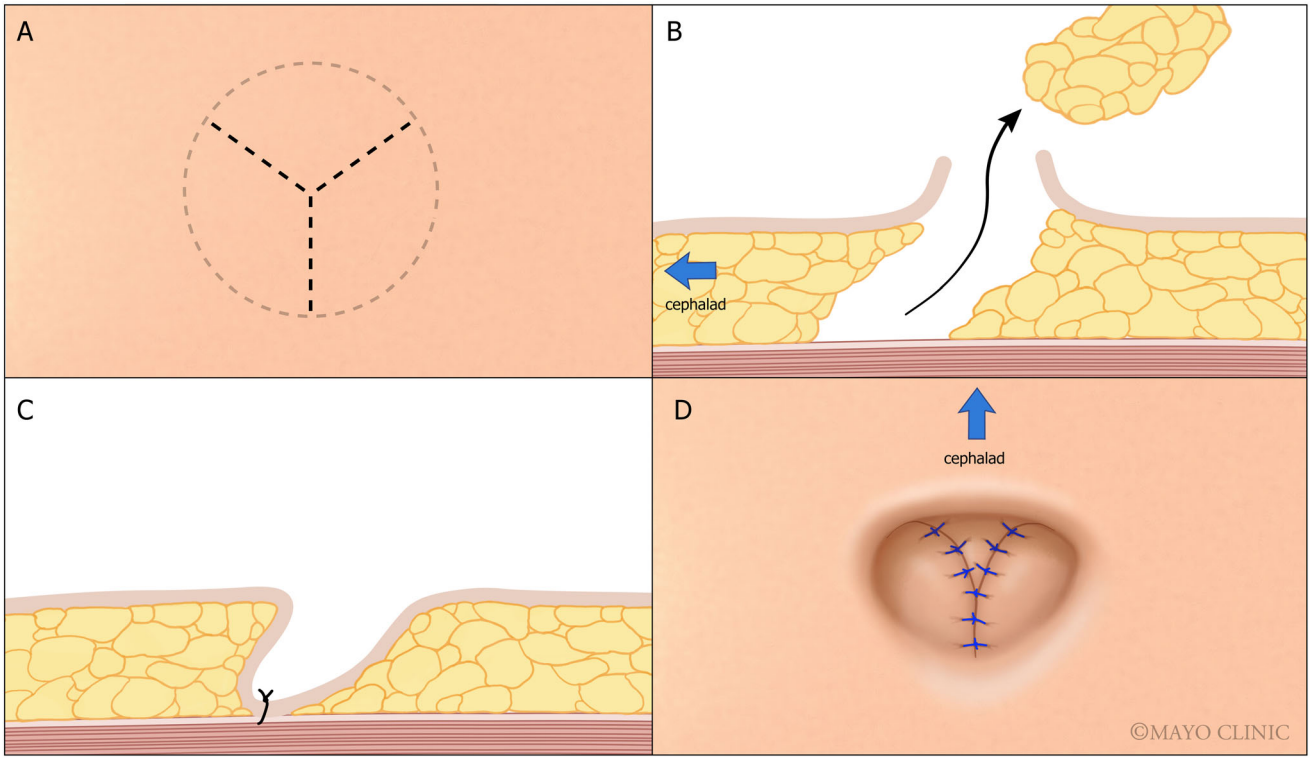

Fig. 1 Three triangular flaps technique, also called tricuspid or diamond shape, Y to V, or Mercedes-Benz [14–16, 18, 19]. **a** Preoperative drawing. **b** Subcutaneous tissue removal. **c** Skin flaps are sutured to the abdominal fascia. **d** Postoperative aspect

Neo-omphaloplasty during inverted T abdominoplasty using the 2 lateral rectangular pedicle flaps technique was described in 4 papers (Fig. 3) [27, 28, 37, 57].

The Four flaps technique was described in 5 papers [3, 40, 54, 70, 74] (Fig. 4), while the Island flap technique was described in 4 [20–23]. Seven articles described the use of more than 1 surgical technique [24, 29, 31, 39, 41, 52, 64].

Figure 5 illustrates the Inverted C–V flap, as described by Shinohara et al. [49] Fig. 6 illustrates the Rabbit head–shaped scar flap, as described by Watanabe et al. [66] Fig. 7 illustrates the Spiral rotational flap, as described by Featherstone and Cuckow [75]. Figure 8 shows the Dome procedure, as described by Senturk et al. [76] Figs. 9 and 10 show 2 representative cases of neo-omphaloplasty during inverted T abdominoplasty using the 2 lateral rectangular pedicle flaps technique.

The types of umbilicus reconstruction were classified according to the cause of reconstruction: congenital umbilicus malformations, exomphalos repair, omphalocele or gastroschisis, urinary malformations, umbilical hernia repair, umbilical endometriosis, abdominoplasty, resection of cutaneous tumors, absent or destroyed umbilicus, abdominal wall surgeries, intra-abdominal surgeries, and multiple causes (Table 3).

The most frequent indication for umbilical reconstruction was after the correction of umbilical hernia, as described in 16 papers [7, 14, 15, 18, 22, 23, 30, 35, 36, 38, 47, 51–53, 68, 76].

Twelve different techniques [27–29, 37, 39, 55, 57, 59, 60, 64, 70, 80] were described for the immediate reconstruction of the umbilicus during abdominoplasty (Fig. 3 illustrates the Neo-omphaloplasty during inverted T abdominoplasty using the 2 lateral rectangular pedicle flaps technique [27, 28, 37, 57]). Scarless umbilicoplasty techniques were described in 2 articles [29, 53].

Regarding umbilicus reconstruction in children, 37 articles described surgical techniques with congenital defects such as umbilical hypogenesis, umbilicus agenesia, exomphalos, urinary malformations, omphalocele, gastroschisis, and umbilical hernia (Table 3) [9, 12, 17–19, 22, 30–34, 40, 41, 43–45, 47–54, 62, 63, 66, 71–75, 78, 81].

Ricci et al. [3] described umbilical reconstruction with four-flap technique after abdominal-based microsurgical breast reconstruction, using the technique previously described by Lee [74], Kaneko [54] and by Ricketts and

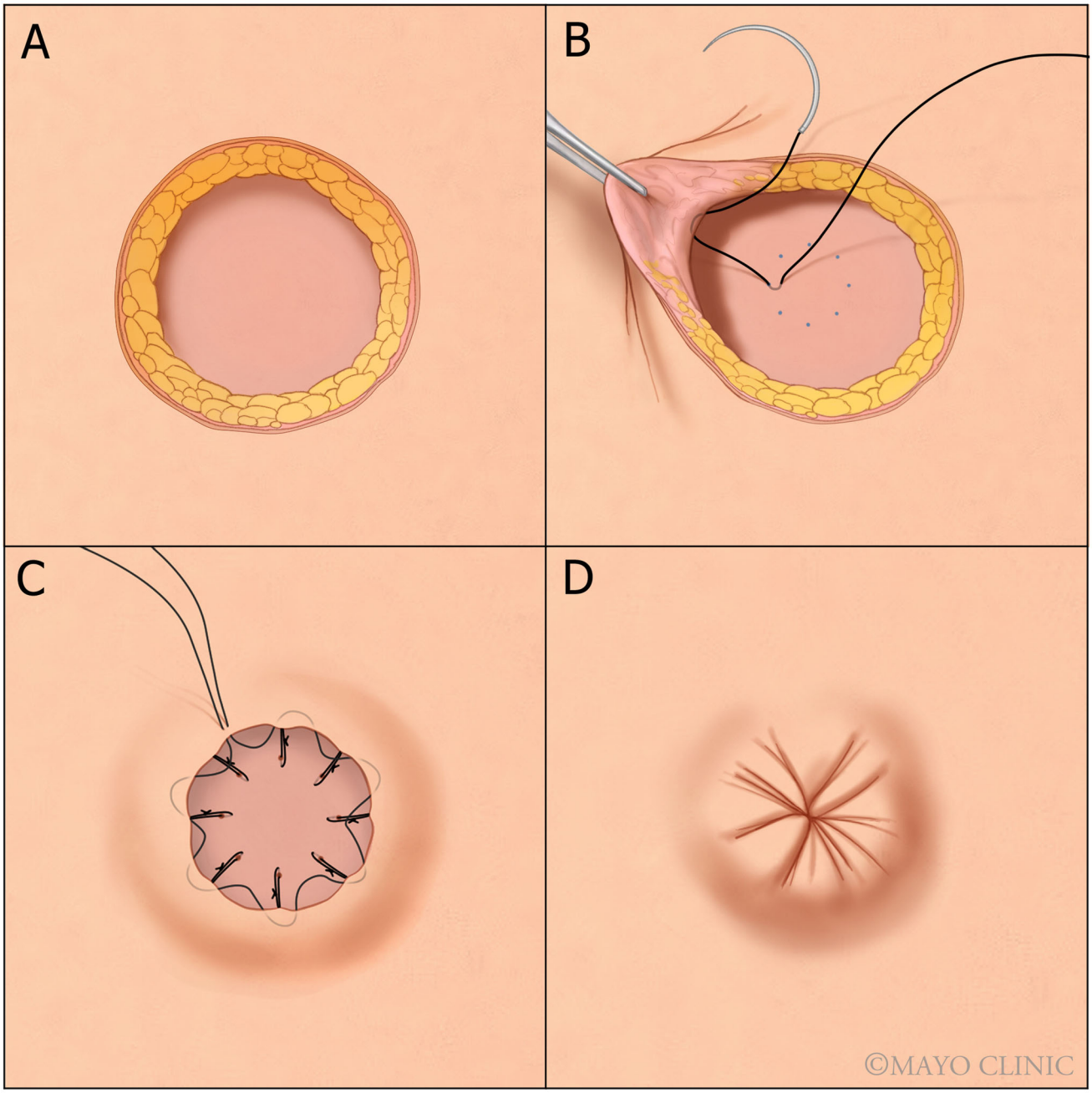

Fig. 2 Purse string technique, as described by Bartisch et al. [9]. The use of purse string technique for umbilical reconstruction was reported by other authors as well [7, 8, 10–13]

Luck [40], while Hazani et al. [80] described the umbilicus reconstruction after TRAM (transverse rectus abdominis muscle) flap for breast reconstruction using a transposition flap and a skin graft.

Discussion

In *umbiliconeoplasty*, a perfect result is difficult to obtain [5, 72, 83, 84]. No real standards define the appearance of an aesthetically pleasing umbilicus; however, a vertically oriented umbilicus with the presence of superior hooding tends to be more attractive than a horizontal one [85–88] Furthermore, the position and dimension of a normal,

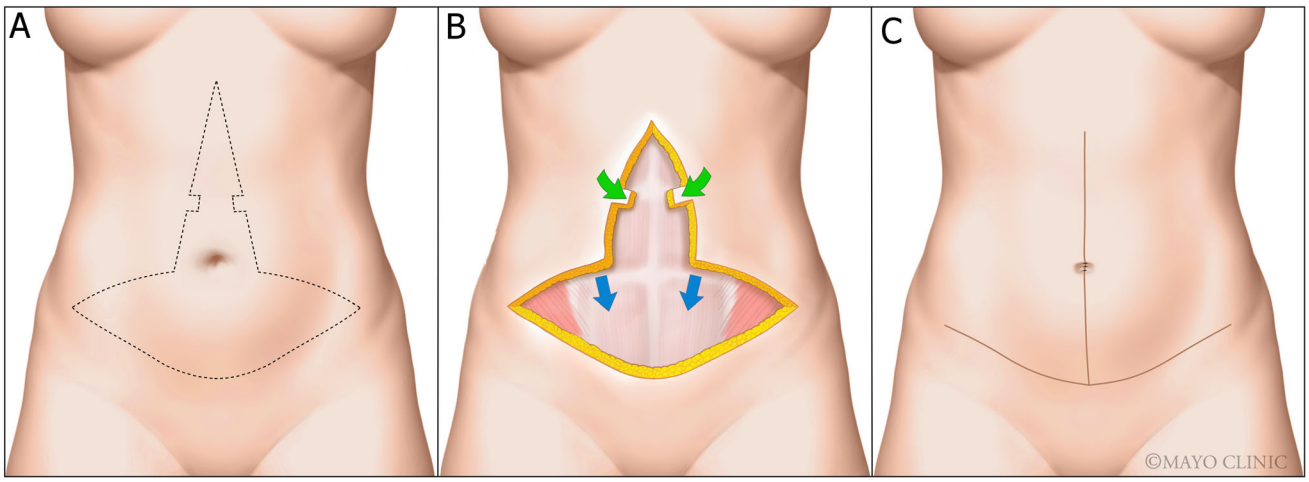

Fig. 3 Neo-omphaloplasty during inverted T abdominoplasty using the 2 lateral rectangular pedicle flaps technique [27, 28, 37, 57]. **a** Preoperative drawing. **b** Movement of the flaps. The opposing skin flaps are sutured to each other and to the abdominal fascia to create a depression (green arrows). **c** Postoperative 'inverted T' scar

good-looking umbilicus should be taken into consideration during surgical planning. Yu et al. [89] observed that the umbilicus is normally located at a mean height distance of -0.7 ± 1.3 cm in relation to the iliac crest (range, 5 cm below to 3 cm above) in young adults. Guerrerosantos et al. [90] proposed the location of neo-umbilicus 1 cm above the horizontal line that connects the 2 iliac crests.

Regarding the transverse position of the umbilicus, Rohrich et al. [91] demonstrated that the umbilicus is not a midline structure as generally thought. Fathi et al. [92] reported 15 mm as the largest dimension of a normal umbilical ring, examining 24 embalmed adult cadavers. Yu et al. [89] reported the mean height of the umbilicus as 2.1 ± 0.6 cm, with a range of 1.3 to 3.7 cm and the mean width as 2.3 ± 0.7 cm (range, 1.0–4.0 cm), in 80 volunteers of normal body habitus.

Reconstruction of the umbilicus can be performed after abdominal hernia repair. McMillan [35] first described an umbilical reconstruction in 1955 using a bilateral lateral advancement flap after the correction of an umbilical hernia. The closure of the skin was accomplished following the vertical laparotomy incision, and at the point where the umbilicus should be located, the skin was sutured to the underlying fascia. This resulted in the formation of a dimple, which makes an excellent substitute for an umbilicus. Borges [36] used a rotation of 2 small paramedian flaps to reconstruct the umbilicus after umbilical herniorrhaphy. Kirianoff [14] first described the 3 flaps technique in 1978 (Fig. 1), then Franco and Franco [16] modified this flap, leaving a central raw area for second-intention healing.

Reconstruction of the umbilicus during vertical or anchor abdominoplasty, when the navel is amputated, has been widely described (Figs. 3, 9, and 10) [27, 28, 37, 57]. Both surgeons and patients have been reported to prefer umbiliconeoplasty to the traditional omphaloplasty with reinsertion of the original navel in the vertical scar, in a study by Vallim et al. [28]. Nevertheless, umbilical transposition is currently more commonly used than umbilical reconstruction. The immediate reconstruction of the umbilicus during vertical or anchor abdominoplasty has been carried out using the 2 lateral pedicle flaps technique in 4 papers [27, 28, 37, 57]. Neo-omphaloplasty during inverted T abdominoplasty using the 2 lateral rectangular pedicle flaps technique is also our personal preference.

Reconstruction of the umbilicus can be performed after surgical correction of pediatric congenital conditions (e.g., bladder exstrophy, omphalocele, and umbilical hernia) as well. In 1969, Tange and Miyake [30] described the use of a transposition flap to reconstruct the umbilicus after surgical repair of umbilical hernia in a 3-year-old child. The 4 flaps technique was first described by Ricketts[38] in 1983, then later by Kaneko and Tsuda in 2004 [54]. In 1999, Matsuo et al. [81] described the use of local flap with cartilage graft for umbilicus reconstruction. The posterior wall of the umbilicus was created by an advancement flap, and the anterior wall of the umbilicus was created by a conchal cartilage composite graft [81]. Since then, many other local flaps have been described to reconstruct the umbilicus in children with bladder exstrophy, omphalocele, or umbilical hernia [9, 12, 15, 17–19, 22, 31–34, 40, 41, 43–45, 47–54, 62, 63, 66, 72–75, 78, 81].

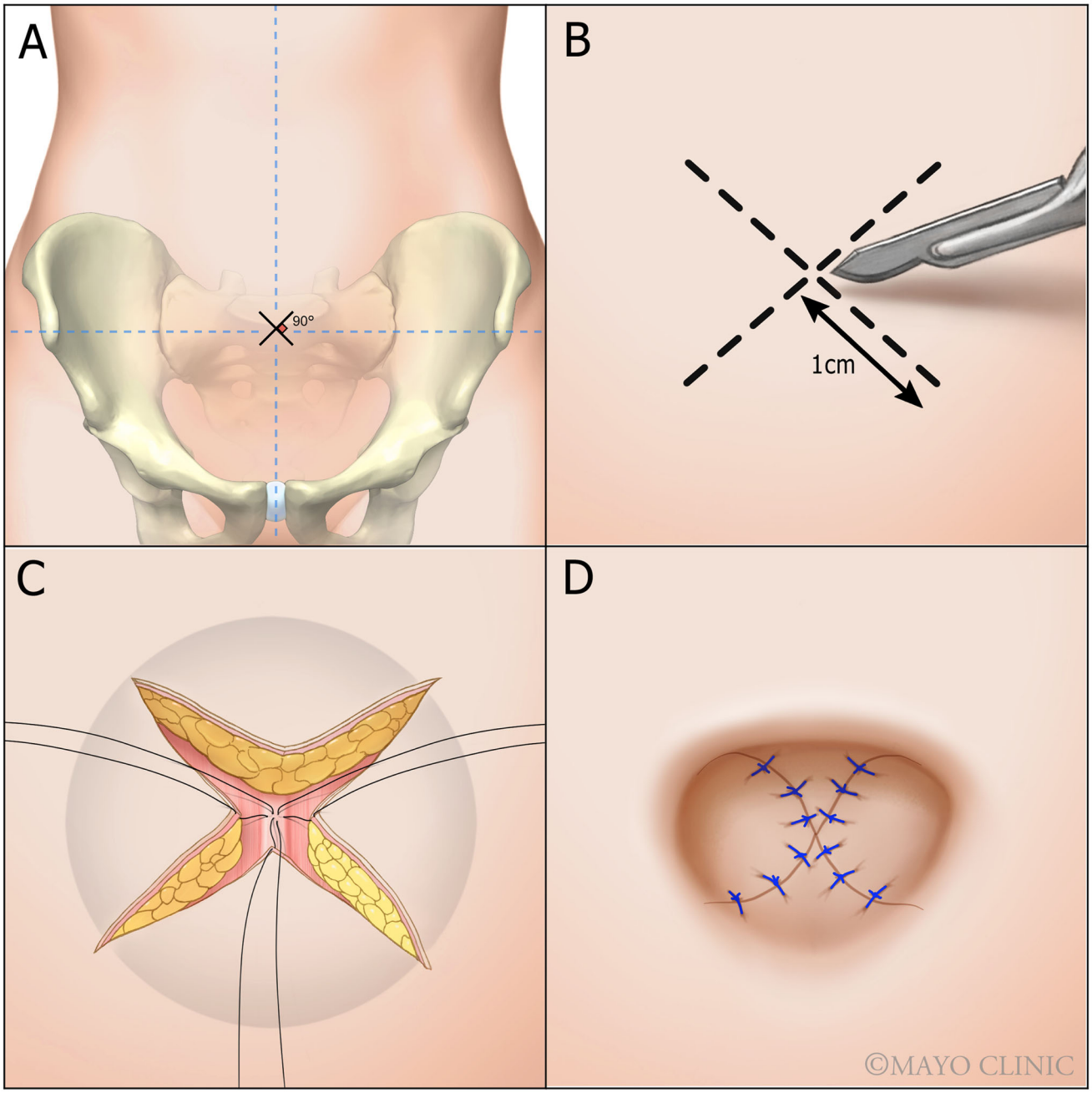

Fig. 4 Four flaps technique, as described by Lee et al. [74]. A cone-shaped portion of the adipose tissue underlying the X-shaped incision is removed to create the depression (C, shaded area). The use of the same technique was reported by other authors as well [3, 40, 54, 70]

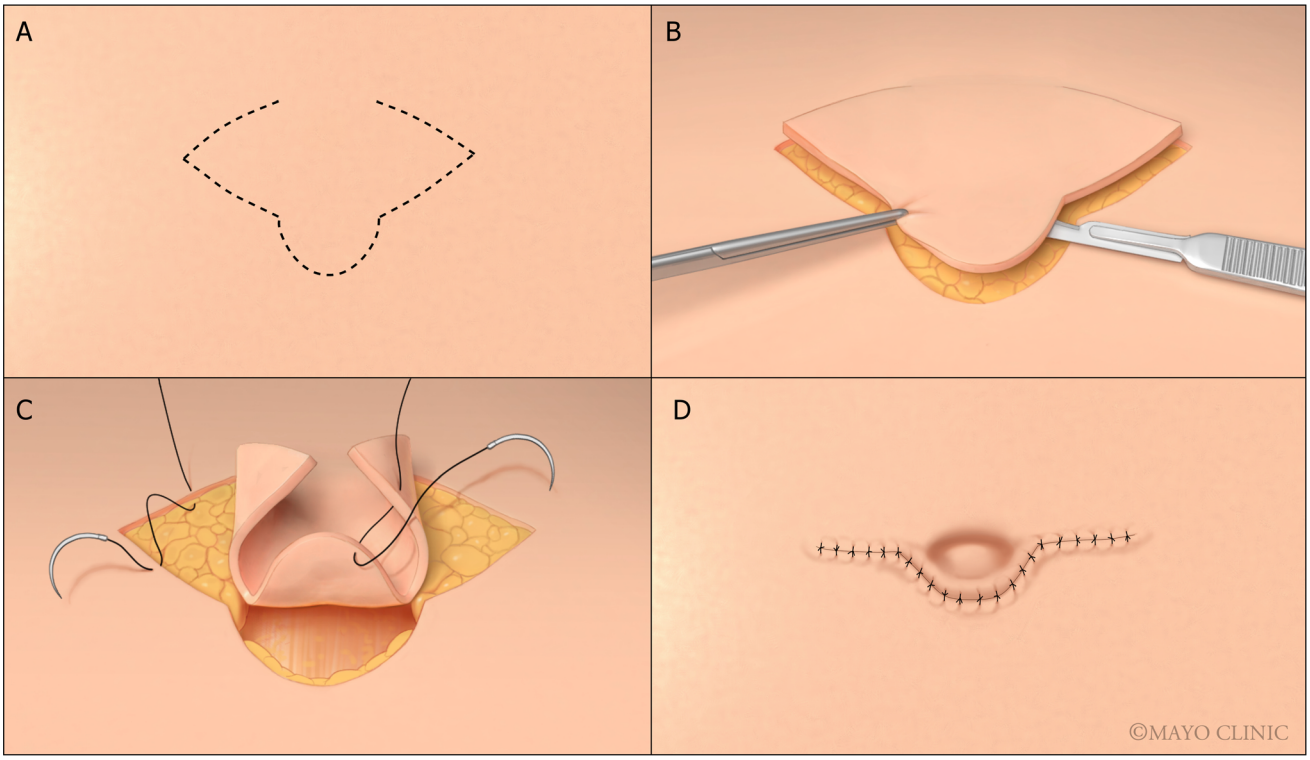

Fig. 5 Inverted C–V flap, as described by Shinohara et al. [49]. **a** preoperative drawing. **b** skin incision. **c** flap rising and initial sutures. **d** immediate post-operative aspect

For the reconstruction of the umbilicus after surgical repair of bladder exstrophy, Hanna and Ansong [32] described the use of a V–Y flap and Sumfest and Mitchell [43] described using a tongue-like flap. Feyaerts et al. [33] described the kangaroo pouch technique, using a rectangular superior pedicled skin flap fashioned as a kangaroo pouch. Three flaps technique, originally described by Kirianoff [14] and later modified by Franco and Franco [16], can also be used. In 2015, Featherstone and Cuckow [75] described the use of spiral rotational flap after correction of bladder exstrophy; they used this technique for the creation of a new umbilicus in 47 patients with excellent cosmetic results and no adverse effects.

Some umbiliconeoplasty techniques were borrowed from nipple-areola reconstruction [93–95]. The reconstruction of the navel is very similar to the reconstruction of the nipple, both generally involving the use of a local flap and the creation of a 3-dimensional structure, but in the case of umbilical reconstruction, the flap will be projected inside. Shinohara et al. [49] were the first to describe the use of C–V flap for umbilicus reconstruction (Fig. 5), then Uraloglu et al. [60] and Lee et al. [72] described modified versions of this technique [49, 60, 72]. Ozbek and Ozcan [55] described the use of a Thomas flap for the reconstruction of umbilicus. Korachi et al. [53] and da Silva Júnior and de Sousa [29] described scarless umbilicoplasty techniques that included defatting a circular area of the abdominal flap, creating an umbilical depression with several transfixed attachment stitches to the underneath muscular fascia. Furthermore, DelMauro et al. reported using a pedicled deep inferior epigastric artery perforator (DIEP) island flap for umbilicus reconstruction [20]. Prior to this, three publications had described the use of an island

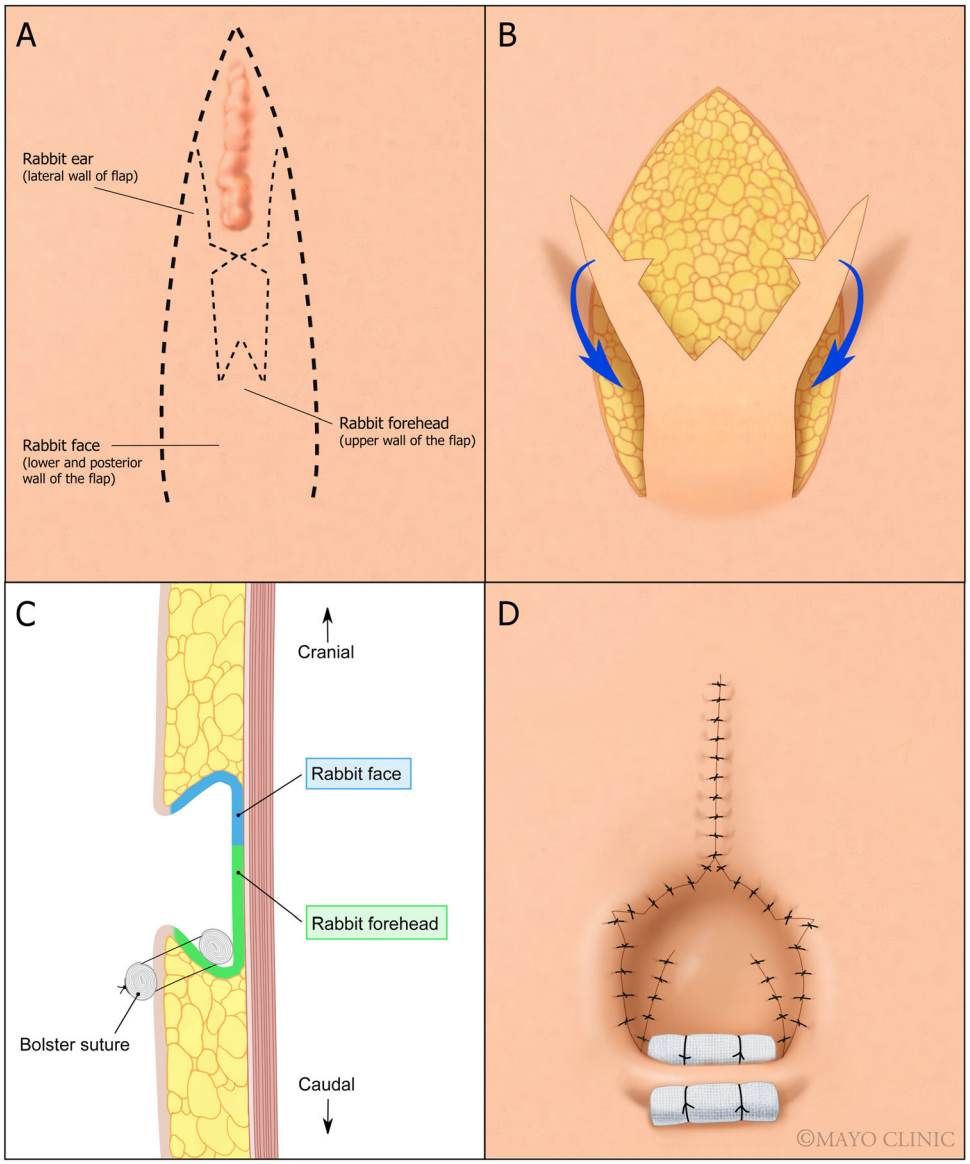

Fig. 6 Rabbit head–shaped scar flap, as described by Watanabe et al. [66]

flap employing otherwise redundant skin from the lateral margin of the defect [21–23].

Conclusion

This is a narrative and pictorial review that aims to make clarity on the currently available options for umbilicus reconstruction. While creating a universal algorithm com-

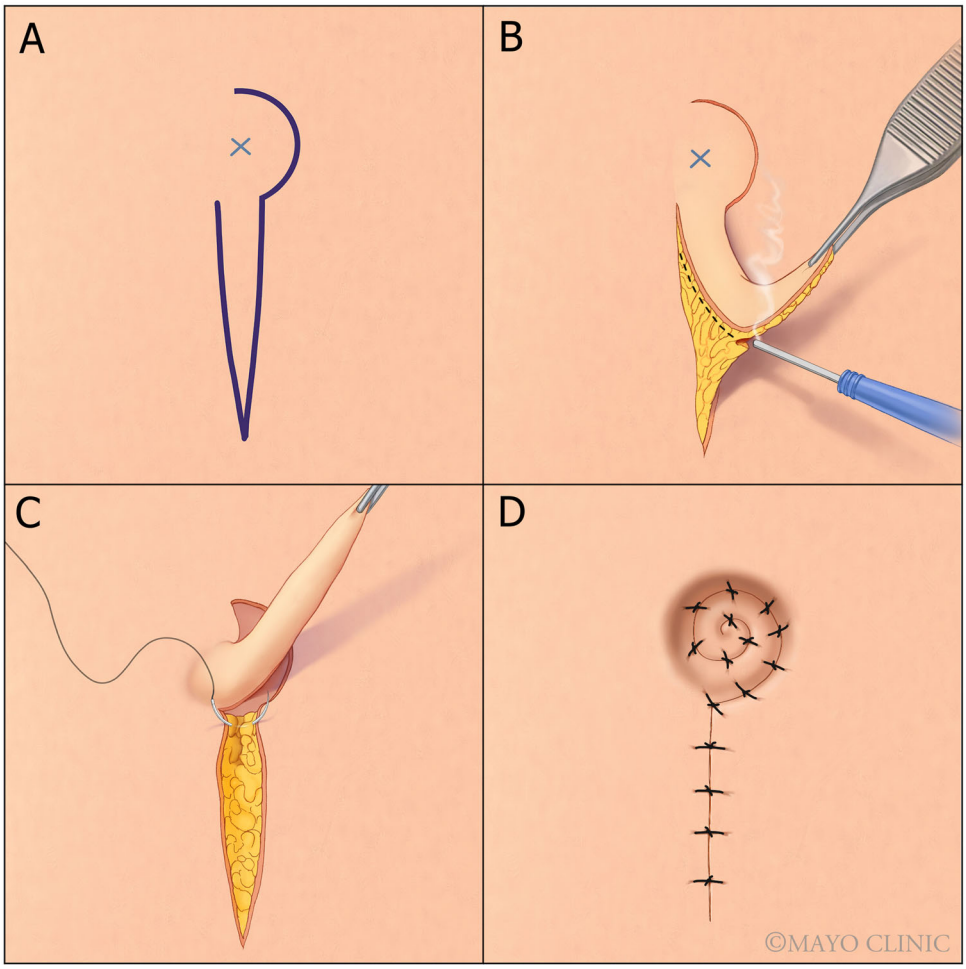

Fig. 7 Spiral rotational flap, as described by Featherstone and Cuckow [75]

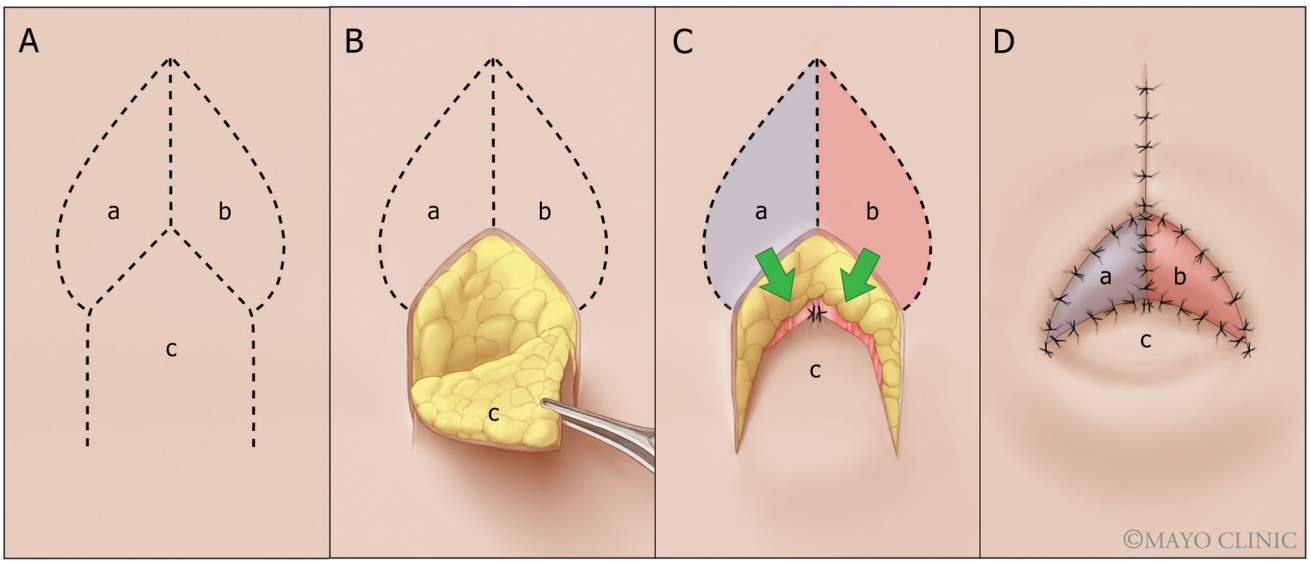

Fig. 8 Dome procedure, as described by Senturk et al. [76]. **a** Preoperative drawing. **b** Rising of c flap. **c** Island flaps b and c are moved downward. **d** Final sutures

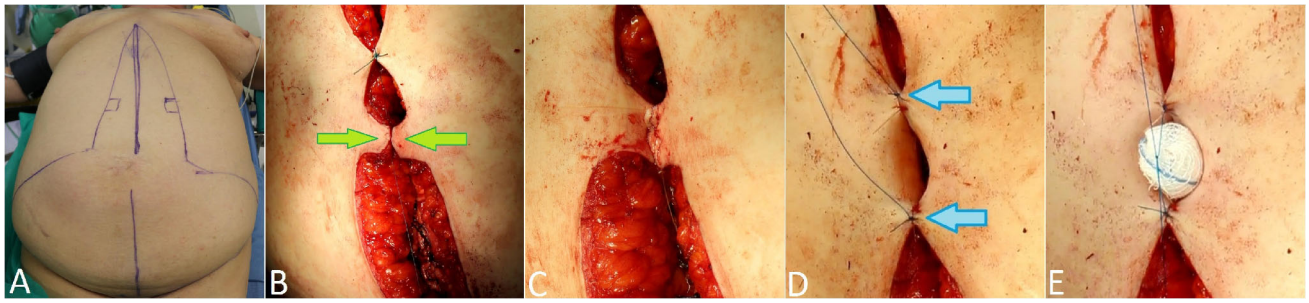

Fig. 9 A 43-year-old female patient. Neo-omphaloplasty during inverted T abdominoplasty using the 2 lateral rectangular pedicle flaps technique [27, 28, 37, 57]. **a**: Preoperative drawing. **b**: The 2 lateral skin flaps (green arrows) are raised and defatted. **c**: The 2 lateral skin flaps are sutured to the abdominal fascia and to each other. **d**: Two prolene stitches (blue arrows) are used to approximate the cranial and caudal ends of the neo-umbilicus. E: A small tampon is inserted inside the neo-umbilicus

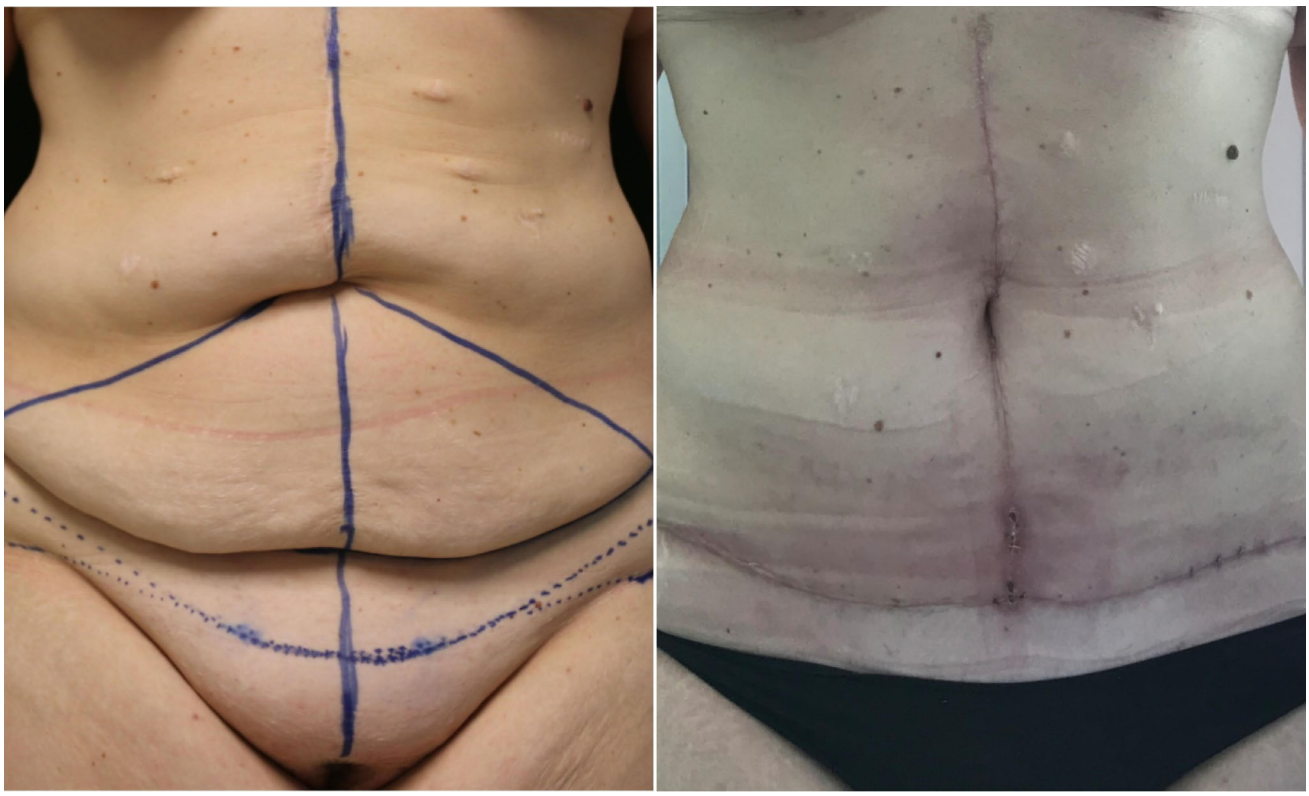

Fig. 10 A 36-year-old patient. Umbilicus reconstruction using the 2 lateral flaps technique, as described by Sabatier et al. [37], Vallim et al. [28], Mendes et al. [27] and Franco et al. [57] Preoperative picture (on the left) and postoperative picture (on the right). The original umbilicus was intentionally amputated and reconstructed during an abdominoplasty, using the two lateral rectangular pedicle flaps technique

Table 3 Type of umbilicus reconstruction due to a specific cause

Causes of reconstruction	Technique	Authors
Congenital umbilicus malformations		
Umbilical hypogenesis	Three flaps technique (Fig. 1)	Iida et al. [17]
Absence of umbilicus	Four flaps technique (Fig. 4)	Lee et al. [74]
Exomphalos repair	Transposition flap	Onizuka et al. [31]
	V–Y flap	Onizuka et al. [31]
	Cone-shaped triangular flap	Itoh et al. [41]
	Cone-shaped rhomboid flap	Itoh et al. [41]
	Triangular conical flap	Sugawara et al. [44]
Omphalocele or gastroschisis	Four flaps technique (Fig. 4)	Ricketts and Luck [40]
	Local flap with cartilage graft	Matsuo et al. [81]
	Lunch box–type method	Onishi et al. [45]
	Inverted C–V flap (Fig. 5)	Shinohara et al. [49]
	Modified inverted C–V flap with conjoint flaps	Omori et al. [71]
	Z omphaloplasty (ZORRO)	Michel et al. [78]
	Elliptical skin flap	Park et al. [48]
	Reverse fan-shaped flap	Masuda et al. [50]
	Rabbit head–shaped scar flap (Fig. 6)	Watanabe et al. [66]
	Cone-shaped rhombotic flap	Itoh et al. [41]
Urinary malformations		
Bladder exstrophy	V–Y flap	Hanna and Ansong [32]
	Tongue-like flap	Sumfest and Mitchell [43]
	Kangaroo pouch technique	Feyaerts et al. [33]
	Tubularized trapezoid flap	Kureel et al. [63]
	Kangaroo pouch technique	Rodo et al. [34]
	Spiral rotational flap (Fig. 7)	Featherstone and Cuckow [75]
Bladder and cloacal exstrophy	Inverted umbilical reconstruction	Cervellione et al. [62]
Urachal cyst repair	Purse-string technique (Fig. 2)	Bartsich et al. [9]
	Two triangular rotation flaps	Omori et al. [71]
Urachal sinus	Purse-string technique	Bongini et al. [12]
Urachal remnants	Three flaps technique (Fig. 1)	Kim et al. [19]
Umbilical cysts	Celtic cross technique	De La Cruz et al. [65]
Umbilical hernia repair	Bilateral advancement flap	Mcmillan et al. [35]
	Transposition flap	Tange et al. [30]
	Rotation of 2 small paramedian flaps	Borges et al. [36]
	Three flaps technique (Fig. 1)	Kirianoff [14]
	Double V–Y procedure	Jamra et al. [38]
	Purse-string technique	Cone et al. [7]
	Three flaps technique (Fig. 1)	Reyna et al. [15]
	Island flap	Marconi et al. [23]
	Two twisted flaps with 1 pedicle	Yotsuyanagi et al. [47]

Table 3 continued

Causes of reconstruction	Technique	Authors
	Lazy-M and omega flaps	Tamir et al. [51]
	Lateral left plasty	Sankale et al. [52]
	Horseshoe plasty	Sankale et al. [52]
	Umbilical graft	Sankale et al. [52]
	Defatted area of skin folded onto itself to create a umbilical depression	Korachi et al. [53]
	Island flap	Kakudo et al. [22]
	Three flaps technique (Fig. 1)	Takasu et al. [18]
	Double opposing Y technique	Dessy et al. [68]
	Dome procedure (Fig. 8)	Şentürk et al. [76]
Umbilical endometriosis	Cone-shaped triangular flap	Itoh et al. [41]
	Purse-string technique	Schoeller et al. [8]
	Two semicircular defatted skin flaps	Kokuba et al. [58]
	Purse-string technique	Malebranche et al. [10]
	Purse-string technique	Moio et al. [13]
Abdominoplasty	Three flaps technique (Fig. 1) and purse-string suture	Pardo Mateu and Chamorro Hernandez [82]
	Circular flap	Apfelberg et al. [39]
	Superiorly-based skin flap	Apfelberg et al. [39]
	Modified *unfolded cylinder* technique	Ozbek and Ozcan [55]
	Bilobed flap	Sevin et al. [59]
	Modified C–V flap technique	Uraloglu et al. [60]
	Double triangular flap and trapezoid flap	Barbosa et al. [64]
	Inverted C flap	Barbosa et al. [64]
	Transposition flap and skin graft	Hazani et al. [80]
	X-shaped incision that creates 4 V-shaped flaps	Clo et al. [70]
	Scarless neoumbilicoplasty	da Silva Júnior and de Sousa [29]
	Lateral horn flaps rotated in opposite directions	da Silva Júnior et al. [29]
	Two rectangular lateral skin flaps (Fig. 3)	Vallim et al. [28]
		Franco et al. [57]
		Mendes et al. [27]
		Sabatier et al. [37]
Resection of cutaneous tumors	*Iris* technique	Miller et al. [42]
	Two opposing trapezoidal skin flaps	Breuninger et al. [46]
	Superior polygonal skin flap	Zaccagna et al. [67]
	Modified 2 twisted flaps technique	Arai et al. [69]

Table 3 continued

Causes of reconstruction	Technique	Authors
	Purse-string technique	Navysany et al. [11]
	Island pedicle flap	Costa-Silva et al. [21]
Absent or destroyed umbilicus	Triangular skin flap	Pfulg et al. [56]
Abdominal wall surgeries		
Panniculectomy	Transposition flap and skin graft	Hazani et al. [80]
Wall reconstruction and transverse lower abdominal panniculectomy	Island flap	DelMauro et al. [20]
Foreign body granuloma after laparotomy	Cone-shaped triangular flap	Itoh et al. [41]
Preexisting scar	Two lateral rectangular pedicle flaps (Fig. 3)	Franco et al. [57]
Vertical midline incision present	Bilateral square *pumpkin-teeth* advancement flap	Purnell et al. [77]
Without midline incision present	Bilateral square *pumpkin-teeth* advancement flap	Purnell et al. [77]
Intra-abdominal surgeries	*Tortellino* shaped graft	Abenavoli et al. [79]
	Double opposing Y technique	Dessy et al. [68]
Multiple causes		
Repair of umbilical hernias, and bladder exstrophy	Three flaps technique (Fig. 1)	Franco and Franco [16]
Umbilical hernia, omphalocele, omphalomesenteric duct, urachal abscess, umbilical granuloma	Four flaps technique (Fig. 4)	Kaneko and Tsuda [54]
Dermolipectomy with umbilical hernias	Maltese cross technique	Rogliani et al. [61]
Abdominal-based microsurgical breast reconstruction	Transposition flap and skin graft	Hazani et al. [80]
	Four flaps technique (Fig. 4)	Ricci et al. [3]
Abdominoplasty, congenital defect of abdominal wall, abdominal wall hernia, abdominal wall tumor, failure of umbilicoplasty	Local flap using 3 methods	Kajikawa et al. [24]
Exomphalos minor, large umbilical hernia	Double purse string technique	Gera et al. [73]

paring the various techniques goes beyond the scope of this study, in order to choose the surgical technique the surgeon might look at the previously reported type of umbilicus reconstruction due to a specific cause (Table 3) and decide accordingly. Illustrations of the most popular techniques (Figs. 1, 2, 3, 4, 5, 6, 7, and 8) may be useful as well.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest to disclose.

Human and Animal Rights, or Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent For this type of study informed consent is not required.

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