



Review

# Indications, outcomes, and complications of neoumbilical reconstruction: A systematic review



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## KEYWORDS

Neoumbilicoplasty;  
Umbilicoplasty;  
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reconstruction;  
Omphalectomy;  
Navel reconstruction

**Summary** *Background and objectives:* Neoumbilicoplasty aims to reconstruct an aesthetically pleasing new umbilicus following agenesis, malignancy, anatomical distortion, or umbilicus loss. Despite the wide variety of surgical techniques described, literature is scarce when it comes to standardized categorization of these as well as the clear definition of patients' selections, specific indications, final outcomes, and possible complications. According to available literature, this work aims to evaluate different surgical approaches, and correlate them to specific surgical needs, to simplify the surgical choice and patient management.

*Methods:* A systematic review was performed in December 2020 in PubMed, Web of Science, and MedLine Ovid databases according to the PRISMA guidelines.

*Results:* A total of 41 studies and 588 patients were finally included. On the basis of the evidence of the literature collected, we divided the studies into four groups according to the neoumbilicoplasty techniques: single suture or purse-string suture, single flap, multiple flap, and skin graft. Patients' surgical comorbidities, neoumbilicoplasty indications, and aesthetic and surgical outcomes were investigated. Direct suture and single and multiple flap techniques assured overall, satisfactory cosmetic outcomes with a low rate of surgical complications.

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Whereas suture-only techniques were chosen mostly by general surgeons/urologists in laparoscopic surgery, the single flap was the preferred method to reconstruct the umbilicus in open abdominal surgery or combined abdominoplasty with herniorrhaphy. Multiple flap and skin grafts were adopted in abdominoplasty-related umbilicus reconstruction, although the latter option showed impactful aesthetic and surgical complications.

**Conclusions:** Umbilicoplasty can assure generally pleasant aesthetic outcomes with relatively low complication rates. Indications for specific techniques correspond to different patient populations and surgical scenarios.

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The umbilicus is a scar developed by the contraction of four postnatal fibrous ligaments: the obliterated umbilical vein, the obliterated urachus, and the two obliterated umbilical arteries.<sup>1</sup>

Surgeons agree that a natural, harmonious, and cosmetically attractive navel consists of a round to oval depression, vertically oriented, with a maximal diameter width between 1.5 and 2 cm. Generally, the umbilicus is located at the midline of the abdomen, slightly above the superior lines between the iliac crests. Dislocation, shape and size distortion, or horizontally oriented umbilical scar is associated with a less appealing abdomen.<sup>2,3</sup>

“Umbilicoplasty” as a term, generally refers to a current procedure in plastic surgery, which aims to reshape/reinsert/reposition/transpose the navel, keeping the original umbilicus and its pedicle, through a newly formed incision in the abdominal skin flap. On the other hand, a “neoumbilicoplasty” (*de novo* neoumbilical reconstruction or umbiliconeoplasty) refers specifically to the reconstruction of the neoumbilicus and it is indicated when the native umbilicus is distorted or its blood supply has been jeopardized, preventing its utilization. This can typically happen when a

congenital malformation (e.g., bladder exstrophy, gastroschisis, or omphalocele) or malignancy involves the native umbilicus, making its complete excision mandatory, followed by a neoumbilicoplasty.<sup>2,4</sup> In literature, not rarely, authors named the transposed umbilicus as “new umbilicus” creating a confused overlap in terminology.

Moreover, when an aesthetic procedure such as abdominoplasty is performed together with ventral/incisional hernia repair, involving rectus abdominis plication and/or mesh insertion, a *de novo* umbilical reconstruction may be necessary to preserve the correct navel vascularization and achieve superior cosmetic outcomes.<sup>5</sup>

No univocal consensus exists in literature, regarding the most appropriate patient selection and surgical indication for the different neoumbilicoplasty techniques. Similarly, no exhaustive quantification exists of the possible complications related to different reconstructive procedures.

The aim of this systematic review is to critically appraise surgical indications, aesthetic outcomes, and complications of different neoumbilicoplasty techniques described in the literature, with a particular focus on patients’ previous abdominal history. Moreover, according to the available

literature, this work aims to eventually correlate different surgical approaches to specific surgical needs, simplifying surgical choice and patient management.

### Materials and methods

In December 2020, a systematic review of the entire Web of Science (<https://clarivate.com/webofsciencegroup/solutions/web-of-science/>), PubMed (<https://pubmed.ncbi.nlm.nih.gov/>), and MedLine Ovid (<https://ovidsp.dc1.ovid.com/ovid-a/ovid-web.cgi>) databases was performed merging the following search items: “neoumbilicoplasty,” “neoumbilicoplasty,” “umbilicoplasty,” “umbilicoplasty,” “omphaloplasty,” and “neoumbilicus reconstruction.”

All article types, except reviews, letters/comments, and conference papers, that were published in English between 1980 and 2020 were considered without restrictions. Other exclusion criteria were reports involving pediatric patients, umbilicus transposition or repositioning only, and those articles where surgical technique, complications, or aesthetic outcomes were missing. Finally, bibliography references were analyzed and supplementary articles were included if pertinent.

All publications were screened manually, and the data extracted according to predetermined criteria. The flow-chart of article selection follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Figure 1).<sup>6</sup>

Apart from bibliometric information, the following data was extracted and tabulated for each article: author, year of publication, type of study, number, sex and age of patients treated, etiology/surgical indication, previous surgeries, patient comorbidities, neoumbilicoplasty technique, complications, cosmetic results, stent/prolonged dressing required, and follow up (Table 1). The term “stent” was used in this article to indicate any type of device to maintain the depth of the neoumbilicus after surgery. It can be a silicon-based conically insert or even a simple pack of gauzes maintained fixed in the new depression.

To simplify the comparability without compromising the exhaustivity, surgical and cosmetic complications mentioned in the studies were classified in subcategories.

Tables, graphs and the statistical analysis were obtained by using Microsoft Excel (Microsoft Corporation) and GraphPad Prism 8 (GraphPad Software).

### Results

To allow comparability between groups, we could detect in the screened literature different clinical scenarios for neoumbilicoplasty (Table 2):

- **open abdominal surgery** such as urachal cyst excision, omphalocele repair, or more generally any type of herniorrhaphy (ventral/incisional, umbilical, with or without mesh or diastasis recti muscles suture);

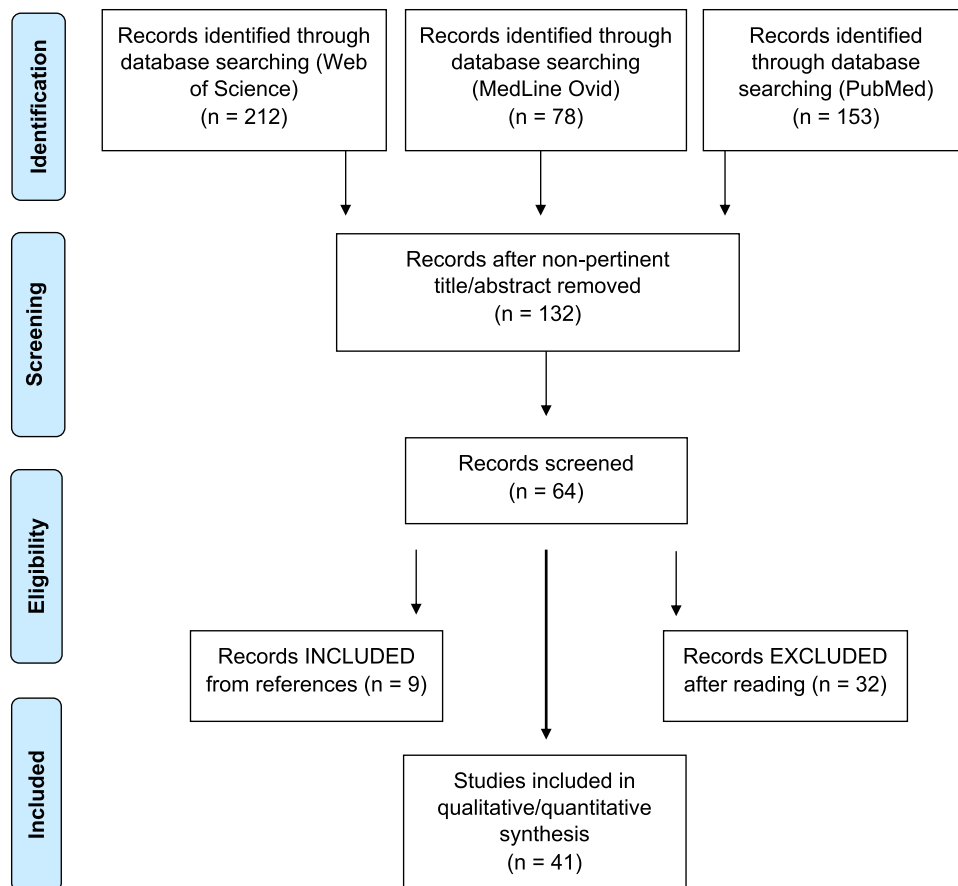


Figure 1 PRISMA flowchart selection process.

**Table 1** Selected publications between 1980 and 2020 in Web of Science, PubMed, and MedLine Ovid according to the research items and our inclusion and exclusion criteria, detailed in material and method section.

Author	Year	Specialty	Patients (N)	Sex (M/F)	Age (Y)	Surgical Scenario (N)	Previous Abdominal Surgery (N)	Comorbidities (N)	Group	Neoumbilicoplasty Technique	Aesthetic Outcomes	Aesthetic Complications	Surgical Complications	Follow Up (Months)
Fode <sup>13</sup>	2016	Urology	9	4 F, 5 M	59	Laparoscopic surgery (Urachal remnant (8) + partial cystectomy(1))	-	-	A	"T" single suture	Satisfactory	None	Infection (2)	-
Huang <sup>14</sup>	2012	General Surgery	40	36 F, 4 M	31	Laparoscopic surgery (Gastric by-pass) (40)	-	Obesity (40, BMI 41.1), Hyperlipidemia (22), Non-alcoholic steatohepatitis (22), Hypertension (9), Diabetes (9), Hyperuricemia (6)	A	"Omega" horizontal suture	Satisfaction questionnaire (3 months) - 4.57 (range 1-5)	None	Seroma (2)	12
Malebranche <sup>42</sup>	2010	Plastic Surgery	1	F	35	Local Excision/Omphalectomy/Scar revision (Umbilical endometriosis) (1)	None	-	A	Purse-string suture	-	None	None	-
Menon <sup>43</sup>	2017	General Surgery	1	M	55	Open Abdominal Surgery (Umbilical hernia) (1)	Laparoscopic surgery (1)	-	A	Horizontal mattress suture	Acceptable	None	None	0.5
Schoeller <sup>44</sup>	2001	Plastic Surgery	3	F	-	Local Excision/Omphalectomy/Scar revision (Umbilical endometriosis) (1), Open Abdominal surgery (Umbilical hernia) (2)	-	-	A	3 purse-string sutures	Satisfactory	None	None	24
Bartsch <sup>16</sup>	2002	Plastic Surgery	3	F	28, 38, 65	Open Abdominal surgery (Urachal cyst (2), Incisional hernia (1))	-	-	A	Purse-string suture + second intention	Satisfactory	-	-	10
Santaneli <sup>15</sup>	2001	Plastic Surgery	1	F	42	Incisional hernia (1)	Open abdominal surgery (1)	-	A	Suture + second intention	Satisfactory	None	None	24
Hanna <sup>22</sup>	1984	Plastic Surgery	2	M	19, 28	Abdominoplasty (1)	Open abdominal surgery (Urinary diversion - bladder extrophy (1))	-	B	1 flap "V-Y"	Satisfactory	None	None	2
Itoh <sup>17</sup>	1992	Plastic Surgery	8	6 F, 2 M	27	Open Abdominal surgery (Omphalocele repair) (4), Local Excision/Omphalectomy/Scar revision (Umbilical scar) (2)	Open abdominal surgery (Laparotomy (2), Omphalocele (1))	-	B	1 flap triangular (7) or rhombic (2)	Acceptable (Good)	None	None	10
Onishi <sup>20</sup>	1995	Plastic Surgery	3	-	18	Open Abdominal surgery (Omphalocele(2), Local Excision/Omphalectomy/Scar revision (Abdominal wall tumor)(1)	-	-	B	1 flap "lunch box technique"	Satisfactory	None	None	9
Ozbek <sup>19</sup>	2004	Plastic Surgery	1	-	-	Open Abdominal surgery (Umbilical hernia) (1)	-	-	B	1 flap reverse "unfolded cylinder"	Satisfactory	None	None	12
Pfulg <sup>45</sup>	2005	Plastic Surgery	2	-	-	Abdominoplasty (2)	-	-	B	1 triangular flap	Satisfactory	None	None	12

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**Table 1** (continued)

Author	Year	Specialty	Patients (N)	Sex (M/F)	Age (Y)	Surgical Scenario (N)	Previous Abdominal Surgery (N)	Comorbidities (N)	Group	Neumbilicoplasty Technique	Aesthetic Outcomes	Aesthetic Complications	Surgical Complications	Follow Up (Months)
Sevin <sup>18</sup>	2006	Plastic Surgery	1	-	-	Local Excision/Omphalectomy/Scar revision (Umbilical scar) (1)	Complicated Abdominoplasty (umbilical necrosis) (1)	-	B	1 vertical bilobed flap	Satisfactory	None	None	12
Sugawara <sup>4,6</sup>	1994	Plastic Surgery	2	F	17, 16	Local Excision/Omphalectomy/Scar revision (Umbilical Scar) (2)	Open abdominal surgery (Omphalocele) (2)	-	B	1 triangular flap	Satisfactory	None	None	16
Tessler <sup>17</sup>	2018	Plastic Surgery	1	F	27	Combined Abdominoplasty + Open Herniorrhaphy (Umbilical hernia + bilateral inguinal hernia) (1)	Cesarian Section (1)	Multiparity (1), Wall laxity (1)	B	1 flap noninverted "U" shaped	Satisfactory	None	None	1.5
Zaccagna <sup>18</sup>	2010	Dermatology	1	F	60	Local Excision/Omphalectomy/Scar revision (Melanoma) (1)	-	-	B	1 polygonal flap	Satisfactory	None	None	86
Ngaage <sup>21</sup>	2019	Plastic Surgery	10	9 F, 1 M	37	Combined Abdominoplasty + Open Herniorrhaphy (Umbilical hernia) (10)	Open abdominal surgery (2)	-	B	1 flap inverted "U" shaped	Satisfaction questionnaire (Likert scale) - 5 points (satisfactory) (7), 4 points (acceptable) (2), 1 point (poor) (1)	Lack of indentation (3), insufficiently notable scar (1)	None	6
Al-shaham <sup>5</sup>	2009	Surgery	17	16 M, 1 F	44	Combined Abdominoplasty + Open Herniorrhaphy (Ventral hernia) (9), Abdominoplasty (8)	-	Multiparity (17), Obesity (17 - BMI range 32.5-39.7) Wall laxity (8)	C	3 triangular flaps	Acceptable	None	None	-
Alfano <sup>26</sup>	2001	Plastic Surgery	1	F	38	Open abdominal surgery (Omphalocele) (1)	-	-	C	2 elliptical flaps	Satisfactory	None	None	24
Arai <sup>24</sup>	2011	Plastic Surgery	1	M	78	Local Excision/Omphalectomy/Scar revision (Bowen disease) (1)	-	-	C	2 flaps rectangular "twisted"	Acceptable (Good)	None	None	10
Baack <sup>1</sup>	1994	Plastic Surgery	2	F	43, 45	Local Excision/Omphalectomy/Scar revision (Umbilical scar) (2)	Open abdominal surgery (Umbilical hernia (1), Abdominoplasty (1))	Obesity (2)	C	2 triangular flaps	Acceptable	None	None	13
Barbosa <sup>49</sup>	2009	Plastic Surgery	2	F	45, 25	Local Excision/Omphalectomy/Scar revision (Umbilical scar) (2)	Complicated Abdominoplasty (umbilical necrosis) (1), Laparotomy (1)	-	C	4 flaps (2 triangular, 2 trapezoid)	Acceptable (Good)	None	None	18
Belay <sup>26</sup>	2020	Urology	1	F	67	Laparoscopic surgery (Urachal adenocarcinoma + partial cystectomy) (1)	-	-	C	4 flaps "Celtic cross"	Acceptable	None	None	-
De la cruz <sup>37</sup>	2009	General Surgery	2	M	27, 30	Open Abdominal surgery (Urachal cyst) (2)	-	-	C	4 flaps "Celtic cross"	Acceptable	None	None	-

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**Table 1** (continued)

Author	Year	Specialty	Patients (N)	Sex (M/F)	Age (Y)	Surgical Scenario (N)	Previous Abdominal Surgery (N)	Comorbidities (N)	Group	Neoubilicoplasty Technique	Aesthetic Outcomes	Aesthetic Complications	Surgical Complications	Follow Up (Months)
Franco <sup>25</sup>	2006	Plastic Surgery	7	-	-	Local Excision/Omphalectomy/Scar revision (Umbilical scar) (7)	Combined Abdominoplasty + abdominal surgery (Ventral hernia (3)), Abdominoplasty (2), Laparotomy (2)	Obesity (7)	C	2 rectangular flaps	Acceptable	None	None	12
Kim <sup>30</sup>	2017	Urology/ Plastic Surgery	16	5 F, 11 M	25	Open Abdominal surgery (Urachal remnant) (16)	-	-	C	3 triangular flaps	Acceptable (Good)	None	Infection (1)	-
Kim <sup>32</sup>	2016	Plastic Surgery	1	F	42	Local Excision/Omphalectomy/Scar revision (Umbilical scar) (1)	Complicated Autologous breast reconstruction (TRAM) (umbilical necrosis) (1)	-	C	4 flaps "iris technique"	Acceptable	None	None	11
Kokuba <sup>27</sup>	2006	Plastic Surgery/ Gynecology	7	F	-	Local Excision/Omphalectomy/Scar revision (Umbilical endometriosis) (7)	-	-	C	2 semicircular flaps	Satisfactory	Hypertrophic scar (2)	-	6
Mateu <sup>30</sup>	1997	Plastic Surgery	5	-	-	Excision/Omphalectomy/Scar revision (Umbilical scar) (1)	Laparotomy/ Open abdominal surgery (4), Complicated Abdominoplasty (umbilical necrosis) (1)	-	C	3 triangular flaps	Acceptable (Good)	None	None	12
Miller <sup>31</sup>	1992	Plastic Surgery	1	F	31	Local Excision/Omphalectomy/Scar revision (Melanoma) (1)	-	-	C	4 flaps "iris technique"	Satisfactory	None	None	6
Nele <sup>29</sup>	2017	Plastic Surgery	3	F	38.5	Local Excision/Omphalectomy/Scar revision (Umbilical scar) (1), Abdominoplasty (2)	Laparotomy/ Open abdominal surgery [Gastrochisis (1), Omphalocele (1)], Complicated Abdominoplasty (flap necrosis) (1)	Obesity (3)	C	2 trapezoidal flaps "bow tie flap"	Good (Acceptable) (1), Very good (satisfactory) (2)	None	None	24
Omori <sup>28</sup>	2011	Plastic Surgery	6	M	33.8	Laparoscopic surgery (Urachal cyst) (5), Open Abdominal surgery (1)	-	-	C	2 triangular flaps	Satisfactory	None	None	17.7
Purnell <sup>23</sup>	2018	Plastic Surgery	55	-	-	Open Abdominal surgery (Abdominal wall reconstruction) (55)	-	-	C	2 rectangular flaps "pumpkin-teeth"	-	Flattened umbilici (1)	Persistent serous drainage (number not mentioned)	-
Senturk <sup>31</sup>	2015	Plastic Surgery	6	-	-	Local Excision/Omphalectomy/Scar revision (Umbilical scar) (6)	Combined Abdominoplasty + abdominal surgery [Incisional hernia (2), Umbilical hernia (4)]	-	C	3 triangular flaps	Satisfactory [VAS score 1-100, mean 77.5 (range 65-85)]	None	Partial flap loss (1)	10.5

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**Table 1** (continued)

Author	Year	Specialty	Patients (N)	Sex (M/F)	Age (Y)	Surgical Scenario (N)	Previous Abdominal Surgery (N)	Comorbidities (N)	Group	Neumbilicoplasty Technique	Aesthetic Outcomes	Aesthetic Complications	Surgical Complications	Follow Up (Months)
Taek Lee <sup>35</sup>	2015	Plastic Surgery	2	F	40	Local Excision/Omphalectomy/Scar revision [Congenital umbilical agenesis (1), hypertrophic umbilicus (1)]	-	-	C	4 triangular flaps	Satisfactory	None	None	16
Teixeira <sup>34</sup>	2012	Plastic Surgery	306	F	46.5	Abdominoplasty (306)	-	-	C	4 flaps "Celtic cross"	Satisfactory (90.7%), Acceptable (9.3%)	None	Infection (12), seroma (7), flap necrosis (4), hematoma (3), dehiscence (1), epidermolysis (1)	15
De Lacerda <sup>33</sup>	1994	Plastic Surgery	9	F	-	Abdominoplasty (9)	-	-	C	4 triangular flaps	Satisfactory (8), Poor (1)	None	None	3
Hazani <sup>40</sup>	2009	Plastic Surgery	5	F	52	Local Excision/Omphalectomy/Scar revision (Umbilical scar) (5)	Combined Abdominoplasty + abdominal surgery [herniorrhaphy (4), bilateral TRAM flap (1)]	Obesity (1, BMI 40)	D	1 "U" shape Flap + Full thickness skin graft	Satisfactory	None	None	9
Villegas <sup>41</sup>	2014	Plastic Surgery	42	F	47	Abdominoplasty (42)	Abdominoplasty (10)	Obesity (22, BMI > 30), smokers (3)	D	Full thickness skin graft	Satisfaction questionnaire: excellent (satisfactory) (20), good (acceptable) (21) and fair (poor) (1)	Epigastric bulging in sitting position (3), epigastric skin redundancy by pinch test (1), higher umbilical position (11), lower umbilical position (4), umbilical deformity (1)	Partial skin-graft failure (10), full skin-graft failure (1)	12
Tobler <sup>52</sup>	2018	Plastic Surgery	1	M	57	Combined Abdominoplasty + Open Herniorrhaphy (Ventral hernia + Umbilical hernia) (1)	Laparotomy/Open abdominal surgery (1)	-	D	Full thickness graft (old umbilicus)	Acceptable	None	None	9
Abenavoli <sup>53</sup>	2001	Plastic Surgery	1	F	54	Open abdominal surgery (Open Herniorrhaphy + ulcerated hypertrophic scar revision) (1)	Laparotomy/Open abdominal surgery (1)	-	D	Full thickness skin graft	Acceptable	None	None	-

**Table 2** Neoumbilicoplasty surgical indications.

Surgical Indications
Open abdominal surgery
Laparoscopic surgery
Local Excision/omphalectomy/scar revision
Abdominoplasty-related umbilicus reconstruction:
o primary abdominoplasty/primary umbilicus reconstruction
o herniorrhaphy and neoumbilicus reconstruction
o secondary neoumbilicus reconstruction after complicated/secondary abdominoplasty

- laparoscopic surgery;
- local tissue excision with omphalectomy (umbilical endometriosis, melanoma, or foreign body excision, etc.) or umbilical scar revision;
- abdominoplasty-related umbilicus reconstruction including:
  - primary abdominoplasty/primary neo umbilicus reconstruction;
  - herniorrhaphy and neo umbilicus reconstruction;
  - secondary neoumbilicus reconstruction after complicated/secondary abdominoplasty.

A total of 41 papers (588 patients) were selected for this study, according to the inclusion criteria. Eight out of 41 were prospective/retrospective studies (19.5%) and 33 out of 41 case reports or case series (80.5%). Female gender was represented by 75% of the patients, whereas male by 8.7%, and sex specification missed in 16.3%.

We divided the studies into four groups according to the surgical technique used to reconstruct the new umbilicus: **single suture or purse-string suture** (Group A, 58 out of 588, 9.9%), **single flap** (Group B, 31 out of 588, 5.3%), **multiple flaps** (Group C, 450 out of 588, 76.5%), and **skin graft** (Group D, 49 out of 588, 8.3%) (Figure 2A, B).

**Group A**

Single or multiple direct sutures or purse-string sutures were grouped in this first category. A total of 86.2% of the patients were treated by general surgeons or urologists with a single-suture technique, whereas 12.1% by plastic surgeons with

purse-string suture procedure or suture with secondary healing (1.7%).

Indeed, this group mainly represented experiences from general surgery units, as the surgical scenarios of neoumbilicoplasty in group A were distributed between laparoscopic surgery (84.5%), open abdominal surgery (10.3%), local tissue excision with omphalectomy (3.4%), and only one case of umbilicus reconstruction in an abdominoplasty scenario (1.7%, all cases of primary abdominoplasty) (Figure 3 A).

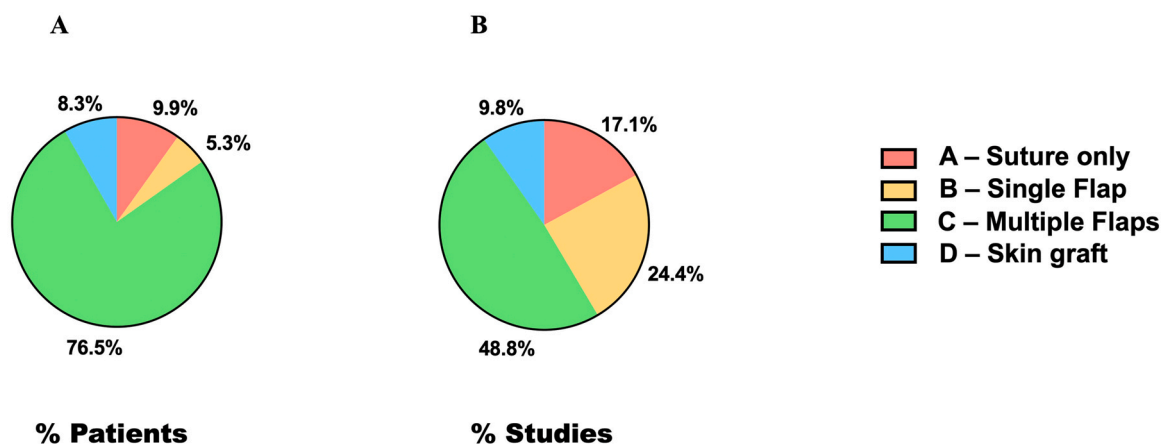
This group showed only two patients having previous abdominal surgery (3.4%) (Table 3).

Aesthetic outcomes were evaluated by surgeons during the patient follow up with general questionnaires in 85.7% of the screened publications. These were satisfactory for more than 95% of the patients with no umbilical hypertrophic scarring, deformities, dislocation, or flattening. Poor outcomes were not reported and in 3.4%, the cosmesis was not mentioned. The postoperative surgical complication rate was 6.9% with half cases of seroma (3.4%) and half cases of wound infection (3.4%) (Tables 4 and 5). Stents were positioned in 14.3% of the studies. Mean patient follow up was 16 months.

**Group B**

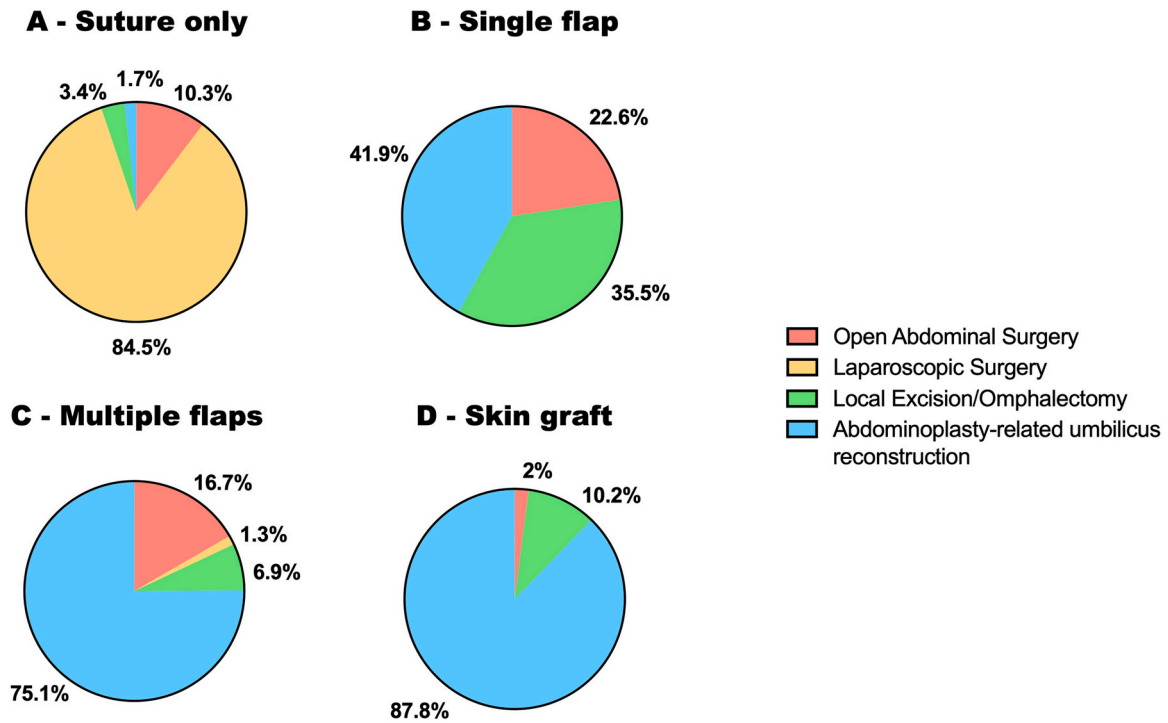
In the second group, we collected all the studies with single-flap reconstruction, independent of the shape and dimension of the flap. A single-flap technique was performed by plastic surgeons in 96.7% and by dermatologists in 3.2%. Neoumbilical reconstruction in this group was most commonly performed in the context of abdominoplasty-related umbilicus reconstruction (41.9%), followed by local tissue excision with omphalectomy and open abdominal surgery accounting for 35.5% and 22.6%, respectively. Specifically, abdominoplasty surgical scenario was distributed as follow: herniorrhaphy and neo umbilicus reconstruction (84.6%), secondary neoumbilicus reconstruction after complicated abdominoplasty (7.7%) or umbilicus reconstruction in primary abdominoplasty (7.7%). (Figure 3 B).

Patients' previous history of abdominal surgery was mentioned as laparotomy/open abdominal surgery in 35.5%, previous abdominoplasty (3.2%), and local tissue excision/omphalectomy and/or laparoscopic access (3.2%). Abdominal



**Figure 2** Number of patients (A) and number of studies (B) included for each neoumbilicoplasty technique group: Group A (Suture only), Group B (Single Flap), Group C (Multiple Flap), and Group D (Skin graft).





**Figure 3** A. Distribution of neoumbilicoplasty surgical indications in the first group (A - Suture only). The suture-only technique mainly reconstructs the neoumbilicus after laparoscopic surgery and was applied by general surgeons or urologists. B. Distribution of neoumbilicoplasty surgical indications in the second group (B - Single flap). The single-flap technique suited for neoumbilicoplasty in open abdominal surgery, especially when the patient underwent to previous abdominal procedures representing the first choice in the case of combined abdominoplasty and herniorrhaphy. C. Distribution of neoumbilicoplasty surgical indications in the third group (C - Multiple flaps). The multiple flaps technique played a significant role in neoumbilicus reconstruction at the end of open abdominal surgeries or in primary abdominoplasty. D. Distribution of neoumbilicoplasty surgical indications in the fourth group (D - Skin graft). The skin-graft technique completed the surgical options, offering a solution in the case of secondary/previous complicated abdominoplasty.

**Table 3** Type of comorbidities and comorbidity rate for each neoumbilicoplasty technique group.

Comorbidities	Group A		Group B		Group C		Group D	
	N	%	N	%	N	%	N	%
Metabolic syndrome or obesity	40.0	69.0	0.0	0.0	29.0	6.4	23.0	46.9
Abdominal wall weakness	0.0	0.0	2.0	6.5	25.0	5.6	0.0	0.0
Laparotomy/open abdominal surgery	1.0	1.7	11.0	35.5	14.0	3.1	2.0	4.1
Local excision/omphalectomy/laparoscopic access	1.0	1.7	1.0	3.2	0.0	0.0	1.0	2.0
Abdominoplasty	0.0	0.0	1.0	3.2	7.0	1.6	10.0	20.4
Combined and/or complicated abdominoplasty	0.0	0.0	0.0	0.0	5.0	1.1	5.0	10.2
Smoke	0.0	0.0	0.0	0.0	0.0	0.0	3.0	6.1
Total	42.0	72.4	15.0	48.4	80.0	17.8	43.0	87.8

Abdominal wall weakness as relevant comorbidity was reported in 6.5% of the patients, confirming how this patient's population was significantly impacted by previous general surgery procedures/care and was then directed to plastic surgery care (Table 3).

Group B showed satisfactory (64.5%) or acceptable (32.3%) cosmetic results with a 3.2% of poor cosmesis, evaluated by a generic questionnaire (77.3%) or the Likert scale (22.7%). Flatted umbilici were described in 9.7%, and

**Table 4** Summary of aesthetic complications for each neoumbilicoplasty techniques group.

Aesthetic Complications	Group A		Group B		Group C		Group D	
	N	%	N	%	N	%	N	%
Flatted umbilici/lack of indentation	0.0	0.0	3.0	9.7	1.0	0.2	1.0	2.0
Hypertrophy/scarring	0.0	0.0	1.0	3.2	2.0	0.4	0.0	0.0
Epigastric bulging/redundancy	0.0	0.0	0.0	0.0	0.0	0.0	4.0	8.2
Higher/lower umbilici position	0.0	0.0	0.0	0.0	0.0	0.0	15.0	30.6
Total	0.0	0.0	4.0	12.9	3.0	0.7	20.0	40.8

**Table 5** Summary of surgical complications for each neoumbilicoplasty techniques group.

Surgical Complications	Group A		Group B		Group C		Group D	
	N	%	N	%	N	%	N	%
Partial flap loss	0.0	0.0	0.0	0.0	1.0	0.2	10.0	20.4
Flap necrosis	0.0	0.0	0.0	0.0	4.0	0.9	1.0	2.0
Seroma	2.0	3.4	0.0	0.0	7.0	1.6	0.0	0.0
Wound infection	2.0	3.4	0.0	0.0	13.0	2.9	0.0	0.0
Hematoma	0.0	0.0	0.0	0.0	3.0	0.7	0.0	0.0
Epidermolysis/dehiscence	0.0	0.0	0.0	0.0	2.0	0.4	0.0	0.0
Total	4.0	6.9	0.0	0.0	30.0	6.7	11.0	22.4

scarring anomalies in 3.2%. Globally, cosmetic complications were listed in 12.9%, whereas no surgical complications were reported (Tables 4 and 5). Stents were applied in 45.5% of the studies. The mean follow-up was 22 months.

### Group C

Multiple flaps techniques were performed by plastic surgeons in 95.6% and by urologists or general surgeons in 4.4%. In most of the cases (81.8%), more than two flaps were used for neoumbilical reconstruction, whereas in 18.2% only two flaps were applied.

Surgical scenarios for the multiple flaps technique neoumbilicoplasty were distributed as following: 75.1% abdominoplasty-related umbilicus reconstruction, 16.7% open abdominal surgery, 6.9% local tissue excision/omphalectomy, and 1.3% laparoscopic surgery. Particularly, in abdominoplasty-related umbilicus reconstruction subcategories, 93.8% umbilicus reconstruction was in primary abdominoplasty, 5% herniorrhaphy and neo umbilicus reconstruction, and 1.2% secondary neoumbilicus reconstruction after complicated abdominoplasty (Figure 3 C).

Patients' systemic and surgical comorbidities were detailed in metabolic syndrome (6.4%), abdominal wall weakness (5.6%), previous laparotomy/open abdominal surgery (3.1%), abdominoplasty with concomitant open herniorrhaphy (1.1%), and previous primary abdominoplasty (1.6%) (Table 3).

Overall, patients achieved satisfactory (77.6%) or acceptable (9.1%) aesthetic outcomes with a cosmetic and surgical complication rate of 0.7% and 6.7%, respectively. Poor cosmetic results were reported by 0.2% of the patients due to flattened umbilici (0.2%) and hypertrophic scar (0.4%) (Table 4). Cosmetic outcomes were not mentioned in 13.3% of the screened publications. Surgical complications were distributed through wound infection (2.9%), seroma (1.6%), flap necrosis (0.9%), hematoma (0.7%), epidermolysis (0.4%), and partial flap loss (0.2%) (Table 5). Stents were positioned in 45% of the studies. Mean patient follow-up was 16 months.

### Group D

Group D consisted of full thickness skin-graft procedures (89.8%) or a combination of single flap plus full thickness skin graft (10.2%). Surgical procedures were performed by plastic surgeons only.

Neoumbilicoplasty in this group was mainly adopted in the context of abdominoplasty-related umbilicus reconstruction

(87.8%), local tissue excision/omphalectomy (10.2%), and open abdominal surgery (2%) (Figure 3 D).

In the abdominoplasty group, the vast majority (74.4%) of the umbilical reconstructions were performed in primary abdominoplasty, followed by 23.3% of umbilical reconstruction after complicated/secondary abdominoplasty and only 2.3% after herniorrhaphy. Comorbidities were assessed as metabolic syndrome (46.9%) and smoking (6.1%). Patients' previous abdominal surgery consisted of abdominoplasty in 20.4%, abdominoplasty with concomitant open herniorrhaphy in 10.2%, open abdominal surgery in 4.1%, and local tissue excision with omphalectomy in 2% of the patients (Table 3).

General questionnaires graded patients' cosmesis as following: 51% satisfactory, 46.9% acceptable, and 2% poor. Umbilici position anomalies (30.6%), higher or lower than expected, epigastric bulging/skin redundancy (8.2%), and flattened umbilici (2%) were reported as the most frequent aesthetic complications. (Table 4). Besides that, surgical complication rate reached 22.4%, mainly represented by partial skin-graft failure with delayed healing (20.4%) or occasionally total skin-graft failure (2%) (Table 5).

Overall, aesthetic and surgical complications impacted significantly the patients' follow-up with 40.8% and 22.4%, respectively.

Stents were positioned in 25% of the studies. Mean patient follow-up was 11 months.

## Discussion

Umbilicoplasty is the most common technique for transposing the navel in elective, noncomplicated abdominoplasty. This technique preserves the original navel and its pedicle, isolating the entire umbilicus from the abdominal flap, and passes it through a new orifice in the upper abdominal flap. However, the new transposition site is limited by the previous position and the length of the pedicle. Vascular complications of the umbilical stalk may occur and cannot be minimized, especially in the case of concomitant plication of the rectus abdominis muscle and/or abdominal surgery.<sup>5,7,8</sup> In such cases, the navel excision followed by neoumbilicoplasty may be the most appropriate option in these scenarios.<sup>9-11</sup>

Conversely, neoumbilicoplasty describes a *de novo* creation of the umbilicus, which can be absent or compromised. A wide range of surgical procedures have been proposed in the last decades, secondary healing to dermal substitute, skin grafts, or local flaps. Whereas periumbilical sutures can lead to visible scars and can increase the risks of stenosis, graft techniques

can have the drawback of donor site morbidity, particularly for the composite grafts (e.g., conchal cartilage) as described by Matsuo et al.<sup>12</sup> On the other hand, the use of local flaps, following the *like-to-like* principles, can give a superior natural appearance and can support a safer wound healing, introducing well-vascularized tissue while minimizing possible surgical complications.<sup>2</sup>

The ideal neoumbilicoplasty should be reliable, reproducible, aesthetically pleasing with low morbidity. Its reconstruction aims to redefine a natural-looking vertically oriented umbilicus with a superior hooding and sufficient depth, limiting the external visible scars.<sup>1,3</sup>

After literature analysis, this systematic review identified four different types [Group A (suture only), B (single flap), C (multiple flaps), and D (skin grafts)] of surgical management for the neoumbilicoplasty as following discussed.

### Group A

Direct closure with a single, "T" shaped, suture was applied by Fode to reconstruct the umbilicus after symptomatic urachal cyst resection with satisfactory cosmetic results, but in 22.2% of the cases, local wound infection was described.<sup>13</sup> Similarly, Huang chose a horizontal single, "Q"

shaped, suture for the neoumbilicoplasty after transumbilical laparoscopic sleeve gastrectomy: favorable cosmesis was achieved with overall 5% of surgical complications.<sup>14</sup>

Single suture or purse-string suture is often designed to leave the central middle defect healing by second intention. Although it could cause prolonged open wound management and higher risk of postoperative infections, satisfactory cosmetic results and uneventful follow up were achieved for neoumbilicoplasty in abdominoplasty,<sup>15</sup> urachal cyst resection, and umbilical hernia repair.<sup>16</sup>

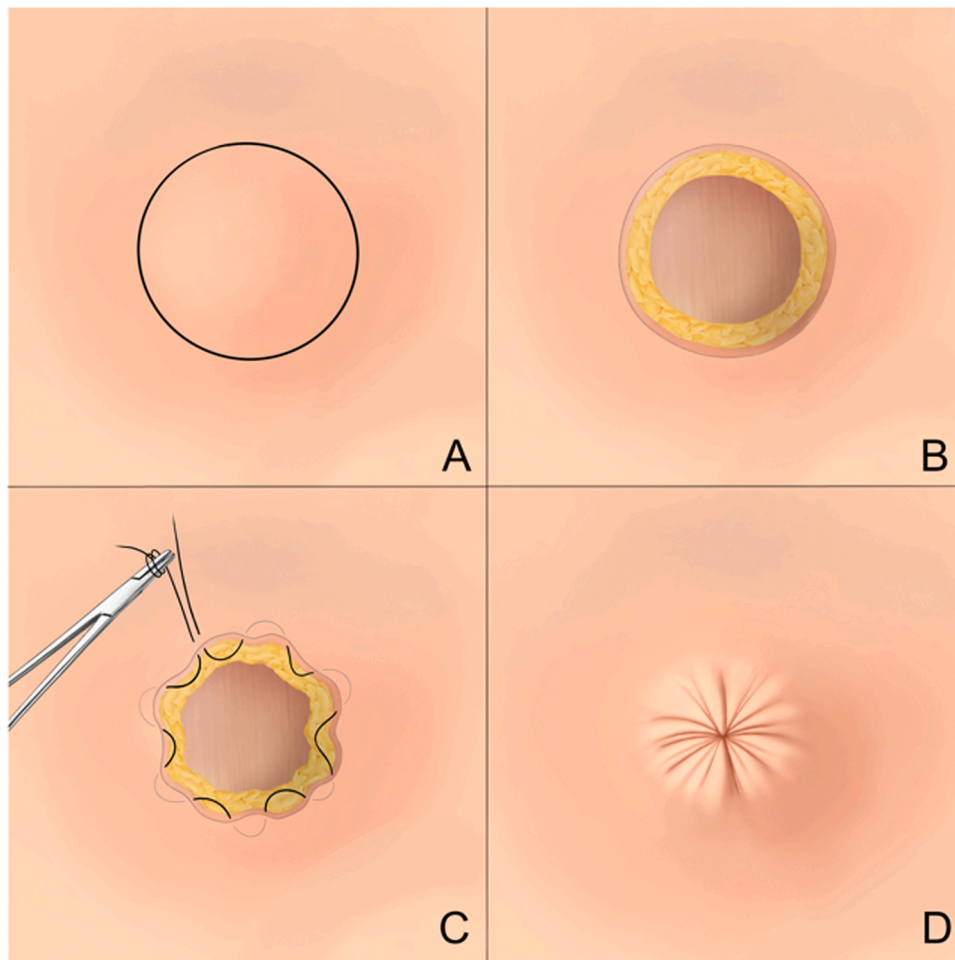
A schematic graphical demonstration of the purse-string suture technique is illustrated in Figure 4.

Despite the functional outcomes in this group being more impactful on patient and surgeon expectations than the aesthetic counterpart, the cosmesis, overall, was judged satisfactory by authors with more than 95% stating no aesthetic deformations/complaints.

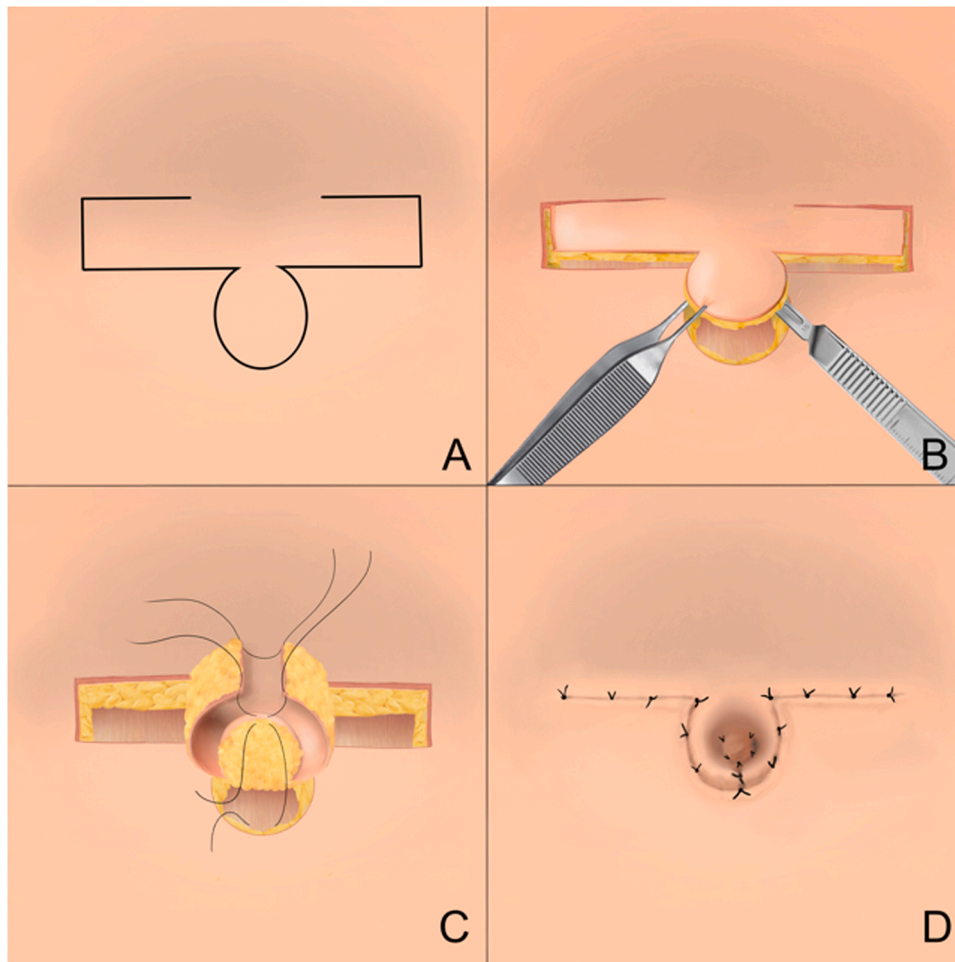
The history of abdominal surgery for the patients of this group was absent, implying that such techniques were mainly applied as primary procedures on nonjeopardized tissues.

### Group B

When considering the cosmetic and surgical outcomes displayed, the single-flap technique seemed to be safe and



**Figure 4** Purse-string suture technique for neoumbilicoplasty. (A) Preoperative drawing, (B) skin incision and tissue removal, (C) open purse-string suture, and (D) neoumbilicus after closure and fixation of the purse-string suture.



**Figure 5** Single-flap technique for neoumbilicoplasty. (A) Preoperative drawings, (B) skin incision and flap dissection, (C) flap harvesting, and (D) neoumbilicus after final sutures.

effective despite the definitely more morbid population or in the case of more extensive wounds/defects, achieving consistent satisfactory outcomes with minimal risk of postoperative surgical complications.

According to the type of the tissue defect, shape, and size of the abdominal scar, the single flap can be harvested in different patterns. A triangular or rhombic “cone-shaped” single flap was applied by Itoh for neoumbilicoplasty in four cases of omphalocele repair, one umbilical endometriosis resection, two cases of umbilical foreign body resection, and one umbilical defect correction.<sup>17</sup>

A single flap splits distally into two terminal ones, referred to as the “lunch box technique,” was proposed by Onishi, whereas a single reverse flap, “unfolded cylinder,” was suggested by Ozbek: umbilical hernia repair, abdominal wall tumor resection, and omphalocele correction were mainly the indication of neoumbilicoplasty for these authors.<sup>19,20</sup>

The “U” or inverted “U” shaped flap was adopted for umbilicoplasty in combined umbilical hernia repair, abdominoplasty, and scar revision in 10 patients with previous abdominal surgery. Aesthetic deformities reported were the lack of indentation in three patients and flattened umbilici in one, despite the previous positioning of a stent for 1 month.<sup>21</sup>

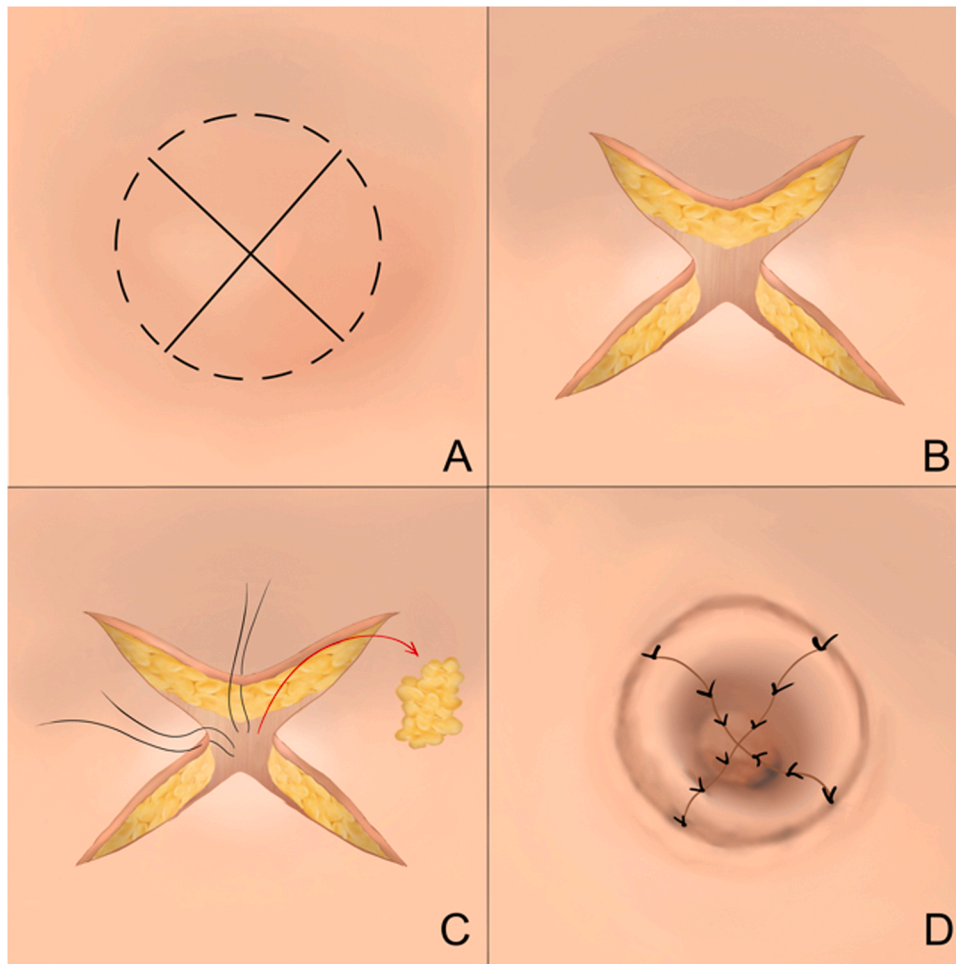
As an example of single-flap reconstruction for neoumbilicoplasty, we propose a graphical illustration of the “unfolded cylinder” technique (Figure 5).

### Group C

In this group, neoumbilicoplasty was mostly part of abdominoplasty-related umbilicus reconstruction, followed by open abdominal surgery. Whereas single and multiple flaps were both adopted in open abdominal surgery, in this group only 3.1% of the patients had previous open abdominal surgery and, more generally, only around 5% had any type of abdominal surgery (including abdominoplasty, herniorrhaphy, or local tissue excision with omphalectomy). This differs with group B, where around 40% of the patients had a previous abdominal procedure before single-flap umbilicus reconstruction.

Neoumbilicus could be designed by two rectangular paramedian flaps in abdominal scar revision surgery (so-called “pumpkin-teeth” advancement flaps technique)<sup>23</sup> or by two rectangular “twisted” flaps after local tumor resection<sup>24</sup> or in scar revision after abdominal surgery.<sup>25</sup>

Alfano<sup>26</sup> (omphalocele repair and rectus diastasis correction), Kokuba<sup>27</sup> (umbilical endometriosis resection), and



**Figure 6** Multiple flaps technique for neoumbilicoplasty. (A) Preoperative drawings, (B) skin incision and flaps dissection, (C) flaps defatting, and (D) neoumbilicus reshaping after final sutures.

Omori<sup>28</sup> (laparoscopic urachal cyst resection) described two triangular flaps, whereas Nele (abdominoplasty and/or scar revision) drew two trapezoidal flaps known as the “bow tie flap” technique.<sup>29</sup>

Moreover, Mateu described navel reconstruction based on three triangular flaps sutured with their vertex to the aponeurotic layer: a purse-string suture recreated the inner walls and enhanced the floor depression. This technique was applied successfully in neoumbilicoplasty concomitant with scar revision and/or abdominoplasty in patients with previous laparotomy and one case of umbilical necrosis post abdominoplasty.<sup>30</sup>

Four-flap techniques with (“Iris technique”)<sup>31,32</sup> or without (“Celtic cross”)<sup>33-37</sup> flap consensual rotation were applied in 40% of the studies in this third group.<sup>31-33,35-39</sup>

Figure 6 shows a schematic presentation of the four-flap neoumbilicoplasty approach.

#### Group D

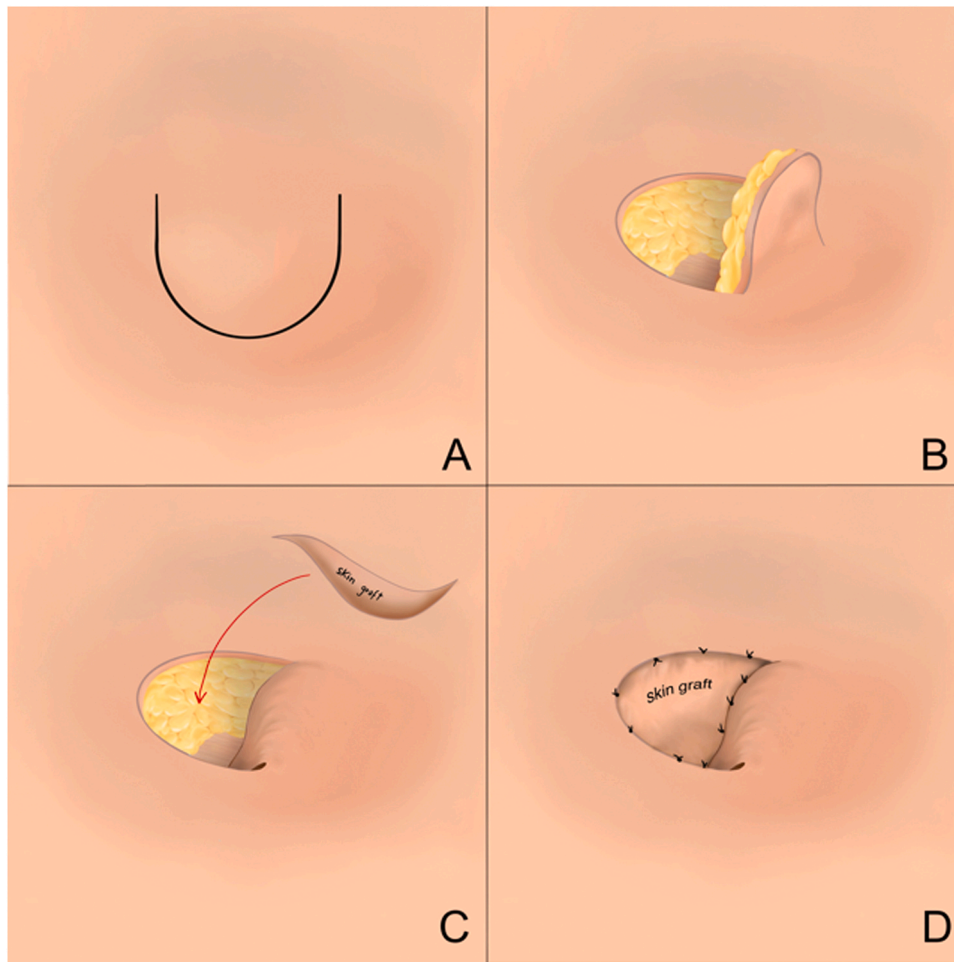
Surprisingly, in this group, the number of patients who received neoumbilicoplasty in primary abdominoplasty was significantly high. Moreover, skin grafts were preferred to multiple flaps in the cases of previous abdominoplasty,

complicated abdominoplasty, or abdominoplasty combined with herniorrhaphies.

In fact, Villegas retrospectively analyzed the outcomes of 42 patients who had undergone an abdominoplasty procedure.<sup>41</sup> Authors chose split-thickness skin graft mainly in obese patients (22 out of 42 with mean BMI 30), occasionally smokers (3 out of 42), in primary abdominoplasty (74.4%) or with previous abdominoplasty (24%). The cosmesis was considered satisfactory in 47.6%, acceptable in 50%, and poor in 2.4%. Main surgical complications reported were partial (23.8%) and complete skin-graft failure (2.4%), whereas from an aesthetic point of view, flattened umbilici (2.4%), odd umbilical position (35.7%), epigastric bulging (9.5%), and umbilical deformity (2.4%) were the most common patients complaints.<sup>41</sup>

Finally, Hazani et al. reported their neoumbilicoplasty experience using a combination of single flap and full thickness skin graft: satisfactory outcomes with no surgical complications were achieved in patients with concomitant abdominoplasty and umbilical/incisional hernia repair (4 out of 5 patients) or bilateral TRAM (Transverse Rectus Myocutaneous) flap (1 out of 5).<sup>40</sup>

For group D, in Figure 7, we graphically summarize the surgical steps to sculpt a new umbilicus with a combination of a single flap (for the umbilical floor) with a skin graft (for lateral walls and roof).



**Figure 7** Skin graft combined with the single-flap technique for neoumbilicoplasty. (A) Preoperative drawing, (B) skin incision and flap dissection, (C) skin-graft inset, and (D) final neoumbilicus shape.

## General discussion

The lack of defined guidelines reflects the absence of large and comparative studies in neoumbilical reconstruction. For this reason, surgeons often opt for a personal experience-based choice, rather than following an approved decisional algorithm. Patient's morbidities, previous abdominal surgeries, and neoumbilicoplasty options should be considered when choosing the procedure, avoiding higher risks of complications and unpleasant aesthetic outcomes.

According to the analyzed literature, direct or purse-string sutures can be an effective option, for both plastic and general surgeons, when the neoumbilicus needs to be reconstructed easily and rapidly at the end of abdominal procedures. When previous multiple abdominal surgeries have deteriorated the quality of soft tissue and weakened the musculoaponeurotic layers, neoumbilicoplasty with single flap should be considered, particularly when neoumbilicoplasty needs to be achieved with a combined herniorrhaphy or major/minor open abdominal surgeries. Multiple flaps and skin grafts have been largely adopted for the neo navel reconstruction in abdominoplasty procedures both as primary indication with concomitant reinforcement of the abdominal wall (eventually with herniorrhaphy), and secondarily to complicated abdominoplasty (e.g.,

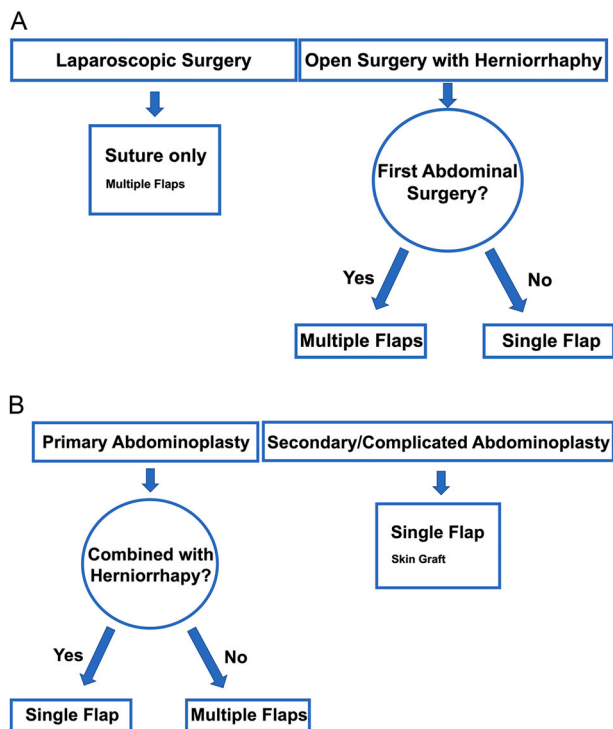
umbilical necrosis). Whereas the multiple flaps technique assures satisfactory or acceptable results with lower surgical complication rates (particularly when no previous abdominal surgery has been undertaken on the patient), the option of using the skin-graft technique, which may seem a safe option in obese patients due to the risk of umbilical necrosis, needs to be carefully considered due to the highest aesthetic (40.8%) and surgical complication (22.4%) rates.

## Limitations

Firstly, this systematic review is limited by the type of studies included, as most of them were case reports or case series (80.5%), with only three of them reporting aesthetic and surgical complications. Conversely, prospective or retrospective studies accounted only for the 19.5% of all the papers selected.

Secondly, patients' surgical abdominal history was mentioned in 48.8% of the papers involved in this review. Half of the papers did not investigate it, leading to a lack of data interpretation.

Finally, the scores used to assess the surgeon's and patient's satisfaction were the Likert score (2.4%), VAS (Visual Analog Scale) score (4.9%), or most commonly a generic evaluation, grading in satisfactory (or very good/excellent),



**Figure 8** Decisional algorithm flow charts. Neoumbilicoplasty in abdominal surgery scenarios (A). Neoumbilicoplasty in abdominoplasty-related umbilicus reconstruction contests (B).

acceptable (or good), and poor (or fair) (90.2%). Patient's satisfaction was not evaluated in 4.9% of the studies. The diversity of the scores applied led to hard comparability between the studies in terms of patients' and surgeons' cosmetic considerations on the reconstructed neoumbilicus.

## Conclusion

This review, despite its obvious limitations, describes the currently available technical options for neoumbilicoplasty, focusing on surgical indications, aesthetic outcomes, and complications to encourage the definition of a proper decisional algorithm. By evaluating on which clinical scenarios the different surgical approaches were used, we could eventually correlate different groups of techniques to specific surgical needs (and previous abdominal status) (Figure 8). Globally, suture only represents the first choice for neoumbilicoplasty in the case of laparoscopic surgery, followed by multiple flaps. In an open abdominal surgery scenario, multiple flaps are chosen in the cases of first abdominal surgery, whereas single flap is commonly applied in patients with a jeopardized abdomen due to previous surgery. Specifically for navel reconstruction in the abdominoplasty in the case of a primary procedure, the multiple flaps are the main option, but when the abdominoplasty is combined with an open herniorrhaphy, the single-flap technique is preferred. Finally, in secondary or complicated abdominoplasty scenarios, the single flap appears to be the first choice, followed by the skin-graft technique.

This work is intended to give the reader a deeper insight on the theme (not only a resumé of the plethora of neoumbilicoplasty available techniques), with the aim of

simplifying the surgical choice and obtaining satisfactory outcomes in such peculiar reconstructions.

Future studies should include a wider cohort of patients, detailed patient history, especially regarding any past abdominal surgeries, and consistently evaluate the aesthetic outcomes with quantitative scores (Likert or VAS) to facilitate the comparability.

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## Ethical approval

Not applicable.

## Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request and deposited at the University of Lausanne.

## Declaration of Competing Interest

The authors declare that they have no competing interests.

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