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ARTICLE

Skin closure following abdominal wall reconstruction: three-layer skin suture versus staples

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ABSTRACT

Skin closure following abdominal wall reconstruction (AWR) has received little attention, even though these patients have demonstrated insufficient wound healing. This study assessed the postoperative wound-related complications and patient-reported outcomes after skin closure using single- or triple layer closure following AWR. This was a retrospective study at a University Hospital from 2016 to 2018. Patients were grouped into a single-layer cohort (SLC) and a triple-layer cohort (TLC). Skin incisions closed with either technique were compared. Postoperative complications were registered from chart review (SLC: $n = 48$, TLC: $n = 40$). Patient reported-outcomes were assessed through the Patient Scar Assessment Questionnaire (PSAQ) and the Hernia Related Quality of Life survey. A total of 51 patients were included (SLC: $n = 26$, TLC: $n = 25$). There was no difference in wound complications after single- or triple-layer skin closure; seroma (SLC: 16.7% vs. TLC: 15%, $p = 1.00$), surgical site infection (SLC: 4.2% vs. TLC: 7.5%, $p = .834$), hematoma (SLC: 6.2% vs. TLC: 2.5%, $p = .744$) and wound rupture (SLC: 2.1% vs. TLC: 2.5%, $p = 1.00$). Patients who had incisions closed using single-layer closure were more satisfied; PSAQ satisfaction with scar symptoms (SLC: 6.7 points (IQR 0.0–18.3) vs. TLC: 26.7 points (IQR 0.0–33.3), $p = .039$) and scar aesthetics (SLC 25.9 points (IQR 18.5–33.3) vs. TLC: 37.0 (IQR 29.6–44.4), $p = .013$). There was no difference in 30-day wound complications after either skin closure technique. The results favoured the single-layer closure technique regarding the cosmetic outcome.

Abbreviations: AWR: abdominal wall reconstruction; SLC: single-layer cohort; TLC: triple-layer cohort; PSAQ: patient scar assessment questionnaire; IH: incisional hernia; QOL: quality of life; BMI: body mass index; HerQLes: hernia-related quality of life; ASA: American Society of Anesthesiologists; SSO: surgical site occurence; SSI: surgical site infection; LOS: length of stay; RCT: randomized controlled trial.

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Introduction

Approximately, 300,000 incisional hernia (IH) repairs are performed annually in Europe [1]. Of these, 15–47% can be classified as large or giant IHs, where corrective surgery is commonly referred to as abdominal wall reconstruction (AWR) [2]. The occurrence of wound complications after AWR is associated with a longer postoperative hospital stay, a higher rate of readmissions, reoperations and hernia recurrence [2–4]. When assessing the results following AWR, little attention has been given to patient-reported outcomes associated with the aesthetic appearance of the scar. A lower perception of body image amongst patients with IH has been reported, leading to a decrease in health related QOL on mainly physical components [5]. On this background, aesthetic components such as the patients' perception of scarring seem of high importance.

Wound healing is enhanced by attachment of the dermal layer, which may reduce the risk of surgical site infections (SSIs) following skin closure [6]. Further, closure of the subcutaneous dead space by multi-layer suturing with absorbable sutures reduces the formation of seromas in general surgery.

Hence, postoperative aesthetics might increase following dermal skin closure.

In an attempt to lower the wound complication rate and increase postoperative aesthetics, our method of skin closure after AWR was changed, and the current study reports the outcomes of skin closure using dermal compared to subcutaneous, dermal and epidermal closure.

Materials and methods

This was a retrospective, cross-sectional study of patients undergoing AWR for a large IH at a single University Hospital from January 2016 to June 2018. A large IH was defined as a horizontal defect >10 cm, referring to the separation of the medial border of the rectus muscles.

On 1 May 2017, the skin closure technique for this patient group was changed, in an attempt to reduce wound-related complications and improve the cosmetic appearance of the scar. Prior to this date, skin closure was performed using skin staples in the epidermis alone. After 1 May 2017, skin closure was done using interrupted sutures (synthetic, slowly resorbable multifilamentous 3-0) in the subcutaneous space (Scarpa fascia), interrupted sutures in the dermis (synthetic, slowly resorbable monofilamentous 3-0) and lastly a running suture in the epidermis (synthetic, slowly

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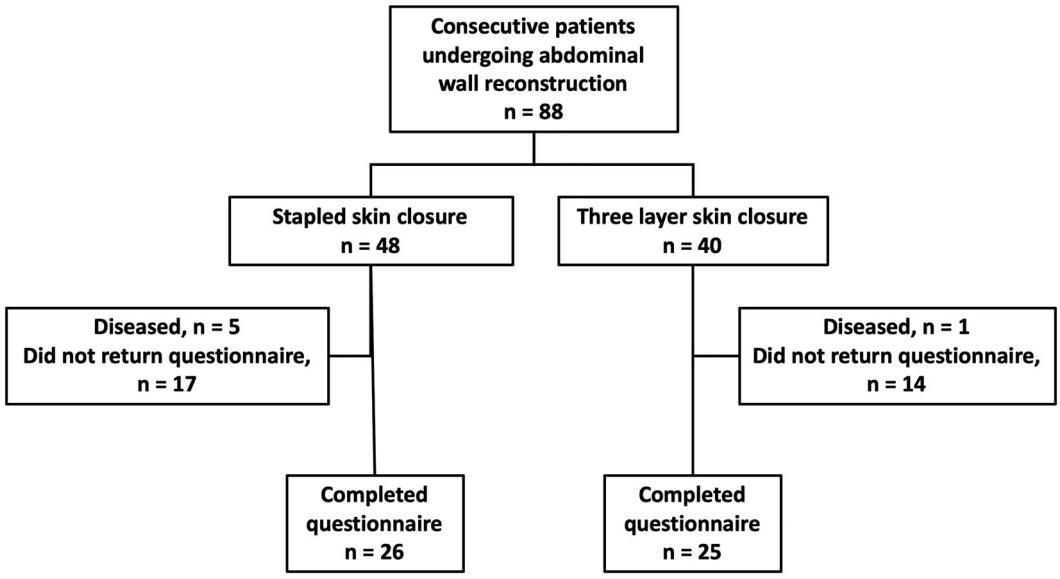

Figure 1. Study flowchart.

resorbable monofilamentous 4-0, triple-suture technique). During the study period, a total of five dedicated hernia surgeons performed the procedures.

The cohort was divided into two groups; patients who underwent AWR before May 2017, the single-layer cohort (SLC), and the patients who underwent AWR after May 2017, the triple-layer cohort (TLC).

The surgical technique otherwise utilized for patients undergoing AWR in our unit has been thoroughly described previously [7]. In brief, all patients underwent midline laparotomy and lysis of adhesion, followed by retromuscular mesh placement a.m. Rives-Stoppa. The procedure was aided by endoscopic anterior components separation or open transversus abdominis release according to intraoperative assessment. Redundant skin was resected on all patients before skin closure and all wounds were closed without major tension. One or two drains (CH14) were placed subcutaneously and removed when daily output was <60 ml. In the SLC, skin staples were removed 14 days after surgery.

Patients with a body mass index (BMI)>35 kg/m^2 and active tobacco smokers were not offered surgery until sufficient weight loss and smoking cessation.

Registered outcomes

Demographic variables were retrieved from chart review and included age, gender, American Society of Anaesthesiologists (ASA) score, BMI and smoking history. Perioperative variables included surgical technique, duration of surgery, hernia dimensions, contamination grade and type of lateral release. Postoperative complications retrieved were based on a clinical assessment and included SSI, seroma, necrosis, superficial wound rupture and hematoma. Further, length of hospital stay, readmissions and surgical reinterventions were registered.

The patient-reported outcomes were assessed through questionnaires focusing on the patients' perception of scarring associated with aesthetics and symptoms, as well as the health related quality of life. The questionnaires were distributed and collected by letter or email in both cohorts. Two instruments were used to measure patient-reported outcomes after AWR.

The Patient Scar Assessment Questionnaire (PSAQ) assesses the patients' perception of scarring. Domains in the questionnaire include scar aesthetics, scar symptoms, scar-related self-consciousness and satisfaction with scar aesthetics/symptoms, respectively. The outcome was a score from 1 to 4 for each domain, with 1 point representing the most favourable category and 4 representing the least favourable category [8].

The Hernia Related Quality of Life survey (HerQLes) was used to evaluate the abdominal wall-related QOL. Possible answers were a score from 1 to 6, representing the degree of impact on abdominal wall-related QOL. A low score represents the most favourable outcome and a high score represents the least favourable outcome [9].

Statistics

Numerical variables were given as mean and the two cohorts were compared using Student's *t*-test or the Mann–Whitney *U* test according to the normality of data. Categorical variables, *n* (%), were compared across the two cohorts using the chi-squared test. $p < .05$ was considered significant.

Approval for this study was given by the Danish National Data Protection Agency (2016-062, I-Suite: 04939) and the Regional Ethics Committee of Copenhagen (journal no. 16044045).

Results

A total of 88 patients underwent AWR for a large IH during the study period. Six patients were deceased and 31 patients failed to answer the questionnaires, leaving 51 patients contributing to the patient-reported outcomes. Of these, 26 patients underwent AWR prior to 1 May 2017 and were included in the SLC, and 25 patients underwent AWR after 1 May 2017 and were included in the TLC (Figure 1).

There was no significant difference between the cohorts regarding age, gender, ASA score, BMI, smoking status, surgical technique, duration of the surgery, type of hernia defect (vertical (mean SLC: 14.6 cm vs. TLC 14.5 cm, $p = .98$) vs. horizontal (mean SLC: 12.1 cm vs. TLC: 11.6 cm, $p = .53$)) or contamination grade (Table 1).

Table 1. Demographic data of consecutive patients undergoing abdominal wall reconstruction for large incisional hernia.

Variable	Level	Single layer ($n = 48$)	Triple layer ($n = 40$)	p
Age	Mean (SD)	65.8 (12.6)	65.1 (10.8)	.794
Gender	Female	16 (33.3)	14 (35.0)	1.00
ASA-score	I	4 (8.3)	11 (27.5)	
	II	36 (75.0)	24 (60.0)	
	III	8 (16.7)	5 (12.5)	.059
BMI	Mean (SD)	27.7 (4.9)	28.3 (4.6)	.578
Diabetes mellitus	Yes	6 (12.5)	1 (2.5)	.183
Former smoker	Yes	16 (33.3)	16 (33.3)	.536
Vertical defect	Mean (SD)	14.6 (6.5)	14.5 (4.7)	.984
Horizontal defect	Mean (SD)	12.1 (3.9)	11.6 (2.5)	.529
Contamination grade	I	41 (85.4)	28 (80.0)	.466
	II	6 (12.5)	7 (20.0)	
	III	1 (2.1)	0 (0.0)	
Component separation type	None	3 (6.2)	0 (0.0)	.161
	TAR	9 (18.8)	11 (31.4)	
	ECS	36 (75.0)	24 (68.6)	
Duration of surgery	Mean (SD)	245.8 (72.7)	259.4 (75.8)	.408

BMI: body mass index; SD: standard deviation; TAR: transversus abdominis release; ECS: endoscopic anterior component separation. ASA: American Association of Anesthesiologists.
Data presented as n (%) unless otherwise stated.

Table 2. Postoperative outcomes, $n = 88$.

Variable	Level	Single layer ($n = 48$)	Triple ($n = 40$)	Total ($n = 88$)	p Value
Intraoperative complications		5 (10.4)	1 (2.5)	6 (6.8)	.297
Seroma		8 (16.7)	6 (15.0)	14 (15.9)	1.00
SSI		2 (4.2)	3 (7.5)	5 (5.7)	.834
Hematoma		3 (6.2)	1 (2.5)	4 (4.5)	.744
Wound rupture		1 (2.1)	1 (2.5)	2 (2.3)	1.00
Reoperation		4 (8.3)	2 (5.0)	6 (6.8)	.847
LOS (days)	Median [IQR]	4.0 [3.0, 6.2]	3.0 [3.0, 4.0]	3.0 [3.0, 5.0]	.050
Readmission		21 (43.8)	17 (42.5)	38 (43.2)	1.00

SSI: surgical side infection; LOS: length of stay; IQR: interquartile range.
Data presented as n (%) unless otherwise stated.

Postoperative complications

There was no difference in the incidence of intraoperative complications (SLC: 10.4% vs. TLC: 2.5%, p=.297), the occurrence of the postoperative complications; seroma (SLC: 16.7% vs. TLC: 15%, $p = 1.00$), SSI (SLC: 4.2%, TLC: 7.5%, $p = .833$), hematoma (SLC: 6.2% vs. TLC: 2.5%, $p = .743$), wound rupture (SLC: 2.1% vs. TLC: 2.5%, $p = 1.00$), surgical site occurrences (SSOs) (SLC: 25.5% vs. TLC: 23.1%, $p = .990$), reoperations (SLC: 8.3% vs. TLC: 5.0%, $p = .846$) or readmissions (SLC: 43.8% vs. TLC: 42.5%, $p = 1.00$, Table 2). There was a significant difference in the median length of stay between the two cohorts (SLC: four days vs. TLC: three days, $p = .049$, Table 2).

Long-term follow-up

There was a significant difference in the median length of follow-up (SLC: 23.5 months vs. TLC: 8.8 months, $p < .001$) and in the patient-reported outcomes concerning the following PSAQ domains: scar aesthetics (SLC 25.9 points (IQR 18.5–33.3) vs. TLC: 37.0 (IQR 29.6–44.4), $p = .013$), self-consciousness (SLC: 22.2 points (IQR 16.7–27.8) vs. TLC: 38.9 (IQR 22.2–50.0), $p = .034$) and satisfaction with symptoms (SLC: 6.7 points (IQR 0.0–18.3) vs. TLC: 26.7 (IQR 0.0–33.3), $p = .039$, Figure 2).

No significant difference was found in the PSAQ domain satisfaction with scar aesthetics (SLC: 21.2 points (IQR 8.7, 30.8) vs. TLC 10.2 (19.2–34.6), $p = .073$) or in the HerQLes score (SLC: 78.0 points (58.3–83.3) vs. TLC: 74.2 (45.5–83.3), Figure 2).

When stratified regarding age, the cohorts differed significantly in the age group >70 years regarding scar aesthetics ($p = .018$).

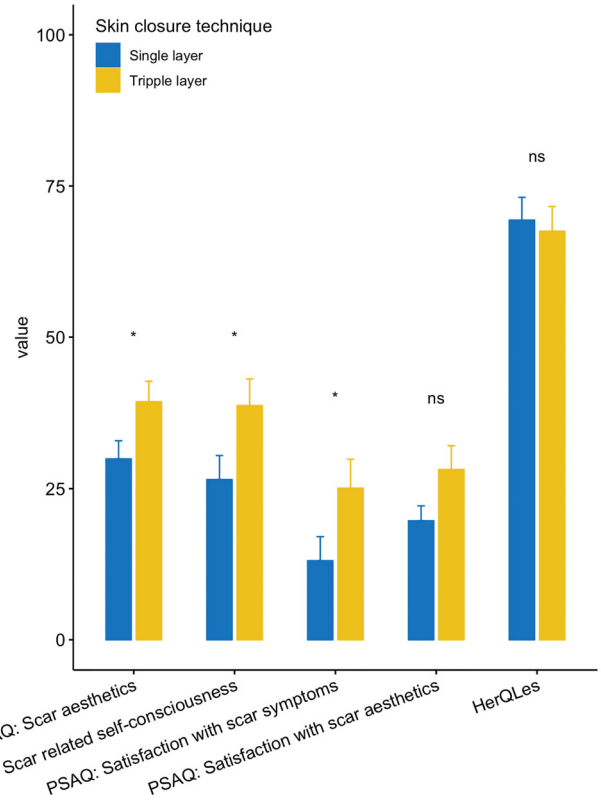

Figure 2. Patient-reported outcomes.
Patient-reported outcomes after abdominal wall reconstruction for large incisional hernia, skin closure using skin staples (SLC, $n = 26$) or sutures in three layers (TLC, $n = 25$). PSAQ: Patient Scar Assessment Questionnaire; HerQLes: Hernia-related Quality of Life Questionnaire. *$p < .05$. ns: not significant.

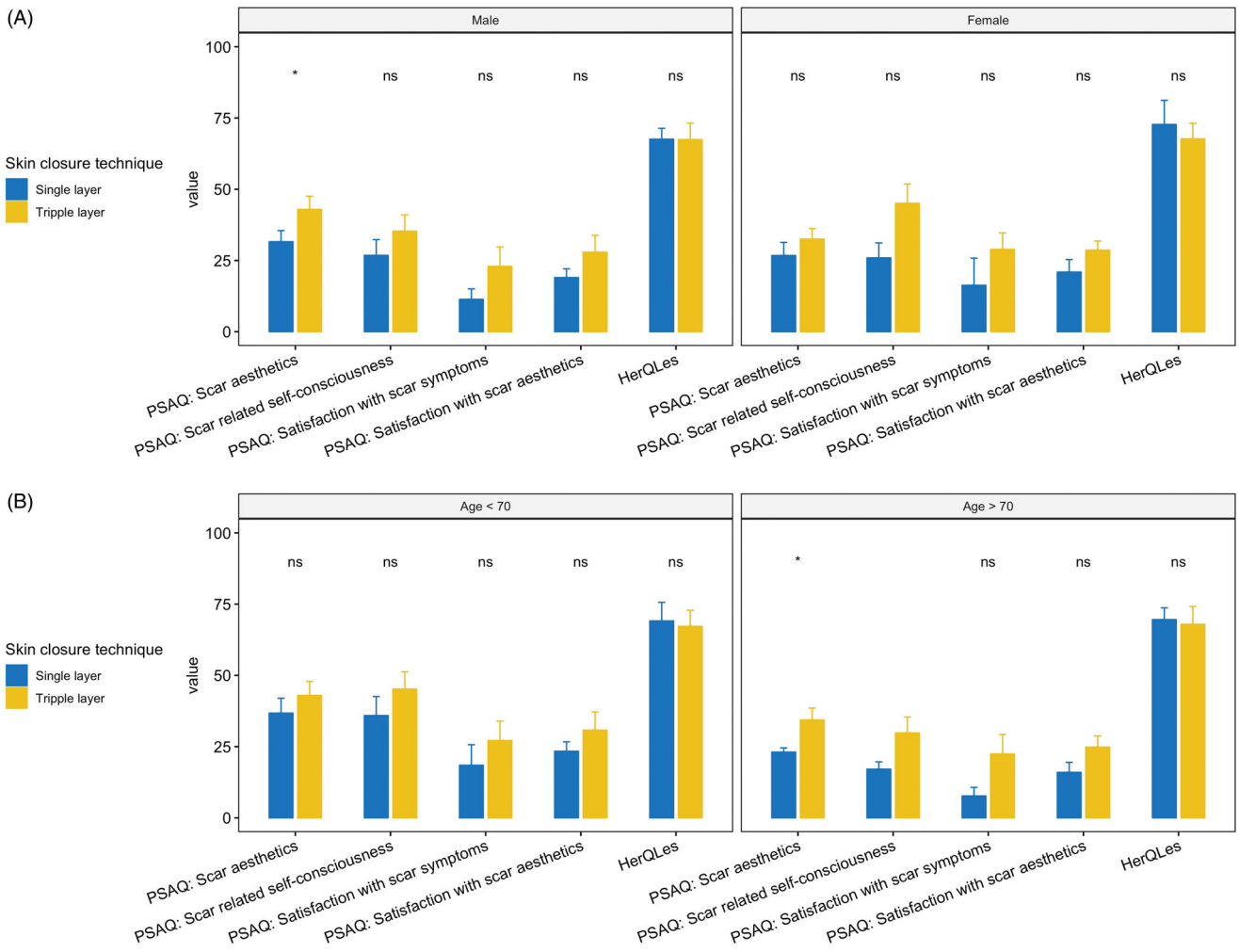

Figure 3. Patient-reported outcomes.
Patient-reported outcomes: stratified regarding age and gender. (A) Male: $N = 33$, female: $N = 18$. (B) Age $<$ 70: $N = 27$, age $>$ 70: $N = 24$. PSAQ: Patient Scar Assessment Questionnaire; HerQLes: Hernia-related Quality of Life Questionnaire. $^{*}p < .05$. ns: not significant.

No significant difference was found in the PSAQ domains in the age group <70 years.

Regarding gender, there was a significant difference between the cohorts regarding scar aesthetics amongst men ($p = .033$). No other significant difference was found in the PSAQ domains (Figure 3).

Discussion

The method used to close the skin after AWR was changed from single layer skin staples to three layer suture to improve the outcome after surgery. Previous studies have found that fewer wound complications reduce the incidence of hernia recurrence [10]. To our surprise, single layer skin staples of the skin resulted in a better patient reported aesthetic outcome, less scar related self-consciousness, a higher patient satisfaction score and we found no difference in wound-related complications.

Factors associated with postoperative wound complications after AWR have been described in several studies; however, the method for skin closure is rarely reported. Seven studies on wound complications do not report the suture technique for skin closure following AWR [11–18]. Well-described risk factors for wound complications after AWR include obesity, smoking, diabetes and contamination grade [7,8,11–16]. In the current study, patients undergoing SLC and TLC were comparable regarding these risk factors, and thus we have no reason to believe our results were confounded by any of these covariates.

Several studies compared the postoperative outcomes after skin closure by subcuticular suture technique versus stapling following abdominal surgery. Two RCTs on laparotomy and colorectal cancer surgery reported no significant difference in the incidence of SSIs [6,19], whereas another large-scale multi-centre RCT on patients undergoing open gastrointestinal surgery found a significantly decreased incidence of SSI after subcuticular sutures compared to skin staples [20]. There was no significant difference when comparing the incidence of SSI following lower- and upper gastrointestinal surgery, perhaps indicating that the bacterial contamination encountered during colorectal surgery may impact on the outcome of skin closure using either approach [20]. In the current study, most procedures were clean, thus supporting this hypothesis.

Skin stapled closure takes less time, however leads to a doubled risk of wound infections in cesarean section incisions [21]. Thus, the comparable complication rates between the two groups in the current study were surprising, and may indicate a different pathogenesis in patients with IH. This, however, has never been reported elsewhere in the literature.

Patients in the two groups reported better outcomes in terms of the aesthetic appearance of the scar. When stratified regarding gender, the difference was only apparent in the scar aesthetics domain in the male group. When stratifying age, the difference was found regarding scar aesthetics in the age group >70 years old.

This result may be caused by a significantly longer follow-up period in the SLC group, which leads to increase of cicatrization- and remodelling, resulting in a better cosmetic appearance, regardless of the applied suture technique. However, the distribution between age and gender should be interpreted with caution due to the small sample size and thus risk of type II error.

It has previously been shown that patients with IH were less satisfied with their body image compared to patients without IH [5]. Further, patients with IH with complaints- and/or a symptomatic IH rated their body image significantly lower compared to patients with IH without complaints or symptoms [5]. This may indicate that functional symptoms affect the perception of body image. In the current study, preoperative symptoms or perceived body image was not available; however, the practice at our centre during the study period was to offer AWR for patients with functional symptoms or cosmetic complaints.

Postoperative hernia-related quality of life was comparable between the two patient groups, which hardly is surprising as the HerQLes questionnaire was designed to specifically assess the functional outcome of patients undergoing AWR [9]. However, four of the 12 questions in the questionnaire may be affected by the aesthetic appearance of the scar (impact on health, interference with sexual function, affection on everyday mood and feeling blue) which is why we chose to include this questionnaire in our study.

Study limitations

The current study has limitations. First of all, registration of wound complications was done retrospectively, which may have introduced a bias, as standardization when reporting on outcomes following hernia reconstruction is absent [16,22].

Comparison of the aesthetics of the scar between the SLC and TLC was limited by the difference in length of follow-up. Furthermore, the small sample size increased risk of type II error when stratifying data regarding age and gender.

Taking these limitations into account, we found no indication that triple-suture technique was superior to single layer closure in terms of reducing the wound complications after AWR. To further explore this finding, prospective trials examining wound complications and aesthetic outcome after different skin closure techniques in patients undergoing AWR are warranted to further improve the treatment of this patient group.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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