Technical aspects of flap fixation after mastectomy for breast cancer

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RESEARCH ARTICLE

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Technical aspects of flap fixation after mastectomy for breast cancer: Guidelines for improving seroma-related outcome

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Abstract

Objectives: Previous studies have identified the added value of flap fixation in reducing seroma formation and its sequelae after mastectomy. The seroma reduction after mastectomy (SAM)-trial proved that sutures were superior to tissue glue. In this article, we will elaborate on the results of the SAM-trial to provide a clear surgical guideline.

Methods: All patients in the suture flap fixation cohort from the SAM-trial were analyzed if details regarding flap fixation were available. The most optimal number of sutures was determined using a receiving operator characteristics curve. The incidence of seroma formation between patients receiving the most optimal number of sutures and patients receiving fewer sutures was compared.

Results: The most optimal number of sutures proved to be 15. Patients with ≥15 sutures had a lower incidence of seroma formation at every time frame during follow-up. There was a significant difference at 6 weeks (odds ratio [OR]: 3.05, 95% confidence interval [CI]: 1.09–8.56), 3 months (OR: 4.62, 95% CI: 1.34–12.92), and 1 year postoperatively (OR: 20.48, 95% CI: 2.18–192.22). Ten days and 6 months postoperatively did not differ significantly.

Conclusions: Flap fixation in general, but also the surgical technique influences the incidence of seroma formation after mastectomy. Results suggest a minimum of 15 sutures, spaced approximately 3.7 cm apart.

KEYWORDS

breast cancer, flap fixation, mastectomy, seroma, sutures

1 | INTRODUCTION

Seroma formation is a notorious problem for patients undergoing mastectomy, and some even consider it to be an inherent part of breast cancer surgery rather than a preventable complication.[1,2] Seroma collections under the skin flaps or in the axillary region can lead to pain, infection, repeated seroma aspirations, and wound breakdown. When interventions such as seroma aspirations are necessary, it is defined as clinically significant seroma, which can affect wound healing, cosmesis and could eventually even delay the onset of adjuvant therapies.[1,3,4] Due to the extent of this problem, many studies have focused on finding permanent solutions using different surgical techniques and devices to reduce seroma and its sequelae. Resolving seroma formation in its entirety has not been achieved yet, possibly due to the fact that the pathophysiology is not yet fully understood. Studies have shown that reducing the dead space using flap fixation seems to be the most promising technique at present. The incidence of

seroma formation decreases by up to 58%.[2,3,5–9] Various flap fixation methods have been evaluated, including fibrin glue, sclerosants, external pressure garments, and (quilting) sutures.[1,5] As high-level evidence was lacking at the time, a randomized controlled trial was performed by de Rooij et al. (the seroma reduction after mastectomy (SAM)-trial).[10] In this trial, flap fixation using tissue glue and flap fixation using sutures were compared with a control group undergoing conventional skin closure. Flap fixation with sutures significantly reduced the amount of seroma aspirations after mastectomy or modified radical mastectomy (MRM). With these results in mind, flap fixation with this method is highly recommended. To perform flap fixation, the skin flaps were sutured to the underlying pectoral muscle using interrupted polyfilament absorbable sutures. However, details on how many sutures were necessary were not published in the paper on the SAM-trial.[10] The aim of this subsequent article is to elaborate on the results of the SAM-trial and develop a more helpful surgical guideline for breast surgeons wishing to implement flap fixation using sutures in their practice.

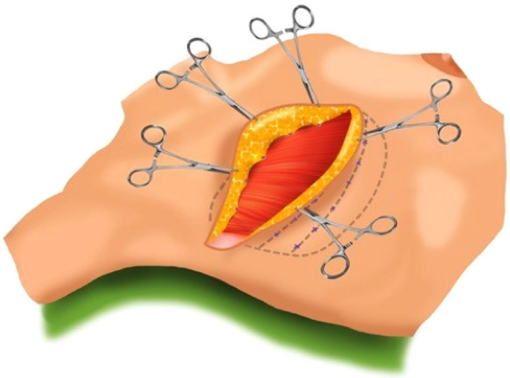

FIGURE 1 Illustration of points of flap fixation after mastectomy

FIGURE 2 Wound surface area formula

2 | MATERIALS AND METHODS

In this study, all patients who had previously participated in the SAM-trial and had undergone flap fixation using sutures were included. Written informed consent was provided by all patients at the beginning of the SAM-trial, including permission to use the data for further research. The methods of the SAM-trial have been published in detail.[10] This trial was approved by the institutional medical ethics committee (METC-Zuyd, NL4777649.096.14) and registered at ClinicalTrials.gov (NCT03305757). Patients with missing data regarding the number of sutures were excluded from this subsequent analysis.

2.1 | Surgical technique

All patients underwent flap fixation using sutures after mastectomy, performed by one of eight surgeons, all with extensive training in breast cancer surgery. Patients underwent mastectomy with or without axillary clearance and immediate breast reconstructions were not performed. Multiple rows of individual intermittent sutures were placed using absorbable polyfilament sutures (Vicryl 3-0). Both cranial and caudal skin flaps were approximated to the pectoral muscle, as presented in Figure 1. Sutures were placed approximately 4 cm apart. Care was taken to prevent dimpling of the skin. Afterwards, skin closure was performed using monofilament sutures (Monocryl 3-0 or V-loc 30 cm). All patients received closed suction drainage using one drain after surgery. The drain was placed before flap fixation or skin closure and was positioned in the mastectomy gutter lateral to the pectoral muscle. The drain was removed after a maximum of 5 days, or when drain output was less than 50 ml/day. Data regarding the number of sutures and the wound area was collected during surgery.

2.2 | Objective and outcomes

The objective of this article was to explore some technical aspects of surgical flap fixation with sutures as described in the SAM-trial to provide breast surgeons with practical tips on how to best perform the procedure. First, the "most optimal number of sutures" threshold was determined, based on information regarding the incidence of seroma formation during the first year after surgery. Evaluation of seroma formation was done 1 week, 6 weeks, 3 months, 6 months, and 1 year following surgery. Seroma was defined as an accumulation of fluid in the dead space after mastectomy and occurrence was based on clinical evaluation during every out-patient clinic visit. The suture threshold was used to divide the population into two groups: one group of patients with fewer sutures than the threshold and one group with an equal or higher number of sutures than the threshold. The incidence of seroma formation between groups was compared at different time points, to evaluate whether the statistically determined threshold also revealed a noticeable clinical difference. Results were corrected for neoadjuvant chemotherapy, BMI, wound surface area, and type of surgical procedure (mastectomy with or without axillary lymph node dissection) as these are renowned risk factors for seroma formation.

Wound surface area was calculated under the assumption that it resembled an ellipse ($A = \pi \times a \times b$, see Figure 2).

2.3 | Statistical analysis

Statistical analysis was performed using SPSS (IBM SPSS statistics for Windows, version 26). All continuous data are presented as mean ± standard deviation (SD) or as median and interquartile range (IQR) in case of severe skewness. All categorical data are presented as absolute numbers (percentage). The threshold for the number of sutures was determined using a receiver operating characteristic (ROC-) curve, using seroma formation as the outcome. As the prevention of seroma formation was considered most important, the aim was to find a threshold with a specificity as high as possible without considerably reducing the sensitivity. This threshold would indicate that patients in our cohort with that many sutures or more would have a lower incidence of seroma formation. Baseline characteristics of these groups were compared using an independent sample *t* test or a Mann–Whitney *U* test for continuous variables and a Pearson χ^2 test for categorical variables. Furthermore, as previously described in Section 2.2, groups were compared using a univariable analysis and a multivariable logistic regression analysis.

3 | RESULTS

3.1 | Patient characteristics

In total, 100 patients were included in this analysis. Nine patients were excluded from the total SAM-trial cohort of the flap fixation group with sutures (FF-S) due to missing information on the number of sutures. Baseline characteristics are described in Table 1. Median age was 66 years. Patients were treated for cTis-cT4 breast cancer and underwent an MRM in 31 cases, a mastectomy and sentinel lymph node biopsy in 57 cases and a mastectomy only in 12 cases.

TABLE 1 Baseline characteristics

	N = 100
Age in years (median (IQR))	66.0 (53–77)
BMI in kg/m^2 (median (IQR))	27.5 (24.3–30.4)
CCI (median (IQR))	5 (3–6)
Procedure	
Modified radical mastectomy	12 (12%)
Mastectomy + SN	57 (57%)
Mastectomy	31 (31%)
Neoadjuvant therapy	
Chemotherapy	18 (18%)
Hormone therapy	1 (1%)
Smoking	23 (23%)
Anticoagulant use	24 (24%)
cT stage	
In situ	10 (10%)
1	28 (28%)
2	46 (46%)
3	12 (12%)
4	3 (3%)
x	1 (1%)

Abbreviations: BMI, body mass index; CCI, Charlson Comorbidity Index; IQR, interquartile range; SN, sentinel node.

3.2 | General surgical information

Median surgical time was 90 (interquartile range [IQR]: 75.5–105) minutes of which a median of 25 (IQR: 21–28.3) minutes was spent on flap fixation and skin closure. The median wound area was 282.7 cm^2. Patients received a median of 20 sutures, divided over a median of three rows in the cranial skin flap and two in the caudal skin flap.

3.3 | Number of sutures

The ROC curve was used to determine the cut-off value for the number of sutures. This is displayed in Figure 3. Since the aim was to find a specificity as high as possible without compromising sensitivity, the displayed cut-off point was selected to prevent a further decline in sensitivity. This cut-off point corresponded with 15 sutures. All subsequent analyses were performed between a group of patients receiving less than 15 sutures ($n = 27$) and a group of patients receiving 15 sutures or more ($n = 73$). The groups did not differ significantly in any of the previously reported baseline characteristics.

3.4 | Suture placement

All information regarding suture placement per group is displayed in Table 2. Sutures in the <15 suture group were placed 4.6 cm apart, compared with 3.7 cm in the ≥15 suture group.

3.5 | Seroma incidence

The incidence of seroma formation per time frame was compared between patients receiving fewer than 15 sutures and patients receiving 15 or more sutures. Incidences are displayed in Figure 4. The incidence of seroma formation in patients with fewer than 15 sutures decreased from 67% after 10 days to 28% after 1 year. Patients with 15 sutures or more had a seroma incidence of 47%, which declined to 3% after 1 year. These differences in seroma incidence were statistically significant at 6 weeks postoperatively (odds ratio [OR]: 3.05, 95% CI: 1.09–8.56), 3 months postoperatively (OR: 4.62, 95% CI: 1.34–12.92) and 1 year postoperatively (OR:

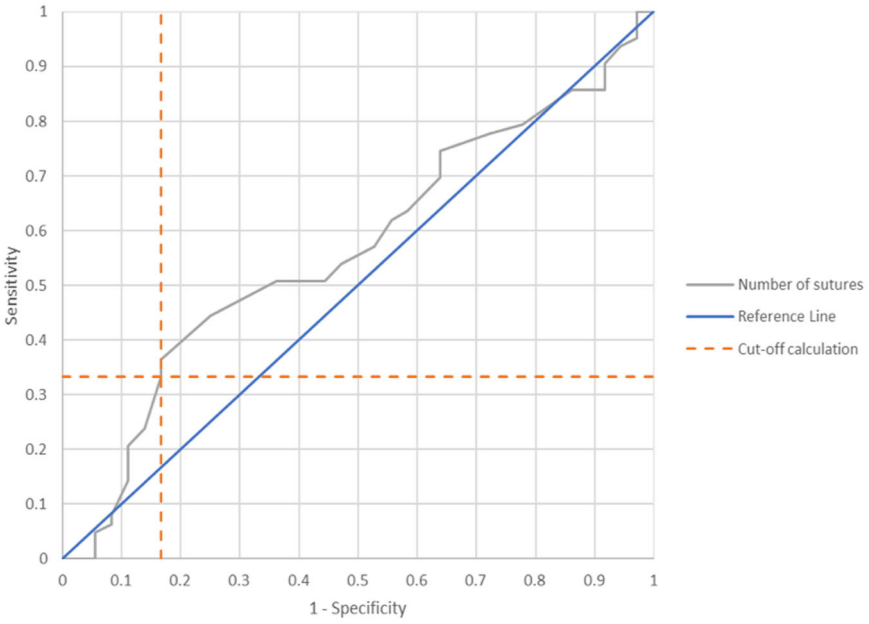

FIGURE 3 Receiver operating characteristic (ROC)-curve for the number of sutures with outcome seroma

TABLE 2 Suture placement in relation to the wound area

	Median wound surface area (cm^2)	Median cm^2 per suture	Median cm between sutures
<15 sutures	253.68 (223.84–276.46)	21.54 (19.75–28.19)	4.6 (4.4–5.3)
≥15 sutures	296.88 (253.68–344.79)	13.74 (11.22–16.00)	3.7 (3.3–4)

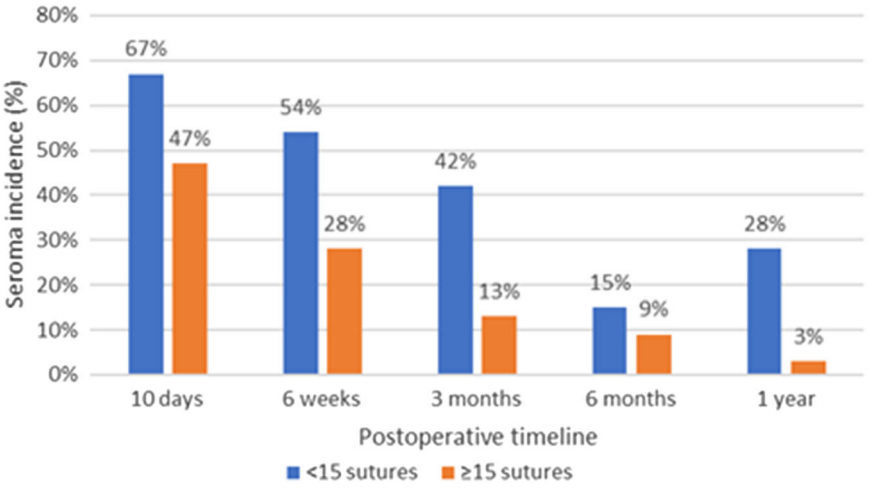

FIGURE 4 Seroma incidence per group, per measurement interval

20.48, 95% CI: 2.18–192.22). Ten days and 6 months postoperatively did not differ significantly (Table 3).

4 | DISCUSSION

Important trials have demonstrated the added value of performing flap fixation after mastectomy or MRM to reduce seroma formation following mastectomy.[2–4,6,10–12] The SAM-trial showed that flap fixation is best performed using sutures rather than using tissue glue. To the best of our knowledge, this is the first trial to report more detailed surgical information on the number of sutures and rows that were used. Previous studies are heterogeneous with regard to the execution of flap fixation. Methods vary in technique (running or interrupted), suture size (Vicryl 0 to 3-0), distance between sutures (2–5 cm), and location.[2,3,6,8,10,12–15] The results of this article should be used to provide a clear guideline on how to perform flap fixation when using sutures.

The primary outcome of this article was defined as a secondary outcome in the SAM-trial. The number of events of the primary SAM outcome (number of seroma aspirations) was relatively low, making statistical analysis impossible. Ideally, an outcome with clinical consequences, such as the incidence of clinically significant seroma,

TABLE 3 Univariable and multivariable analysis of seroma formation between groups

	Unadjusted OR (95% CI)	*p* value	Adjusted OR (95% CI)[a]	*p* value
10 days postoperatively	2.25 (0.89–5.71)	0.088	2.14 (0.78–5.92)	0.141
6 weeks postoperatively	2.95 (1.16–7.52)	0.024[b]	3.05 (1.09–8.56)	0.034[b]
3 months postoperatively	4.73 (1.66–13.48)	0.004	4.16 (1.34–12.92)	0.014[b]
6 months postoperatively	1.76 (0.45–6.83)	0.415	1.74 (0.39–7.67)	0.466
1 year postoperatively	11.28 (2.15–59.20)	0.004[b]	20.48 (2.18–192.22)	0.008[b]

Note: Reference group is patients with ≥15 sutures.

Abbreviations: CI, confidence interval; OR, odds ratio.

[a]Corrected for neoadjuvant chemotherapy, BMI, wound surface area, and type of surgical procedure.

[b]Statistically significant.

should be used. However, to provide more power, the incidence of seroma formation was regarded to be the next best outcome measure.

The cut-off value for the minimal amount of required sutures given our aim proved to be 15. The incidence of seroma formation in both groups decreased over the course of 1 year, however, the incidence was consistently lower in the group of patients receiving 15 sutures or more. Remarkably, the number of patients with seroma in the <15 sutures group seems to increase between 6 months and 1 year postoperatively. Adjuvant chemotherapy or radiotherapy may be risk factors for aggravating seroma formation. However, these factors have not been described as risk factors for seroma formation in previous papers.

Previous studies raised some concerns regarding shoulder mobility and cosmesis after flap fixation.[5] The SAM-trial showed that shoulder mobility seems to be equally affected in patients undergoing mastectomy with or without flap fixation using sutures.[10,15,16] There was a gradual decrease in shoulder mobility disability scores in all groups after mastectomy, suggesting that shoulder mobility in general worsens after mastectomy. Cosmesis and especially skin dimpling do not seem to differ between groups.[10,17] However, while placing sutures, care should be taken to prevent dimpling at the suture sites.

Limitations of this study are mainly related to the design, as this is a follow-up analysis using a smaller sample of a previous randomized controlled trial. For this reason, the number of participants in this study is limited, compromising the precision of the results. Moreover, the actual number of sutures used was left at the discretion of the surgeon and hence, confounding by indication may be a substantial source of bias in our study. Therefore, we used multivariable modeling to adjust for any known confounding variables. However, the results of this study could be considered to be a guideline for surgeons with the best available evidence to date.

5 | CONCLUSIONS

This subsequent analysis of the SAM-trial indicates that, besides performing flap fixation after mastectomy in general, the technical execution of flap fixation using sutures determines the success rate of preventing seroma formation. This study suggests that at least 15 sutures placed 3.7 cm apart from each other lead to the best results in reducing seroma formation after mastectomy.

AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Merel Spiekerman van Weezelenburg, Loeki Aldenhoven, Sander van Kuijk and James van Bastelaar. The first draft of the manuscript was written by Merel Spiekerman van Weezelenburg and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The datasets analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

ETHICS STATEMENT

This trial was approved by the institutional medical ethics committee (METC-Zuyd, NL4777649.096.14) and registered at ClinicalTrials.gov (NCT03305757). Informed consent was obtained from all individual participants of the SAM-trial, including their consent for further analysis.

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