


Quilting following mastectomy reduces seroma, associated complications and health care consumption without impairing patient comfort

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Abstract

Background: An important complication following mastectomy is seroma formation. Quilting, in which skin flaps are sutured to the underlying muscle, is reported to reduce seroma incidence, but might induce pain and impair shoulder function. Main objective is to compare quilting with conventional wound closure, regarding seroma incidence, health care consumption, and patient discomfort.

Methods: In a combined prospective and retrospective study, 254 patients undergoing mastectomy and/or axillary lymph node dissection (ALND) were included. Patients received quilting sutures or conventional closure. Primary outcome was clinical significant seroma (CSS). In prospectively included patients shoulder function and analgesic use was observed.

Results: CSS incidence was 12.9% in the quilted versus 62.3% in the nonquilted cohort ($p < 0.001$). Surgical site infections were reported significantly less in the quilted cohort. Duration of hospital stay was shorter and outpatient clinic visits were less in the quilted cohort. Surgical procedure required 10 additional minutes for quilting. No significant differences were observed in postoperative shoulder function and analgesic use.

Conclusion: Quilting following mastectomy reduces CSS incidence. Quilting requires 10 additional minutes during surgery. It facilitates day treatment and results in less additional outpatient clinic visits culminating in reduced health care consumption. Shoulder function and pain are not affected by quilting.

KEYWORDS

health care consumption, mastectomy, patient comfort, quilting, seroma, surgical flaps

Abbreviations: ALND, axillary lymph node dissection; ASA, American society of anesthesiologists; BMI, body mass index; CDC, centers for disease control and prevention; CSS, clinical significant seroma; CWZ, Canisius Wilhelmina hospital; DASH, disability of the arm, shoulder and hand; NAC, neoadjuvant chemotherapy; NSAID, nonsteroidal anti-inflammatory drugs; RH, Rijnstate hospital; SSI, surgical site infection; TNM, classification of malignant tumours.

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1 | INTRODUCTION

Despite a trend for less radical surgery,¹ still one out of three women with breast cancer undergo mastectomy, with or without axillary lymph node dissection (ALND).² The most common complication is seroma formation, defined as a serous fluid collection underneath the skin following surgery.³ Incidences of seroma following mastectomy are reported between 15% and 90%.⁴⁻⁶ The huge range and discrepancy between various publications can be attributed to different seroma definitions and subjective grading of seroma. Deleterious consequences of seroma are repeated aspirations, surgical site infections (SSIs), skin flap necrosis, repeated visits to the outpatient clinic and delay of adjuvant therapy all resulting in patient worry and discomfort.^{4,6-9}

Seroma prevention has been studied for many years. Bovine thrombin, fibrin glue, and steroids all demonstrated to be ineffective in reducing seroma.¹⁰⁻¹² Inconsistent results were reported for shoulder immobilisation and external compression.¹³⁻¹⁵ One of the key factors in reducing seroma formation seems mechanical closure of the dead space left after surgery.^{6,16} The quilting suture technique, where dead space left after surgery is minimised by fixation of the skin flaps to the underlying muscle, was reported to significantly reduce seroma incidence in several studies.^{6,9,16-20} Number of aspirations, volume of aspirations, and SSI were also decreased after quilting.^{9,17,19,21,22} Where conventional closure of mastectomy usually includes applying a wound suction drainage system, recent studies suggest no need for drainage after flap fixation with the quilting technique. Seroma incidence was found similar after flap fixation with or without postoperative drainage.^{21,23,24} This facilitates day treatment and obviates the need for drain care at home and postoperative wound care in the outpatient clinic. As a result, physical and mental recovery can potentially start earlier.

Despite these advantages, potential disadvantages of quilting are subject of discussion. Among them are an increase in surgery time and impaired shoulder function, pain and scar retraction due to tightening of the skin to the pectoral muscle. To study the pros and cons of quilting a combined pro- and retrospective study was conducted in two breast cancer centres. The primary aim of the study was to compare consecutive patients who underwent quilting without drainage following mastectomy with patients who underwent conventional wound closure including wound drainage. Main focus was seroma incidence, patient discomfort, and health care consumption in terms of hospital stay, unplanned postoperative outpatient visits, and treatment of complications.

2 | METHODS

2.1 | Study design

A combined pro- and retrospective cohort study was conducted in two teaching hospitals in the Netherlands: Canisius Wilhelmina Hospital (CWZ) in Nijmegen and Rijnstate Hospital (RH) in Arnhem. Both hospitals combined provide breast cancer care to more than 600 patients annually over two dedicated breast cancer units. At

CWZ quilting without postoperative wound drainage was applied following mastectomy and/or ALND. In RH skin and subcutaneous closure was applied, over closed suction drainage. All surgical procedures were performed or supervised by dedicated breast surgeons in both hospitals. The ethical committees of CWZ and RH approved the study, complying with current regulations. Prospectively included patients signed informed consent.

A prospective cohort study was conducted in CWZ and RH from November 2018 until May 2020. All consecutive patients of 18 years and older undergoing mastectomy and/or ALND were included. Patients were excluded if they were unable to complete a questionnaire, were pregnant or received immediate breast reconstruction. Given the small number of prospectively included patients, a retrospective cohort was included, including all patients who underwent mastectomy and/or ALND in CWZ or RH in November 2018 until May 2020 and were not included in the prospective cohort. Shoulder function and pain evaluation were not feasible in these patients.

2.2 | Study interventions

Conventional closure consisted of a subcutaneous absorbable multifilament size 3/0 sutures followed by a 3/0 or 4/0 absorbable monofilament intracutaneous running suture as skin closure. A low vacuum closed suction drain was placed beneath the skin flaps. The drain was removed at day of discharge if production was less than 200 ml per 24 h.

In the quilting suture technique, skin flaps were fixated to the pectoralis major muscle before subcutaneous and skin closure as described earlier.⁹ Briefly, skin flaps were sutured to the pectoral muscle using absorbable running sutures, size 0, large needle. The cranial skin flap was quilted from cranial to caudal, in several rows. Suture started medially, with five to seven stitches laterally and back. Caudal flap was quilted from caudal to cranial, in several rows. Subcutaneous and skin sutures were similar to the conventional cohort. No drains were used when quilting was performed.

According to the CWZ protocol, patients who underwent ALND received prophylactic antibiotics, 1 g cefazoline 1 h before incision. Prophylactic antibiotics were not routinely administered in RH. All patients received a postoperative compressive bandage. Patients were encouraged to mobilise the shoulder postoperatively and all patients had a visit to the outpatient clinic 2 weeks after surgery.

2.3 | Study outcomes

Primary outcome was clinical significant seroma (CSS). Since primary aim was patient discomfort, any postoperative fluid underneath the skin requiring aspiration was defined as CSS. Secondary outcomes were overall seroma rate (including CSS and nonaspirated seroma detected by palpation), SSI, bleeding complications, wound healing complications (including wound necrosis, skin flap necrosis, and wound dehiscence), shoulder function, postoperative use of

analgesics, surgery time (only unilateral mastectomy), duration of hospital stay after surgery (day care or amount of days), number of unexpected visits to the outpatient clinic due to a local wound problem or aspiration and time to first adjuvant therapy (radiation or systemic treatment). SSI was defined according to the Centers for Disease Control and Prevention definition (CDC).²⁵ Moreover, wound infections occurring within as well as beyond 30 days postoperative were defined SSI, since seroma often persists over 30 days and can induce delayed wound infections. Complications were only scored if intervention, treatment, or additional outpatient visits were necessary. The Clavien Dindo Classification was used to score complication severity.

Patient characteristics were collected, based on assumed risk factors for CSS.^{6,7,10,10,26–29} Included were age, BMI, ASA classification, TNM classification, type of surgery, and neoadjuvant chemotherapy (NAC). In line with Dutch legislation, registration of ethnicity is forbidden and was not performed.

Data were partially extracted from the electronic patient file. Shoulder function and pain were evaluated in patients who were prospectively included. Shoulder function was evaluated administering the validated DASH questionnaire (disability of the shoulder and hand), consisting of 30 items concerning symptoms and limitations of the upper extremity during the past week. The higher the score the more limitations are experienced. This questionnaire was administered preoperative ($t = 0$), 2 weeks postoperative ($t = 1$), and 6 months postoperative ($t = 3$). Castor electronic data capture system (<https://www.castoredc.com>) was used to record data.

2.4 | Statistical analyses

Statistics were performed using SPSS (IBM SPSS statistics for Windows, Version 26.0). Continuous data were presented as mean or median \pm SD and the independent t test was used to analyse normally distributed data. The Mann-Whitney U test was used for non-normally distributed data. Categorical data were presented as frequency or percentage and was analysed by the χ^2 test or Fisher's exact test. Multivariate logistic regression analysis was performed to identify the risk for CSS in quilted versus nonquilted patients, after adjustment for potential confounding factors. Patient characteristics that were significantly associated with CSS in the univariate analysis (Table 1) were included as potential confounders in the multivariate analysis. Due to the small number of patients included in the prospective cohort multivariate analysis was only performed in the combined cohort. p value was derived from a two-tailed test. A p value lower than 0.05 was considered clinically significant.

3 | RESULTS

3.1 | Patient characteristics

A total of 56 patients were prospectively included in the study: 29 patients were enrolled in the quilted cohort and 27 in the nonquilted

cohort. The patients in the different cohorts were comparable for age, BMI, ASA classification, recurrent breast cancer, prior breast irradiation, and TNM stage. Differences were found in the type of surgery, with nine patients who underwent (31%) ALND in the quilted cohort versus one (3.7%) in the nonquilted cohort. NAC was significantly less given in the quilted cohort: 27.6% versus 55.6% in the nonquilted cohort ($p = 0.034$). In the combined cohort (including prospective and retrospective cohorts), a total of 255 patients were enrolled: 140 in the quilted cohort and 114 in the nonquilted cohort. Similar to the prospective cohort patient characteristics differed for the type of surgery and administration of NAC. Besides, ASA classification was significantly higher in the nonquilted cohort. Recurrent breast cancer and prior breast irradiation were significantly more frequent in the nonquilted cohort. TNM Stage 3 and 4 were observed more often in the quilted cohort (Table 1).

Multivariate logistic regression analysis showed that quilting reduces CSS, adjusted for potential confounders (adjusted odds ratio [aOR]: 0.06, 95% confidence interval [CI]: 0.03–0.14, $p < 0.001$). Higher ASA classification and ALND were also found to be independent risk factors for CSS formation (Table 2).

3.2 | Perioperative data

Mean duration of surgical procedure was comparable for both cohorts in the prospective group. Yet mean duration of surgical procedure was significantly longer in the quilted cohort in the combined group, 77.8 min for quilting versus 68.5 min for conventional wound closure ($p = 0.001$). Quilting was associated with a significantly shorter length of hospital stay (Table 3).

3.3 | Postoperative outcome

Clinically significant seroma (CSS) was less often observed in the quilted cohort compared with the nonquilted cohort in both the prospective and combined group. In the prospective group, CSS was observed in 2 of 29 patients (6.9%) in the quilted cohort, compared with 16 of 27 patients (59.3%) in the nonquilted cohort ($p < 0.001$). In the combined group, CSS rate was 12.9% versus 62.3% in respectively the quilted cohort versus the nonquilted cohort ($p < 0.001$). Overall seroma rate was significantly lower in the quilted cohort.

A tendency of an increased amount of SSI and bleeding complications was observed in the nonquilted cohort in the prospective group, this increase was significant in the combined group. Wound healing problems were reported less in the quilted cohort in the prospective as well as in the combined group (Table 3 and Figure 1).

3.4 | Early results

There was no significant difference in the number of readmissions and reoperations between the quilted and nonquilted cohort in

TABLE 1 Patient characteristics

Characteristics	Prospective group			Combined group (including prospective and retrospective data)		
	Nonquilted cohort (n = 27)	Quilted cohort (n = 29)	p value	Nonquilted cohort (n = 114)	Quilted cohort (n = 140)	p value
Age	63.5 ± 12.4	60.7 ± 13.6	0.433	64.1 ± 12.8	62.3 ± 12.9	0.264
BMI	27.3 ± 5.4	26.0 ± 4.7	0.322	27.5 ± 5.1	26.7 ± 4.8	0.229
ASA classification			0.269			<0.001
1	6 (22.2)	12 (41.4)		16 (13.9)	49 (35.3)	
2	14 (51.9)	14 (48.3)		63 (54.8)	81 (58.3)	
3	6 (22.2)	3 (10.3)		26 (22.6)	9 (6.5)	
4	1 (3.7)	0 (0)		10 (8.7)	0 (0)	
Recurrent breast cancer	3 (11.1)	7 (24.1)	0.203	20 (17.4)	11 (7.9)	0.019
Prior breast irradiation	3 (11.1)	6 (20.7)	0.329	20 (17.4)	9 (6.5)	0.005
TNM stage			0.078			0.007
In situ	2 (7.4)	3 (10.3)		9 (7.9)	19 (13.6)	
1	5 (18.5)	8 (27.6)		33 (28.9)	25 (17.9)	
2	13 (48.1)	6 (20.7)		39 (34.2)	59 (42.1)	
3	1 (3.7)	9 (31.0)		11 (9.6)	24 (17.1)	
4	1 (3.7)	0 (0)		2 (1.8)	1 (0.7)	
No malignancy	2 (7.4)	1 (3.4)		5 (4.4)	8 (5.7)	
ypTON0	3 (11.1)	2 (6.9)		11 (9.6)	3 (2.1)	
Angiosarcoma	0 (0)	0 (0)		2 (1.8)	1 (0.7)	
Type of surgery			0.023			0.008
Mastectomy	26 (96.3)	20 (69.0)		103 (90.4)	107 (76.4)	
ALND	0 (0)	5 (17.2)		5 (4.4)	22 (15.7)	
Mastectomy and ALND	1 (3.7)	4 (13.8)		6 (5.3)	11 (7.9)	
NAC	15 (55.6)	8 (27.6)	0.034	54 (47.4)	38 (27.1)	0.001

Note: Variables are presented as mean ± standard deviation, or frequency (%).

Abbreviations: ALND, axillary lymph node dissection; ASA, American Society of Anaesthesiology; BMI, body mass index; NAC neoadjuvant chemotherapy; TNM, Classification of Malignant Tumours.

the prospective group, however quilting resulted in a significant reduction of readmissions and reoperations in the combined group. Quilting was associated with significantly less additional visits to the outpatient clinic in both the prospective and combined group. There were no differences observed in time to adjuvant therapy (Table 3).

3.5 | Long-term outcome

In the prospective quilted cohort, one patient was lost to follow up and did not complete the postoperative questionnaires. In the nonquilted cohort, four patients did not fill out the questionnaires 2 weeks postoperative and only one patient 6 months postoperative.

In the prospective group, no differences were observed in shoulder function and analgesic use between the quilted and non-quilted cohort (Table 4).

4 | DISCUSSION

The effect of quilting in mastectomy and/or ALND was studied in a combined prospective and retrospective study in two breast cancer centres. Although the quilting technique required an additional 10 min of operation time, a significant reduction in CSS incidence was observed in the prospective cohort as well as the combined cohort. Significant reduction of nonaspirated seroma, SSI, bleeding complications, and other wound complications were found following quilting. Quilting resulted in less postoperative visits to the outpatient

TABLE 2 Multivariate analysis for the risk on CSS formation

Characteristics	Combined group (including prospective and retrospective data)		
	aOR	95% CI	p value
Quilting	0.06	0.03–0.14	<0.001
ASA classification			
1	ref.		
2	1.7	0.75–4.02	0.200
3	4.4	1.33–14.72	0.016
4	2.0	0.40–9.94	0.399
Recurrent breast cancer	1.2	0.19–7.22	0.854
Prior breast irradiation	0.9	0.14–6.07	0.942
TNM stage			
No malignancy	ref.		
In situ	0.6	0.10–43.99	0.632
1	0.5	0.09–2.58	0.391
2	0.9	0.17–4.47	0.880
3	0.5	0.07–3.25	0.461
4	1.0	0.05–21.22	0.988
ypT0N0	0.6	0.08–4.64	0.625
Angiosarcoma	3.7	0.10–136.41	0.475
Type of surgery			
Mastectomy	ref.	3.19–34.66	<0.001
ALND	10.5	0.31–9.42	0.546
Mastectomy and ALND	1.7		
NAC	0.9	0.41–1.89	0.734

Abbreviations: ALND, axillary lymph node dissection; ASA, American Society of Anaesthesiology; aOR adjusted odds ratio; CI, confidence interval; CSS, clinical significant seroma, NAC, neoadjuvant chemotherapy; TNM, Classification of Malignant Tumours.

clinic and a shorter length of hospital stay. In a prospectively analysed group of patients, postoperative shoulder function and analgesic use did not differ significantly between the two cohorts.

In the present study, patients were prospectively registered, given the small number of prospectively included patients a retrospective cohort was included in the study. Both cohorts were comparable for age and BMI, but different for ASA classification, prior breast irradiation, TNM stage, type of surgery, and NAC. Contrary to earlier reports, in this series ASA classification of three emerges as a risk factor for CSS formation according to multivariate analysis (aOR: 4.4, 95% CI: 1.33–14.72, $p = 0.016$). It should be noted that differences in ASA classification could be attributed to this rather subjective classification, resulting in interobserver variability between anaesthesiologists at different hospitals.^{30,31} Data regarding ASA

classification was revised for prospectively included patients in both hospitals. After this revision ASA classification was not significantly different for both cohorts ($p = 0.269$). Differences in the type of surgery and NAC were most likely explained by different policies applied in the hospitals. Also TNM stage was different between the cohorts, reflecting diverging tumour board decisions between the breast cancer centres regarding mastectomy indications. The higher ASA classification in patients treated in the nonquilting hospital could reflect a preference for mastectomy at the local multidisciplinary tumour board in frailer patients. In contrast, the tumour board of the quilting hospital tended to reserve mastectomy for larger tumours explaining lower TNM stage in the nonquilting cohort. Multivariate analysis showed an association between higher ASA classification or ALND and increased CSS. A review of the literature, however, demonstrated that patient characteristics seem to have no influence on seroma formation, in contrast to the type of surgery and degree of tissue damage which are consistent risk factors for seroma formation.^{1,6,7,10,27} We therefore expect ASA not to influence the results in contrast to the type of surgery. In the quilted cohort more ALNDs were performed, increasing the risk for seroma formation in the quilted cohort compared with the nonquilted cohort.

Seroma is a much discussed topic for which preventive measures have extensively been studied.^{6,32} Mechanical closure of the dead space was reported to be one of the key factors in seroma prevention.⁶ Coveney et al.³³ reported quilting sutures as a method to obliterate dead space after mastectomy, finding seroma incidences of 25% in the quilted cohort versus 85% in the nonquilted cohort ($p < 0.001$). This is in line with the results of the present study, CSS incidence was 12.9% in the quilted cohort and 62.3% in the nonquilted cohort ($p < 0.001$). Ouldamer et al.²² reported similar results, quilting led to a seroma reduction from 21.7% to 6.8% ($p = 0.03$). Once there is CSS, neither the amount of aspirations per seroma patient nor the volume of aspirations differed significantly between the cohorts in the present study.

CSS is reported as a risk factor for SSI.^{34,35} This study shows an association between quilting and SSI, with SSI being significantly less frequent in the quilted cohort than the nonquilted cohort (5.0% vs. 14.0%; $p = 0.013$). A similar decrease in seroma and seroma-associated complications was reported earlier by our group.⁹ According to the CDC criteria, SSI must occur within 30 days after operative procedure.²⁵ Since seroma induced wound infections not only occur within but also beyond 30 days, incidences of wound infections following mastectomy could be underreported in literature. The present study shows that quilting decreases the number of bleeding complications and wound healing problems.

Mastectomy and ALND are known risk factors for long-term impairments in arm and shoulder function. The associated pain, sensory changes, and scar contraction negatively influence the range of motion and muscle strength of the shoulder girdle.³⁶ The possible effect of quilting on shoulder function, due to tight fixation of the skin flap on the pectoralis muscle, remains unclear. We examined shoulder function with disability of the arm, shoulder and hand (DASH) questionnaires, a self-reported measurement that comprises

TABLE 3 Comparison of outcomes

Endpoints	Prospective group		<i>p</i> value	Combined group (including prospective and retrospective data)		<i>p</i> value
	Nonquilted cohort (n = 27)	Quilted cohort (n = 29)		Nonquilted cohort (n = 114)	Quilted cohort (n = 140)	
CSS	16 (59.3)	2 (6.9)	<0.001	71 (62.3)	18 (12.9)	<0.001
Overall seroma rate	22 (81.5)	9 (31.0)	<0.001	94 (82.5)	41 (29.3)	<0.001
Aspirations (per CSS pt)	2.75 ± 2.0	3.0 ± 2.8	0.874	3.3 ± 2.7	5.0 ± 2.1	0.067
Volume of aspirations	224.8 ± 137.8	92.5 ± 60.1	0.207	197.8 ± 108.2	183.1 ± 93.8	0.596
SSI	5 (18.5)	1 (3.4)	0.068	16 (14.0)	7 (5.0)	0.013
Bleeding complication	3 (11.1)	0 (0)	0.065	11 (9.6)	4 (2.9)	0.022
Wound healing problems	4 (14.8)	0 (0)	0.031	11 (9.6)	4 (2.9)	0.022
Operation time	82.9 ± 34.2	80.7 ± 19.5	0.767	68.5 ± 20.20	77.8 ± 17.76	0.001
Days of hospital stay	2.7 ± 1.17	1.4 ± 0.49	<0.001	2.6 ± 1.10	1.5 ± 0.55	<0.001
Readmission	1 (3.7)	0 (0)	0.296	4 (3.5)	0 (0)	0.025
Reoperation	3 (11.1)	0 (0)	0.065	6 (5.3)	0 (0)	0.006
Additional visits to the outpatient clinic			<0.001			<0.001
0	7 (25.9)	26 (89.6)		41 (36.0)	108 (77.1)	
1–3	16 (59.3)	2 (6.9)		44 (38.6)	26 (18.6)	
>3	4 (14.8)	1 (3.4)		29 (25.4)	6 (4.3)	
Time to adjuvant therapy (days)	44.5 ± 11.9	39.5 ± 10.6	0.210	43.4 ± 10.4	42.8 ± 14.0	0.798

Note: Outcomes are presented as mean ± standard deviation, or frequency (%).

Abbreviations: CSS, clinical significant seroma; SSI, surgical site infection.

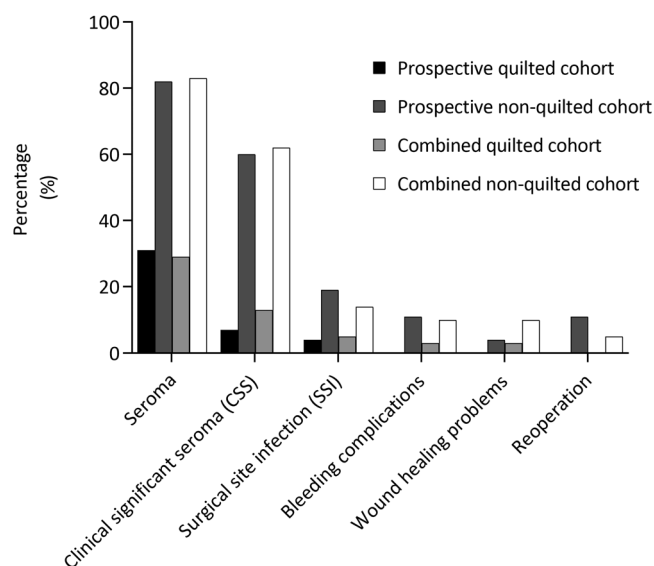


FIGURE 1 Wound complications following mastectomy comparing quilting without wound drainage and conventional wound closure with wound drainage in both the prospective and combined cohort

clinical relevance. There was no significant difference in shoulder function between the two cohorts. Similar to Granzier et al.,¹⁷ we found a modest and temporarily decline in shoulder function in both cohorts 2 weeks following surgery. Six months postoperatively, DASH scores were 14 in the quilted cohort versus 22 in the non-quilted cohort ($p = 0.127$). Our findings are similar to the results of Granzier et al.¹⁷ suggesting that flap fixation, including wound drainage, following mastectomy does not have an adverse effect on self-reported shoulder function. Myint et al.²⁰ also reported that quilting did not restrict shoulder movement.

Another concern is that quilting might induce more pain and discomfort. Ouldamer et al.²² evaluated self-reported pain with the Visual Analog Scale (VAS), 15–21 days postoperatively after quilting suture flap fixation and conventional closure. A higher rate of patients free of pain was reported in the quilted cohort compared with the nonquilted cohort (61% vs. 30%, $p < 0.001$). Myint et al.²⁰ reported that the amount of analgesic use did not differ between the quilted and nonquilted cohorts. This is in line with the results of our study. In both cohorts, there was no increase in the use of analgesics, not 2 weeks postoperatively nor 6 months postoperative compared with preoperative use, nor was there a difference in the type of

TABLE 4 Comparison of shoulder function limitation and pain

Endpoints	Nonquilted cohort (n = 27)	Quilted cohort (n = 29)	p value
DASH score (preoperative)	15 ± 22	11 ± 14	0.384
DASH score (2 weeks postop)	35 ± 24	34 ± 16	0.848
DASH score (6 months postop)	22 ± 23	14 ± 16	0.127
Use of analgesics (preoperative)	5 (18.5)	6 (20.7)	1.000
Use of analgesics (2 weeks postop)	12 (50)	17 (58.6)	0.587
Use of analgesics (6 months postop)	6 (23.1)	5 (17.9)	0.741

Note: DASH is presented as points ± standard deviation, analgesics is presented as frequency (%). DASH disability of arm, shoulder and hand, postop postoperative: low score means less impairment, higher score means more impairment.

used analgesics (paracetamol, nonsteroidal anti-inflammatory drugs (NSAID) or opioids) between the cohorts.

Cosmetic result, including dimpling of the skin and scar retraction, have previously been cited as possible disadvantages of the quilting technique. The interim analyses Granzier et al.¹⁷ reported, did not show differences in skin appearance, nor patient reported cosmetics 1 year after surgery, comparing flap fixation with conventional closure. Ouldamer et al.²² reported significantly better patient-reported cosmetics in the quilted cohort. In our study we did not report on cosmetic results.

This study shows that prevention of seroma and associated complications translates in benefits in terms of perioperative health care consumption. Postoperative wound suction drainage in mastectomy is globally embedded in daily practice, but remains subject of discussion, especially regarding type and duration of drainage. Since postoperative wound drainage can be omitted,²¹ day treatment is facilitated. Hospital stay is significantly reduced aided by quilting compared with conventional wound closure, down to the level of day treatment (mean duration was 1.5 vs. 2.6 days; $p < 0.001$). Our findings are in line with those reported by Ouldamer et al.,²² mean duration of stay was 5.4 nights in the nonquilted cohort and 4.2 nights in the quilted cohort ($p < 0.001$). A lower incidence of additional visits to the outpatient clinic was seen in the quilted cohort ($p < 0.001$). Furthermore, more nonquilted patients had more than three additional outpatient visits (25.4% vs. 4.3%; $p < 0.001$). Granzier et al.¹⁷ did report a not significant tendency to less frequent visits to the outpatient clinic following quilting. It is often reported that the quilting procedure requires 10–20 min operating time.^{20,37} This is in line with our results, surgery took on average 10 min longer in the quilted cohort ($p < 0.001$). Reoperations and readmissions were significantly higher in the nonquilted cohort. Operation time, hospital stay, and readmissions are budget-consuming events. The budgetary impact however is highly dependent on the health and insurance system with considerable geographical variation. The aforementioned data urge for a prospective cost-benefit analysis, focussed on the local situation and encompassing all variables to better address and quantify the perceived gain in health care consumption of quilting.

Main limitation to this study is the small amount of patients included in the prospective cohort, to evaluate shoulder function and

pain following mastectomy. However, the results show a trend in favour of quilting, rendering adverse outcomes with more included patients improbable. Observed interinstitutional therapeutic variation is another drawback, resulting in heterogenic study populations, partly attributable to different views of local tumour boards and screening anaesthesiologists. Strengths of the study relate to its partially prospective and multicentre, real-life design. Moreover, it is one of the first studies regarding quilting with special attention for shoulder function and postoperative pain. Additionally, it is the first study which extensively describes health care consumption with regard to quilting following mastectomy and/or ALND. To further explore the results of this study, a multicentre stepped wedge design study is planned to prospectively compare the quilting suture technique to conventional wound closure.

In conclusion, the quilting suture technique following mastectomy and/or ALND reduces CSS compared with conventional wound closure with postoperative drainage but requires an additional 10 min operating time. The presented data show an association between general condition (presented as ASA classification) or type of surgery (ALND) and CSS. Quilting does not affect shoulder function and postoperative analgesic use is not increased. Health care consumption is reduced through day care treatment and a reduction in complications and resulting unplanned visits, readmissions, and reoperations.

DATA AVAILABILITY STATEMENT

The data set generated during the current study is available on reasonable request.

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