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Capsulectomy for chronic encapsulated seroma after breast cancer surgery: prone to complications and limited efficacy

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ABSTRACT

Introduction: Chronic encapsulated seroma is a challenging complication after breast cancer surgery, and evidence guiding its optimal management is limited. Surgical excision (capsulectomy) has been proposed as a treatment option, although data on its effectiveness and associated morbidity remain scarce.
Methods: We reviewed follow-up data from 6812 breast cancer surgeries performed at a single university hospital and identified patients who underwent capsulectomy for chronic encapsulated seroma. Risk factors and long-term outcomes were analyzed.
Results: Chronic seroma requiring capsulectomy occurred in 1.7% (47/2736) of patients after mastectomy and in none of the patients undergoing breast-conserving surgery without axillary lymph node dissection (0/3083). Obesity was a major risk factor: 4.4% of patients with a BMI >30 kg/m^2 who underwent mastectomy required seroma capsulectomy compared with 0.9% of those with normal BMI.
Following seroma capsulectomy, 68% of patients had persistent seroma beyond three months, 46% developed surgical site infection, and 48% required reoperation. Uneventful healing with complete resolution of seroma within three months from seroma capsulectomy was observed in seven patients (14%).
Conclusion: Chronic encapsulated seroma appears to occur predominantly in obese patients after mastectomy. Seroma capsulectomy is associated with considerable morbidity and relatively low rates of resolution. These findings should be considered when evaluating the role of surgery in clinical practice.

1. Introduction

Postoperative complications following breast cancer surgery are common and may significantly affect patient recovery, quality of life, and delay initiation of adjuvant treatments [1–3]. One of the most frequent complications is seroma formation, defined as a sterile accumulation of serous fluid at the surgical site. It is thought to result from tissue trauma, disruption of lymphatic vessels, and the creation of dead space. Although the exact mechanisms related to the development of seroma are only partly understood, the aetiology is widely accepted to be multifactorial [4,5]. The reported incidence of seroma ranges from 3% to 85%, depending on surgical technique, extent of axillary surgery, and duration of follow-up [6–9]. It is suggested that all patients undergoing mastectomy develop some extent of seroma, but in majority of patients, seroma resolves spontaneously within a few weeks from the operation [10,11]. Compared with mastectomy, breast-conserving surgery (BCS) is associated with a lower incidence of seroma, and most seromas are small, asymptomatic and resolve spontaneously. Clinically significant or chronic seroma after BCS is uncommon, but there is a lack of data regarding the exact incidence [12].

In cases where symptomatic seroma requires treatment, it can be usually managed conservatively with drainage, observation, or aspiration [10,11]. As seroma aspiration is associated with a risk of infection and bleeding, aspiration of completely asymptomatic seroma should be approached with caution [13,14].

In a subset of patients, seromas persist despite repeated interventions and may become chronic and eventually, encapsulated [15]. Encapsulated seroma is associated with a fibrous capsule lining the seroma cavity. Once encapsulated, seroma responds poorly to conservative management and may cause persistent pain, discomfort, and seroma infections [3,16,17].

No standardized treatment strategy for encapsulated seroma has

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been established [18]. Various approaches have been described in the literature, including repeated aspirations, compression, sclerotherapy using a variety of agents (e.g. talc, fibrin sealant, tetracycline, and hypertonic saline), and surgical interventions [19–21]. The available evidence on the effectiveness of these treatments is scarce, and while some approaches have shown efficacy in small cohorts, findings have not been consistently replicated in larger prospective studies.

Surgical excision of the seroma capsule has been proposed as an effective treatment option in selected patients, particularly when conservative measures have failed [16,17,22,23]. However, to date, the literature provides mainly case reports, and there is very limited systematic research regarding the outcomes of this procedure [17].

This study aims to describe the incidence of chronic encapsulated seromas requiring surgical intervention following breast cancer surgery. In addition, we evaluated the safety, clinical outcomes, and postoperative complications of the procedure in a single-center cohort.

2. Materials and methods

2.1. Study population

This retrospective single-center study included breast cancer patients treated at Turku University Hospital between January 2010 and December 2022. Inclusion criteria were a diagnosis of invasive breast cancer (ICD-10 code C50) or ductal carcinoma in situ (ICD-10 code D05.1) and performance of breast cancer surgery.

2.2. Surgical technique

Primary breast surgery consisted of mastectomy, breast-conserving surgery without oncoplastic techniques (BCS), or oncoplastic breast-conserving procedures (OBCS). Axillary management was carried out in accordance with contemporary breast cancer treatment guidelines. Sentinel lymph node biopsy (SLNB) was performed in patients with a clinically and radiologically negative axilla, whereas axillary lymph node dissection (ALND) was undertaken when axillary metastasis was detected preoperatively or when current treatment guidelines indicated ALND following intraoperative detection of axillary metastasis.

Information on symmetrizing breast reduction mammaplasty was recorded and included in the per-procedure analysis.

In mastectomy and ALND procedures, energy-based instruments were predominantly used. During the study period, the most commonly applied devices were LigaSure™ (Medtronic, Minneapolis, MN, USA), SonoSurg® (Olympus, Tokyo, Japan), THUNDERBEAT® (Olympus, Tokyo, Japan), and Harmonic Focus® (Ethicon, Cincinnati, OH, USA). In mastectomy, elliptical incision was performed. Skin flaps were prepared to a thickness of approximately 5–10 mm, and the pectoral fascia was removed. The wound was closed with intracutaneous sutures. During the study period, quilting sutures were not used at our institution.

Conventional electrocautery was used in BCS, with or without oncoplastic techniques, as well as in SLNB. The technique used in BCS may have varied between surgeons. In practice, the surgical cavity was closed with absorbable sutures in layers, and absorbable sutures were also used for skin closure. No drainage was used in case of BCS.

2.3. Treatment of postoperative seroma formation

Patients who underwent mastectomy or ALND had a surgical drain placed in the operative field. Drains were removed no later than one week postoperatively, or earlier if drainage output was low. Drains were most commonly removed when the daily output was less than 80 mL, but the threshold may have varied between surgeons. After drain removal, any accumulated seroma was managed by needle aspirations. Aspiration was typically performed by a physician in primary care.

Patients were routinely scheduled for a follow-up visit at the surgical outpatient clinic 2–3 weeks after surgery until the onset of the COVID-19 pandemic. During the pandemic, visits were replaced by telephone calls. After the pandemic, in-person visits were reintroduced for mastectomy patients, but for patients undergoing BCS, the practice of follow-up telephone calls was continued. At this visit, seroma aspiration was commonly performed, and the need for previous seroma aspirations was documented. After this visit, patient care was transferred to the oncology clinic, and no routine surgical follow-up was scheduled. If symptomatic seroma persisted, the patients were re-referred for surgical evaluation.

2.3.1. Definitions

There are no standardized definitions for persistent and chronic seroma. For the purpose of this study, terminology related to seroma was defined as follows. “Persistent seroma” was defined as a clinically evident seroma requiring ongoing interventions beyond the expected postoperative course, typically necessitating repeated aspirations. “Chronic encapsulated seroma” was defined as a persistent seroma with formation of a fibrous capsule and requiring surgical management (seroma capsulectomy), usually preceded by repeated aspirations and confirmed by fluid aspiration.

The diagnosis of chronic encapsulated seroma was based on a clinically evident persistent seroma, typically confirmed by aspiration. In cases of diagnostic uncertainty, the diagnosis was confirmed by ultrasound performed by a breast radiologist. Subclinical seroma collections detected only on imaging and not requiring intervention were not considered persistent.

2.4. Surgical treatment of chronic seroma

If the patient was referred for surgical evaluation due to persistent seroma, initial management typically consisted of complete aspiration of the seroma cavity followed by intralesional injection of a sclerosing agent. As none of the agents used had, in clinical experience, demonstrated superiority over others, several different sclerosing agents were employed during the study period. During the study period, the following agents were most often used: doxycycline and tetracycline (pharmaceutical-grade preparations; various manufacturers), sterile talc, polidocanol (Aethoxysklerol®; Kreussler Pharma, Wiesbaden, Germany), and fibrin sealant (FibroSeal®; Ethicon, Cincinnati, OH, USA).

In cases of chronic seroma refractory to conservative management, surgical excision of the seroma capsule was undertaken. In the absence of clear guidelines, the decision to proceed with surgery was made in agreement with the patient, taking into account the duration and severity of symptoms as well as patient preference.

The procedure involved complete removal of the fibrous capsule surrounding the seroma cavity, with the aim of eliminating the dead space and preventing recurrence. The decision to proceed with surgical treatment was made on an individual basis by the surgeon. During surgery, the surgical cavity was often treated with topical hemostatic agents, including oxidized regenerated cellulose or a collagen-based hemostatic agent, in an attempt to reduce postoperative seroma formation. Negative pressure wound therapy was used in many patients, but not systematically.

Seroma was considered completely resolved if no further interventions, including aspiration in specialized care, were required beyond 3 months after seroma capsulectomy. Subclinical seroma collections detected only on imaging, or small collections not requiring aspiration, were not considered persistent.

2.5. Data collection

Clinical data were retrospectively collected from electronic medical records. Extracted variables included patient age and body mass index (BMI) at surgery, use of neoadjuvant therapy (NACT), history of breast cancer, surgical procedures performed (including reoperations),

American Society of Anesthesiologists (ASA) physical status classification, diabetes, and smoking status. Although data collection aimed to be comprehensive with respect to proposed risk factors for seroma formation, information on hypertension or use of antihypertensive medications was not collected as it was not consistently available.

Information regarding postoperative course was collected, with particular focus on seroma requiring surgical intervention. Patients who underwent any reoperation or had an unplanned outpatient visit at our institution during the study period were reviewed in detail. Patients who underwent surgical excision of seroma (seroma capsulectomy) were identified, and additional data were collected, including use of antihypertensive medications, receipt of radiation therapy, timing of seroma capsulectomy, surgical site infections, and postoperative outcomes following capsulectomy. Outcome data included recurrence of seroma, postoperative complications, and need for further surgical interventions.

Follow-up data was collected throughout the entire study period.

2.6. Statistical analysis

Continuous variables are presented as medians with interquartile ranges (IQR) and categorical variables as frequencies and percentages. Comparisons between groups were performed using the Mann–Whitney *U* test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables. A two-sided p-value <0.05 was considered statistically significant.

To identify risk factors for seroma capsulectomy, multivariable analysis was performed. Variables with a p-value of <0.15 in univariable analyses were included in the multivariable model. The analysis was repeated with stepwise removal of non-significant variables until only statistically significant variables ($p < 0.05$) remained in the final model. Given the limited number of events, stepwise selection was used as an exploratory approach to reduce the risk of overfitting. Results are reported as odds ratios (ORs) with 95% confidence intervals (CIs) and p-values. Missing data were handled using complete case analysis.

To evaluate the significance of risk factors that were not systematically available in the collected dataset (hypertension, postoperative radiation therapy), the analysis was performed using a case–control study design. Controls were matched for patients undergoing seroma capsulectomy based on a BMI difference of no more than 1 kg/m^2 and the same initial surgical procedure. Matching was performed by ordering eligible patients by age according to these criteria and selecting the nearest neighbor.

Ethical approval

According to national regulations and institutional policies, formal approval from an ethics committee was not required for this retrospective study and informed consent was waived. Permission to conduct the study was obtained from the Hospital District of Southwest Finland (T537/2022).

3. Results

In total, 6240 patients fulfilled the inclusion criteria, 572 (9.2%) of whom underwent bilateral surgery, totaling 6812 breast surgeries in total. The demographics of the patients are presented in Table 1 and details of surgical procedures are presented in Table 2. Risk factors and outcomes were defined on a per-procedure basis.

Seroma capsulectomy was performed in 50 patients. In the initial stage of the analysis, it was observed that seroma capsulectomy was not performed in patients who had undergone neither mastectomy nor ALND (Table 3).

Due to zero events in several patient groups, only patients who underwent mastectomy were included in the detailed statistical analysis. Results of the univariable and multivariable analysis are presented in Table 4. In total sixteen surgeons performed more than 50 mastectomies.

Table 1
Demographics of patients included in the analysis. Data is presented as n (%) unless otherwise specified.

Number of patients	6240
Age (median, IQR) in years	65.3 (56.5-74.2)
Body-mass index (median, IQR), in kg/m^2	26.6 (23.5-30.7)
ASA Classification	
I	940 (15.1%)
II	3271 (52.6%)
III	1864 (30.0%)
IV	146 (2.3%)
Missing data	19
Diabetes	595 (9.5%)
Smoking status	
Active smokers	905 (14.5%)
Former smokers	1219 (19.5%)
Never smokers	3888 (62.3%)
Information missing	228 (3.7%)
Received neoadjuvant chemotherapy	242 (3.9%)
Antithrombotic medication	1309 (21.0%)
Unilateral surgery	5668 (90.8%)
Bilateral surgery	572 (9.2%)

Table 2
Information on performed surgeries pre-procedure. BCS = breast-conserving surgery. Information is given in n(%).

Total number of surgical procedures	6812
Conventional breast conserving surgery	3387 (49.7%)
Oncoplastic breast conserving surgery	374 (5.5%)
Mastectomy	2736 (40.2%)
Reduction mammaplasty	315 (4.6%)
Sentinel lymph node biopsy	3832 (56.3%)
Axillary lymph node dissection	2132 (31.3%)
No axillary surgery	848 (12.4%)
Mastectomy for locally recurrent breast cancer	275 (4.0%)
Mastectomy as a reoperation after BCS	284 (4.2%)
Surgical instrument	
Energy instrument	3033 (44.5%)
Conventional electrocautery	2276 (33.4%)
Instrument not recorded	1503 (22.1%)

The operating surgeon had no association with seroma capsulectomy ($p = 0.82$).

In the multivariable analysis, high BMI, and the type of surgical instrument used were the only factors that remained statistically significant. A total of 1854 patients were included in the final multivariable model.

The three cases who had undergone BCS + ALND as the primary operation were reviewed in light of these findings. The BMI of these patients were 31.5 kg/m^2, 35.3 kg/m^2 and 38.9 kg/m^2, respectively. Each of these patients had seroma on ALND site.

The cases who underwent seroma capsulectomy were reviewed in detail to identify events preceding any additional reoperations, the timing of the seroma capsulectomy, and the long-term outcomes of the procedure. In all patients, intensive conservative management was attempted before proceeding with surgery. Most patients had completed adjuvant breast cancer therapies before seroma capsulectomy, since receiving these treatments in time was considered more important than

Table 3
Risk of seroma capsulectomy related to each primary procedure. MT = mastectomy, BCS = breast-conserving surgery, OBCS = oncoplastic breast conserving surgery, SLNB = sentinel lymph node biopsy, ALND = axillary lymph node dissection. *in one patient, a cross-over sentinel lymph node was detected in preoperative lymphoscintigraphy.

Surgery	Number of operations	Number of patients undergoing seroma capsulectomy	Percentage of patients undergoing seroma capsulectomy
MT + no axillary surgery	175	5	2.9%
MT + SNLB	1107	12	1.1%
MT + ALND	1454	30	2.1%
BCS + no axillary surgery	344	0	0%
BCS + SLNB	2417	0	0%
BCS + ALND	626	3	0.5%
OBCS + no axillary surgery	15	0	0%
OBCS + SLNB	307	0	0%
OBCS + ALND	52	0	0%
Reduction mammaplasty + no axillary surgery	314	0	0%
Reduction mammaplasty + SLNB	1*	0	0%

treating the seroma.

The majority of patients underwent numerous seroma aspirations, typically once per one or two weeks. In addition, attempts were made to treat seroma using various compression therapies, physiotherapy, and sclerosing agents aiming at inducing sclerosis of the seroma capsule. In practically all cases, patient records indicated no clinical response to these treatments, which likely explains the large number of therapies and agents attempted.

Radiotherapy and hypertension have previously been identified as risk factors for seroma formation. These variables were not systematically available in the study data. Therefore, for each patient who underwent capsulectomy, a control patient matched for age, BMI, and type of surgical treatment was selected from the cohort. The prevalence of these risk factors was then compared between the groups in case-control study setting. It was observed that hypertensive medications were more often used in the control group, and that also significant portion of control patients had visits to specialized health care for seroma treatment (Table 5). In patients who received radiotherapy, seroma capsulectomy was performed after completion of radiotherapy.

To evaluate the long-term outcomes of seroma capsulectomy, the patient data was reviewed for the entire study period and in the patients undergoing initial breast cancer surgery during the last year of study period, for at least a year after the initial operation. The data is presented in Table 6.

Notably, reoperation due to persistent seroma was performed in nine patients (18%). In addition, several patients declined further reoperation to treat persisting seroma, reporting a preference to accept the condition, as a previous reoperation had not alleviated the symptoms.

In fifteen patients (30%), reoperation was required due to surgical wound problems, and several patients received conservative treatment of wound dehiscence.

In total, seven patients (14%) with either persistent seroma or long-term wound-healing complications ultimately required extensive revision of the surgical site with reconstructive flap surgery, most commonly using a latissimus dorsi (LD) flap.

Only seven of 50 patients (14%) had an uncomplicated recovery combined with resolution of seroma within three months after capsulectomy, eliminating the need for further aspirations. These patients had a significantly lower BMI than the remaining cohort (26.9 vs. 31.5 kg/

Table 4
Results of the univariate and multivariate analyses performed on mastectomy patients. ASA = American Society of Anesthesiologists, BCS = breast conserving surgery, CI = confidence interval, SLNB = sentinel lymph node biopsy, ALND = axillary lymph node dissection.

	Risk for seroma capsulectomy	p-value (univariable analysis)	p-value and Odds-Ratio (95% CI) (multivariable analysis)
Age		p = 0.06	
Under 50 years	0.3% (1 of 389)		
50-70 years	2.0% (22 of 1094)		
Over 70 years	1.9% (24 of 1253)		
Body-Mass Index (kg/m^2)		p < 0.0001*	p = 0.003
Under 20	0% (0 of 162)		No events
20-25	0.9% (8 of 860)		Reference
25-30	1.4% (11 of 801)		1.70 (0.55-5.25)
30-35	4.8% (21 of 437)		5.61 (1.98-15.93)
35-40	3.6% (5 of 138)		5.23 (1.37-19.90)
Over 40	3.0% (2 of 66)		4.74 (0.89-25.18)
ASA Classification		p = 0.28	
I	0.6% (2 of 359)		
II	1.9% (23 of 1200)		
III	2.0% (21 of 1067)		
IV	1.0% (1 of 102)		
Antithrombotic medication	2.6% (19 of 728)	p = 0.03*	
Diabetes	3.0% (10 of 329)	p = 0.05*	
Smoking status		p = 0.64	
Active smokers	1.3% (5 of 372)		
Former smokers	1.6% (6 of 381)		
Never smokers	2.0% (36 of 1808)		
Information missing (175)			
Axillary surgery		p = 0.13	
None	2.9% (5 of 175)		
SLNB	1.1% (12 of 1107)		
ALND	2.1% (30 of 1454)		
Surgical instrument		p = 0.04*	p = 0.003
Harmonic Focus	0.4% (1 of 250)		0.17 (0.02-1.26)
Ligasure	1.7% (3 of 172)		0.84 (0.25-2.83)
Sonosurg	2.2% (28 of 1263)		Reference
Thunderbeat	0% (0 of 212)		No events
Not recorded	0.7% (6 of 828)		
Mastectomy for locally recurrent breast cancer	2.2% (6 of 275)	p = 0.53	
Mastectomy as a reoperation after BCS	2.5% (7 of 284)	p = 0.31	
Neoadjuvant chemotherapy	3.1% (7 of 229)	p = 0.10	

Table 5
Comparison of patients undergoing seroma capsulectomy and control patients. Numbers are in n (%) unless otherwise specified.

	Seroma capsulectomy patients (n = 50)	Control patients (n = 50)	p-value
Time from primary operation to seroma capsulectomy (median, IQR), days	304 (196-478)		
Age (median, IQR), years	70.5 (62.8-76.7)	70.1 (63.5-78.4)	p = 0.89
BMI (median, IQR), kg/m^2	30.9 (27.4-34.1)	30.1 (27.3-34.1)	p = 0.89
Seroma infection (in patients undergoing capsulectomy, before the operation)	29 (58%)	14 (28%)	p = 0.005*
Postoperative radiation therapy	35 (70%)	28 (56%)	p = 0.17
Antithrombotic medication	21 (42%)	17 (34%)	p = 0.41
Antihypertensive medication	34 (68%)	39 (78%)	p = 0.26
Visits to specialist care due to seroma.	50 (100%)	18 (36%)	p < 0.001

Table 6
Long-term outcomes on seroma capsulectomy. Data is given in n (%).

Event	Patients
Seroma persisted at least three months after the capsulectomy, requiring treatment in specialized health care	34 (68%)
Surgical site infection within three months after seroma capsulectomy	23 (46%)
Additional surgery required to treat seroma	9 (18%)
Surgical treatment required for wound dehiscence	15 (30%)
Deceased within 12 months after seroma capsulectomy	3 (6%)

m^2, p = 0.03). Detailed statistical analysis of other outcomes was limited by heterogeneous complications and small sample size.

The seroma capsule was submitted for pathological examination in 36 patients (72%). In all cases, histopathological evaluation revealed only benign encapsulated seroma.

4. Discussion

We found that persistent seroma after breast cancer surgery is almost entirely associated with mastectomy, with or without ALND, while the risk after BCS is negligible. Notably, seroma capsulectomy was usually performed late, at a median of 301 days postoperatively, highlighting the need for prolonged follow-up when evaluating these surgical complications.

Within this large dataset, mastectomy and obesity emerged as the principal risk factors for persistent seroma. It is noteworthy that 4.4% (28 of 641) of mastectomy patients with BMI over 30 kg/m^2 later underwent seroma capsulectomy, corresponding to one out of 23 patients. In practice, all these patients had undergone a prolonged period of conservative management prior to surgical intervention, highlighting the patient burden associated with the complication.

Another major finding was the high incidence of seroma-related infections in both seroma capsulectomy cases and controls. Many infections occurred late in the postoperative course, likely reflecting the chronic nature of seroma. Given that surgical complication research frequently limits follow-up to 30 days, the risk of seroma-associated infections may be underestimated. This finding warrants further study.

It is also noteworthy that the procedure was associated with a high rate of wound complications. Direct comparison of complication rates with existing literature is challenging, as published data on capsulectomy for chronic encapsulated seroma are scarce. Most available studies focus on implant removal or related procedures, which are not comparable to the present clinical setting. Therefore, these findings should be interpreted with caution, and further studies are needed to better contextualize these complication rates.

In addition to the high complication rates, the results indicate that only a small proportion of patients experienced complete resolution of seroma accumulation following surgery. Actually, the number of patients with an uncomplicated outcome was equal to the number of patients who ultimately required plastic surgical reconstruction due to wound complications or persisting symptomatic seroma (n = 7, 14%). It should be noted that the evidence regarding the utility of the method is, to date, largely based on individual case reports describing the procedure rather than scientific studies on its efficacy.

A key interpretation for high prevalence of complications appears to be that, during mastectomy, skin flaps are prepared very thin in order to minimize the risk of residual breast tissue, which is a fundamental objective in the surgical treatment of breast cancer. Consequently, when seroma capsule is excised, the procedure further thins the already thin skin flap, compromising the blood supply of the skin flaps. This likely contributes to impaired wound healing and an increased risk of infection.

When interpreting these results, it should be noted that this study was conducted in a single centre using a retrospective design. In our institution, a relatively radical mastectomy technique has been preferred to ensure oncological safety. Variations in surgical technique, particularly flap thickness, may significantly influence both the incidence of chronic seroma and the risk of complications following capsulectomy. Therefore, validation of these findings in independent cohorts is warranted.

Seroma-related infections were frequent in both the treatment and control groups. An association between seroma and infection risk has been reported previously [24]. However, causality cannot be established based on the present study. It is possible that patients who developed infection were more likely to undergo surgical intervention as part of seroma management.

Another interpretation arising from the data is that, although seroma encapsulation is associated with failure of conservative management, surgical excision of the capsule does not appear to substantially reduce ongoing seroma formation, as seroma persisted to a significant extent even after capsulectomy. Encapsulation therefore appears to be a consequence of seroma formation rather than a perpetuating factor.

Numerous risk factors for seroma formation have been proposed in the literature. However, prior studies have yielded highly heterogeneous results, and few, if any, of the proposed factors have been consistently associated with seroma risk across studies [23].

Obesity, the key risk factor identified in this study, is a well-established determinant of seroma formation [25,26]. Our multivariable analysis further suggests that obesity may confound previously reported associations between seroma and other proposed risk factors.

However, higher BMI may predispose to chronic encapsulated seroma through increased dead space, impaired adipose tissue adherence to the chest wall, or delayed wound healing associated with obesity. Clinically, this highlights the importance of minimizing dead space and ensuring careful postoperative management in patients with higher BMI, although effective preventive strategies remain to be established.

Although age has been associated with seroma risk in prior studies [18,25,27], no statistically significant association was observed in the present analysis. Nevertheless, a trend toward a lower risk of chronic seroma in patients under 50 years of age was noted, meriting further study.

Although hypertension has been proposed as a risk factor for seroma formation in prior studies [6,25,28,29], our case-control analysis did not support this association. Hypertension was common among obese breast cancer patients overall, suggesting that previously reported associations may be confounded by age and obesity.

Smoking has been proposed as a potential risk factor for seroma formation [30,31]. In the present study, no association between smoking and seroma risk was observed.

Antithrombotic medications have previously been proposed as potential risk factors for seroma formation [25]. In the present study, an association was observed in univariable analysis, but multivariable analysis indicated that this finding was attributable to confounding factors.

In addition, this study observed that the type of surgical instrument used may be associated with seroma formation. However, given the wide confidence intervals, clinical significance of this finding remains unclear and warrants further investigation. As the patients included in the study were primarily operated using energy-based instruments, the findings do not allow conclusions regarding potential differences in seroma risk between these instruments and conventional diathermy. The association may reflect differences in procedure type, time period, or other unmeasured confounders rather than a direct causal relationship. Further studies would be needed to clarify this issue.

4.1. Limitations

The main limitation of this study is its retrospective design. It is possible that not all reoperations were captured in the registry-based data. Although efforts were made to account for variables previously associated with seroma-related complications in the literature, the presence of unrecognized confounding factors cannot be excluded. Important potential confounders, such as extent of dead space and duration of drainage, were not available. Furthermore, the primary focus of this study was seroma capsulectomy and its long-term outcomes. Therefore, the risk factors identified in surgically treated patients cannot be assumed to be generalizable to other seroma-related complications.

Both conservative and surgical management were heterogeneous. In the conservative treatment of encapsulated seromas, multiple approaches were used, including aspirations, compression, physiotherapy, and sclerosing agents, without a standardized protocol, reflecting the absence of established treatment guidelines. This may reduce the comparability of results and introduce heterogeneity in treatment effects.

The indication for capsulectomy was not standardized and may have been influenced by surgeon preference. This may introduce selection bias and limit the generalizability of the findings. Negative pressure therapy was used in a subset of patients but not in a standardized manner. This may introduce confounding and limit the interpretation of treatment effects.

5. Conclusion

The risk of chronic encapsulated seroma is high in obese patients after mastectomy. In the present study, seroma capsulectomy was associated with a high rate of complications, and in many patients, seroma persisted. These findings should be considered when evaluating the role of surgery in clinical practice.

Author contributions

Conceptualization (AT), Methodology (AT, RA), Data Collection (AT, RL), Data Curation (RL, AT), Analysis and interpretation (AT, RL, RA), Writing the draft of the article (AT), critical revision of the article (RL, RA), Funding acquisition (AT).

Data availability statement

The datasets generated during the current study are not publicly available due privacy or ethical restrictions but are available from the corresponding author on reasonable request.

Ethics approval

This research study was conducted retrospectively from data obtained for clinical purposes. The research protocol of the study was approved by the Hospital District of Southwest Finland (T537/2022). Informed consent was waived, and no ethical approval was required due to the retrospective nature of this study.

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Role of the funding source

The funding source has had no role in the design, conducting, analysis, or reporting of the study.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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