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Foreseeing Fluids: Risk Factors for Seroma Formation Following Skin- and Nipple-Sparing Mastectomy with Immediate Reconstruction.

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Background

Mastectomies with immediate implant-based reconstruction are increasingly common, particularly among younger breast cancer (BC) patients and individuals undergoing risk-reducing surgery. Skin-sparing and nipple-sparing mastectomies are now well-established techniques; however, they are associated with specific perioperative complications. Notably, prolonged drain duration and seroma formation can hinder recovery, increasing the risk of infection, potentially requiring further intervention. Identifying risk factors for seroma formation is crucial to improving postoperative outcomes and guiding surgical planning.



Figure 1: Clinical presentation of seroma post surgery.
Left: Presentation 14 days after unilateral nipple-sparing mastectomy with immediate prepectoral implant reconstruction, showing seroma formation.
Middle: Sonographic image of the seroma (indicates seroma; # indicates implant).*
Right: Presentation after seroma puncture.

CONTEXT

→ Nipple-sparing mastectomies (NSMs) are becoming increasingly **common** (Valera et al. 2020)
→ Seroma formation is one of the **most frequent complication** (Wang et al., 2025)
→Identifying **risk factors** is vital for both informed consent and perioperative management.

Methods

In this retrospective study, patients who underwent unilateral or bilateral nipple- or skin-sparing mastectomy with immediate implant reconstruction between 2017 and 2024 were analyzed.
The primary aim was to identify risk factors for seroma formation, defined as either a drain remaining in place beyond postoperative day 7 or the need for seroma aspiration following drain removal.

For this purpose, patients were divided into two cohorts (Seroma vs. No Seroma), and potential risk factors as well as postoperative outcomes were compared using Pearson's chi-squared test and the Mann–Whitney U test. p-values < 0.05 were considered statistically significant.

Results

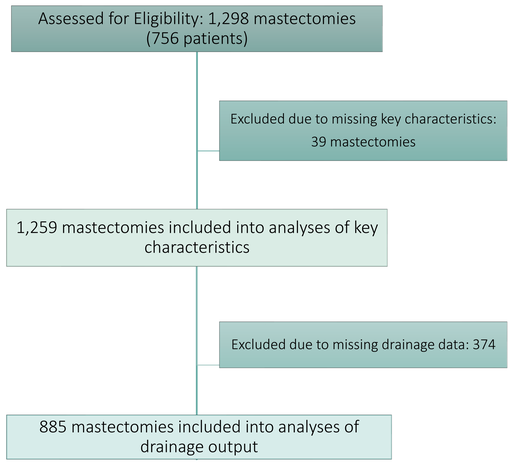


Figure 2: STROBE Flow Chart

In a retrospective analysis of 1,259 mastectomies, the incidence of seroma formation and/or prolonged drainage was found to be 30.1%, with 12.9% of cases requiring seroma aspiration. Statistical evaluation using univariate analyses identified several risk factors for seroma development following skin- and nipple-sparing mastectomy with immediate implant-based reconstruction. Patients who developed seroma were, on average, older at the time of surgery (46.4 vs. 42.9 years, $p < 0.001$) and had a higher body mass index (BMI: 24.8 kg/m² vs. 23.7 kg/m², $p < 0.001$) compared to those without seroma. Medicated hypertension was more prevalent in the seroma group (14.5% vs. 10.0%, $p = 0.021$), and invasive breast cancer as the indication for surgery was also associated with increased risk (47.2% vs. 32.8%, $p < 0.001$).
Furthermore, larger implant volumes (350.8 vs. 320.0 cc, $p < 0.001$) and higher postoperative drainage volumes within the first 72 hours (e.g., 0–24 h: 131 ml vs. 83 ml, $p < 0.001$) were significantly correlated with seroma formation.

		Overall	Seroma+prolonged Drainage	No Seroma	p-value
	N	1259 (100%)	379 (30.1%) prolonged drainage: 315 (25.0%) Seroma in need of puncture: 163 (12.9%)	880 (69.9%)	
Indication for surgery	Risk reducing	486 (38.6%)	135 (35.6%)	351 (39.9%)	**p < 0.001**
	DCIS	114 (9.1%)	33 (8.7%)	81 (9.2%)	
	BC	468 (37.2°)	179 (47.2%)	289 (32.8%)	
	Other	150 (11.9%)	21 (5.5%)	129 (14.7%)	
	History of BC	41 (3.3%)	11 (2.9%)	30 (3.4%)	
Patient characteristics	Age at time of surgery (mean ± SD)	43.99 ± 11.65	46.43 ± 11.38	42.94 ± 11.62	**p < 0.001**
	BMI (mean ± SD)	24.25 ± 4.70	24.82 ± 4.76	23.72 ± 4.43	**p < 0.001**
	Medicated hypertension	143 (11.4%)	55 (14.5%)	88 (10.0%)	**p = 0.021**
	Anticoagulation	45 (3.6%)	17 (4.5%)	28 (3.2%)	p = 0.253
	Diabetes mellitus	22 (1.7%)	10 (2.6%)	12 (1.4%)	p = 0.113
	Current smoker	269 (21.4%)	72 (19.0%)	197 (22.4%)	p = 0.178
	Neoadjuvant chemotherapy	352 (28.0%)	101 (26.6%)	251 (28.5%)	p = 0.497
Intraoperative Features	Nipple-sparing mastectomy	1096	320 (84.4%)	776 (88.2%)	p = 0.069
	Skin-sparing mastectomy	163	59 (15.6%)	104 (11.8%)	
	Use of mesh	879 (69.8%)	255 (67.3%)	624 (70.9%)	p = 0.198
	Implant-based reconstruction	1159 (92.1%)	369 (97.4%)	790 (89.8%)	**p = 0.001**
	Submuscular plane of implant	718 (61.9%) Missing values	217 (58.8%)	501 (63.4%)	
	Epipectoral plane of implant	441 (38.1%) 100 (7.9%)	152 (41.2%)	289 (36.6%)	P = 0.132
	Weight of implant (mean ± SD, cc)	330.42 ± 109.08 130 (10.3%)	350.81 ± 108.07	320 ± 108.35	**p < 0.001**

Table 1: Risk factors for seroma formation.
The absolute numbers of operated breasts are indicated, with column-wise percentages in parentheses. In this univariate analysis, Pearson's chi-squared test was used for categorical variables, and the Mann–Whitney U test was used for continuous variables. Statistically significant p-values are shown in bold.

		Overall	Seroma and/or prolonged Drainage	No Seroma	Missing values	p-value
	N	885	305 (24.2%)	580 (46.1%)	374 (29.7%)	
Drainage Volumes	Drainage output 0-24 hours post surgery (mL, mean ± SD)	99.31 ± 72.88 (N = 885)	130.97 ± 77.05 (N = 305)	82.66 ± 64.78 (N = 580)		**p < 0.001**
	Drainage output 25-48 hours post surgery (mL, mean ± SD)	59.40 ± 40.93 (N = 854)	83.63 ± 45.50 (N = 302)	46.15 ± 31.11 (N = 552)		**p < 0.001**
	Drainage output 49-72 hours post surgery (mL, mean ± SD)	56.00 ± 31.79 (N=671)	73.33 ± 33.69 (N = 287)	43.94 ± 23.00 (N = 384)		**p < 0.001**

Table 2: Drainage flow after NSM / SSM.
Mann–Whitney U test was used for statistical analyses. Statistically significant p-values are shown in bold.

Patients experiencing seroma or prolonged drainage also showed higher rates of postoperative complications, including infections (7.9% vs. 2.5%, $p < 0.001$) and capsular contracture (9.5% vs. 4.0%, $p < 0.001$). Revision surgeries were more frequent in the seroma group, though this did not reach statistical significance (17.7% vs. 14.0%, $p = 0.092$).

		Overall	Seroma and/or prolonged Drainage	No Seroma	p-value
	N	1259 (100%)	379 (30.1%)	880 (69.9%)	
Outcome	Infection		30 (7.9%)	22 (2.5%)	**p < 0.001**
	Delayed wound healing	36 (2.9%)	10 (2.6%)	26 (3.0%)	p = 0.758
	Capsular contracture	71 (5.6%)	36 (9.5%)	35 (4.0%)	**p < 0.001**
	Revision required	190 (15.1%)	67 (17.7%)	123 (14,0%)	p = 0.092

Table 3: Association of seroma and postoperative complications.
The absolute numbers of operated breasts are indicated, with column-wise percentages in parentheses. In this univariate analysis, Pearson's chi-squared test was used for statistical analyses. "Revision required" includes all secondary surgeries, e.g. also secondary autologous tissue reconstruction due to patient's whishes, etc.

Discussion

Taking into account the limitations of the retrospective and single-center design, this large analysis of nipple- and skin-sparing mastectomies has identified several risk factors for seroma formation that concur with those reported in other studies. The rates of seroma occurrence and extended drainage periods observed are consistent with existing literature, underscoring the continued importance of these complications in clinical practice. These findings may support informed discussions and shared decision-making when advising patients undergoing breast surgery.

TAKEHOMEMESSAGES

Risk Factors for Seroma Formation (pre-Op / peri-Op):
- ✓ High BMI
- ✓ Invasive breast cancer
- ✓ Higher age
- ✓ Medicated hypertension
- ✓ Large implant
- ✓ High drainage volume day 1-3 post surgery

The study was approved by the Ethics Committee of the University of Ulm.

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Literature:
Wang, J., R. L. Shammas, E. Montes-Smith, L. A. Boe, J. Levy, F. D. Graziano, C. S. Stern, J. A. Nelson, and J. J. Disa. "Complications and patient-Reported Outcomes in prepectoral Vs Submuscular Breast Reconstruction Following Nipple Sparing Mastectomy." [In eng]. *plast Reconstr Surg* (Mar 17 2025). https://doi.org/10.1097/prs.0000000000012096.
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