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ORIGINAL PAPER

The effect of superior pedicle breast reductions on breast sensation

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Keywords Breast reduction · Breast sensation · Semmes–Weinstein filaments · Vibrometer · Temperature perception · Pain perception

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Introduction

Breast reduction is the most common operation on the female breast in plastic surgery, with a rate of up to 9.5 in 100,000 women [1]. Despite this frequency, or on account of it, there has been a confusing multitude of surgical techniques available. Whereas the inverted-T scar techniques dominated breast reduction surgery for a long time, the use of vertical scar techniques gained in popularity only at the end of the twentieth century. In general, both of these techniques are carried out with different pedicles ranging from superior to inferior with the claim that it should be a technique "for all seasons" [2], suitable to all breasts. Yet, it is difficult to objectively appraise the benefits of all these techniques. In trying to establish standards, Ferreira [3] proposed a reasonable scheme to evaluate the postoperative result of reduced breasts. He proposed five visual characteristics—volume, shape, symmetry, nipple–areola complex, and scars—to be assessed using a scoring chart. Nowadays, these characteristics should also be augmented with the term "sensation," as preservation of breast sensation has become an equally important quality goal in selecting a technique for breast reduction.

Concerning breast sensation, the nerve supply to the breast and especially to the nipple–areola complex has long been perplexing; but now, there is agreement to a large extent that the breast receives its innervation from the lateral and anterior cutaneous branches of the second to the sixth intercostal nerves and from the supraclavicular nerves in a converging path to the areola and nipple [4]. All these nerves travel on the surface of the gland and not along fibrous ligaments or milk ducts through the gland [5]. Given this superficial and converging course of the nerve branches from the periphery of the breast to the areola and the nipple, those breast reductions with a predominantly central tissue resection and a limited lateral and medial undermining should theoretically be most advantageous in sparing the main nerve branches to the breast. Although all modern breast reduction techniques try to spare the nerves to the nipple and areola under all circumstances, contradicting theses have been published which technique of breast reduction with which pedicles and with which scars, either vertical or inverted-T scars, achieves this goal best of all. Whereas some authors stated that the use of superior pedicle techniques reduced sensation more than the use of inferior pedicles [6], other authors could find no such difference between using different pedicles with short or long scars [7]; thus, so far, no consensus has been reached concerning the ultimate nerve sparing breast reduction technique.

The aim of this study was to evaluate breast sensation after breast reductions with a superior pedicle technique, one vertical short-scar technique (a central resection without peripheral undermining [8, 9]) compared to an inverted-T long-scar technique with a central, a medial, and a lateral resection of the lower poles with limited peripheral undermining [10].

Materials and methods

A total of 40 consecutive women with the vertical technique (group I) and 16 women with the inverted-T technique (group II) agreed to undergo qualitative and quantitative testing of the sensory pattern of their breasts. The testing protocol and the questionnaire were reviewed and accepted by the local Ethics Committee.

The questionnaire included the general physical data of the women (Table 1) along with comorbidities [11], previous pregnancies, breast feeding, hormonal contraception, and history of smoking. Additionally, the nipple-to-notch distance, the degree of ptosis [12], and the volume of the breast (by cup dimensions of the brassiere) were recorded.

Exclusion criteria were secondary breast reductions, further previous operations on the breast, and neurological diseases including diabetes.

All sensory examinations were performed in the presence of two female doctors.

The participants were examined in a semi-sitting position in a temperature- and humidity-controlled experimental studio with a constant temperature of 22°C. During the evaluation, the women were asked to close their eyes in order not to see the tested area.

Nine coordinates on each breast including the mid-nipple, four points over the mid-areola area (12, 3, 6, and 9 o'clock), and four points on the skin of the breast (12, 3, 6, and 9 o'clock, at a distance of the radius of the areola from the areola edge [13]) were selected bilaterally as testing sites according to the scheme of Courtis et al. [14]

The four modalities used to evaluate sensitivity were pressure (slowly adapting receptors—touch), vibration (fast adapting receptors—moving touch such as nursing), temperature (warmth and cold), and pain perception. Nipple erection was also tested to evaluate the autonomic nervous system.

Pressure

The sensation of pressure or touch was measured with the complete set of 20 nylon filaments of varying diameter attached to a Lucite rod (Semmes–Weinstein Rolyan monofilaments, Smith and Nephew, Solothurn, CH). Each filament is calibrated to deliver a given force in milligrams required to bend the nylon monofilament. This force has been converted into the log 10 of force, which is a linear function and, thus, should provide easier comparison of thresholds (1.65 to 6.65). For the same reason, and to support the quick assessment of the degree of sensitivity, the filaments are lettered (A–T) and color-coded (green = normal, blue = diminished light touch, purple = diminished protective sensation, red = loss of protective sensation; Tables 2, 3, and 4).

The filaments were applied on the skin in an ascending way as advocated by Weinstein [15] until the filament slightly bent. The first monofilament that evoked a feeling of "touch" on the test sites was recorded by the log 10 values and then transformed into gram per square millimeter.

Vibration

To evaluate the vibratory thresholds, a handheld vibrometer (Somedic Sales AB, Farsta, S) was applied on the selected breast coordinates at 120 Hz. The probe was held against each coordinate to be tested, and the voltage was gradually increased until the patient sensed a first breath of vibration. Measurements were recorded quantitatively in micrometer.

Temperature

Temperature perception was evaluated qualitatively by two metal probes with an adjustable temperature controller at the top (Smith and Nephew, Solothurn, CH). One probe was heated in a temperature-controlled water bath to 44°C, the

Table 1 General and preoperative data of women undergoing two different kinds of superior pedicle breast reduction

		Preoperative group	Vertical-scar group	(I) T-scar group (II)	*p* Value
Number of women		46	36	10	
Age (years)		36±11 (17–64)	35±11 (17–54)	41±12 (27–64)	n.s.
Weight (kg)		66±8 (52–82)	66±7 (53–81)	67±9 (52–82)	n.s.
Height (cm)		163±6 (149–180)	164±7 (149–180)	161±4 (155–168)	n.s.
BMI (kg/m^2)		24.8±2.6 (18.9–30.9)	24.3±2.0 (20.8–28.7)	25.9±3.8 (18.9–30.9)	n.s.
Previous pregnancy (%)		64	62	70	n.s.
Breast feeding (%)		47	46	50	n.s.
Hormonal contraception (%)		31	42	10	0.02
Smoke (%)		47	46	50	n.s.
Nipple to notch distance (cm)		28.0±2.0 (24.0–33.0)	27.0±2.0 (24.0–31.5)	29.5±2.0 (26.0–33.0)	0.00
Ptosis (%)	Grade I	3.2	4.5	–	
	Grade II	38.7	50.0	11.1	
	Grade III	58.1	45.5	88.9	
Brassiere Cup (%)	C	19.4	19.4	20.0	0.01
	D	36.1	50.0	–	
	DD	13.9	11.5	20.0	
	E	19.4	15.4	30.0	
	F	5.6	3.8	20	
	>F	5.6	–	10	
Breast resection weight (g)	Right side	312±114 (100–482)	301±117 (100–482)	342±103 (200–480)	n.s.
	Left side	327±109 (62–500)	314±111 (62–467)	363±101 (216–500)	n.s.
Subjective evaluation of most sensitive part (%)	Nipple	76	72	81	n.s.
	Areola	11	14	6	
	Breast skin	13	14	13	

n.s. no significant difference between groups I and II

other probe was cooled in an ice water bath to 0°C as suggested by Terzis [13]. When the required temperature was reached, the probes were applied onto the nine selected coordinates on the breast for up to 3 s, and the patients were asked if they felt either a warm or cold sensation in a yes/no manner.

Pain

Pain sensation was provoked by a sharply tapered forceps (JF-4, S&T, Neuhausen, CH). One jaw of the forceps was very gently applied on the skin, and the patients responded qualitatively in a yes/no manner.

Table 2 Sensation qualities before breast reduction

		Pressure g/mm^2	(log force)	%				Vibration (μm)	Temperature and pain (%)		
				Green	Blue	Purple	Red		C	W	P
1	Nipple	16.1±8.0	2.83–4.31	8.3	36.1	55.6	–	4.51±14.22 (0.30–40.00)	100	100	86
2	Superior areola	22.6±10.2	2.83–4.74	5.6	11.1	72.2	11.1	5.40±9.26 (0.30–40.00)	94	97	94
3	Medial areola	22.3±10.1	3.22–4.74	-	19.4	66.7	13.9	7.32±16.67 (0.20–92.00)	100	97	97
4	Inferior areola	25.7±12.7	3.22–4.93	-	11.1	75.0	13.9	6.57±13.67 (0.20–70.00)	97	94	97
5	Lateral areola	23.1±9.6	3.61–4.56	–	22.2	75.0	2.8	4.93±10.33 (0.10–53.00)	97	100	100
Σ areola 2–5		23.7 ± 10.7	2.83–4.93	1.4	16.0	72.2	10.4	6.05±11.97 (0.10–92.00)	97	97	97
6	Upper quadrant	27.4±71.2	2.83–6.65	8.3	47.2	41.7	2.8	6.52±8.80 (0.30–32.00)	94	97	89
7	Medial quadrant	16.6±9.0	2.44–4.31	11.1	30.5	58.4	–	7.17±9.86 (0.20–40.00)	94	97	83
8	Lower quadrant	19.8±10.7	2.83–4.31	5.6	27.7	66.7	–	11.46±8.59 (0.20–87.00)	94	97	92
9	Lateral quadrant	16.8±9.0	2.44–4.31	8.4	30.5	61.1	–	7.00±9.62 (0.20–40.00)	100	97	83
Σ quadrants 6–9		19.9±38.0	2.44–6.65	8.3	34.0	57.0	0.7	8.04±10.39 (0.20–87.00)	96	97	87

Concerning pressure values, green (1.65–2.83; 1.69–6.52 g/mm^2) = normal, blue (3.22–3.61; 7.50–9.29 g/mm^2) = diminished light touch, purple (3.84–4.31; 15.7–29.5 g/mm^2) = diminished protective sensation, red (4.56–6.65;36.6–439 g/mm^2) = loss of protective sensation

Table 3 Sensation qualities 1 year after vertical scar breast reduction

	Pressure g/mm²	(log force)	% Green	Blue	Purple	Red	Vibration (μm)	Temperature and pain (%) C	W	P
1 Nipple	21.2±17.4 ↓	1.65–4.93	25.0	15.0	40.0	20.0	4.80±24.03 (0.20–101.40) ↓[a]	85 ↓	65 ↓[a]	90 ↑
2 Superior areola	24.7±10.3 ↓	1.65–4.74	5.0	5.0	65.0	25.0	2.15±8.66 (0.40–26.60) ↑	80 ↓	65 ↓[a]	85 ↓
3 Medial areola	29.0±15.4 ↓[a]	1.65–6.65	10.0	–	55.0	35.0	3.20±12.26 (0.30–47.30) ↑	85 ↓	70 ↓[a]	80 ↓[a]
4 Inferior areola	37.5±22.3 ↓[a]	1.65–5.07	5.0	10.0	40.0	45.0	4.05±13.20 (0.20–49.70) ↑	80 ↓	70 ↓[a]	85 ↓
5 Lateral areola	27.5±11.6 ↓	1.65–4.74	15.0	–	45.0	40.0	3.86±15.14 (0.40–53.40) ↓[a]	90 ↓	80 ↓[a]	85 ↓
Σ areola 2–5	29.7±16.0 ↓	1.65–6.65	8.8	3.8	51.3	36.3	9.86±10.59 (0.20–53.40) ↓	84 ↓	71 ↓	84 ↓
6 Upper quadrant	4.2±4.0 ↑[a]	1.65–3.84	80.0	15.0	5.0	–	2.20±16.76 (0.30–44.70) ↑	95 ↑	95 ↓	95 ↑
7 Medial quadrant	2.5±2.0 ↑[a]	1.65–3.22	95.0	5.0	–	–	1.75±4.89 (0.20–21.60) ↑	95 ↑	90 ↓	95 ↑
8 Lower quadrant	17.2±14.3 ↑	1.65–4.74	30.0	20.0	30.0	20.0	5.00±8.59 (0.20–27.10) ↑	85 ↓	90 ↓	85 ↓
9 Lateral quadrant	5.5±7.3 ↑[a]	1.65–4.08	75.0	10.0	15.0	–	5.10±14.49 (0.20–52.30) ↑	95 ↓	95 ↓	95 ↑
Σ quadrants 6 –9	7.4±10.0 ↑	1.65–4.74	70.0	12.5	12.5	5.0	7.60±8.22 (0.20–52.30) ↑	93 ↓	93 ↓	93 ↑

Concerning pressure values, green (1.65–2.83) = normal, blue (3.22–3.61) = diminished light touch, purple (3.84–4.31) = diminished protective sensation, red (4.65–6.65) = loss of protective sensation

[a] Values are significantly higher ↑ or lower ↓ than the preoperative values

Nipple erection was evoked by running one fingernail over the lateral part of the breast several times.

The subjective part of the evaluation consisted of questioning which part of the breast (nipple, areola, or breast skin) was the most sensitive in the women's opinion.

The final postoperative evaluation was performed at 12 months postoperatively.

To maintain as homologous patient groups as possible (large breasts are deemed significantly less sensitive to pressure [16, 17]), women with a resection weight below and beyond 500 g per side were evaluated separately.

Statistical analysis

Results were analyzed using SPSS 13.0 (SPSS, Chicago, IL, USA). Continuous variables were summarized as mean ± standard deviation and were compared between the groups using the Mann–Whitney test. Comparison between the left and right breast was carried out by using the Wilcoxon signed rank test. Nominal variables were presented as *n* (%), and differences were compared by the Fisher's exact test.

Correlations were investigated by the Spearman rank correlation. *P* values less or equal to 0.05 were considered significant (two-tailed test).

Table 4 Sensation qualities 1 year after inverted T-scar breast reduction

	Pressure g/mm²	(log force)	% Green	Blue	Purple	Red	Vibration (μm)	Temperature and pain (%) C	W	P
1 Nipple	23.1±33.3 ↓	2.44–5.07	28.6	42.8	14.3	14.3	5.48±5.00 (0.30–15.20) ↓[a]	71 ↓	57 ↓	100 ↑
2 Superior areola	32.2±29.1 ↓	2.83–5.07	14.3	–	57.1	28.6	11.58±20.17 (0.20–56.00) ↓	86 ↓	86 ↓	100 ↑
3 Medial areola	30.3±23.2 ↓	2.83–4.93	14.3	14.3	42.8	28.6	7.89±8.67 (0.20–24.80) ↓	71 ↓	71 ↓	100 ↑
4 Inferior areola	33.3±30.5 ↓	2.83–4.93	14.3	14.3	42.8	28.6	4.33±2.71 (0.70–7.50) ↑	71 ↓	71 ↓	86 ↓
5 Lateral areola	31.6±30.5 ↓	2.83–5.07	14.3	14.3	42.8	28.6	5.32±4.23 (0.60–13.20) ↓	86 ↓	71 ↓	71 ↓
Σ areola 2–5	31.8±26.9 ↓	2.44–5.07	14.3	10.7	46.4	28.6	7.28±8.17 (0.20–56.00) ↓	79 ↓	75 ↓	89 ↓
6 Upper quadrant	8.2±11.6 ↑	1.65–4.17	57.1	28.6	14.3	–	3.75±4.67 (0.50–13.70) ↑	100 ↑	100 ↑	100 ↑
7 Medial quadrant	7.6±10.0 ↑	1.65–4.31	57.1	28.6	14.3	–	4.84±5.20 (0.30–14.60) ↑	100 ↑	100 ↑	100 ↑
8 Lower quadrant	59.9±81.7 ↓[a,b]	2.44–6.10	14.3	–	28.6	57.1	26.12±58.24 (0.30–158.00) ↓	86 ↓	86 ↓	57 ↓
9 Lateral quadrant	14.5±27.3 ↑	1.65–4.93	57.1	28.6	–	14.3	8.95±19.28 (0.20–52.40) ↓	100 –	86 ↓	86 ↑
Σ quadrants 6–9	22.6±46.8 ↓	1.65–6.10	46.4	21.5	14.3	17.8	10.91±21.62 (0.20–158.00) ↓	97 ↑	93 ↓	86 ↓

Concerning pressure values, green (1.65–2.83) = normal, blue (3.22–3.61) = diminished light touch, purple (3.84–4.31) = diminished protective sensation, red (4.65–6.65) = loss of protective sensation

[a] Values are significantly higher ↑ or lower ↓ than the preoperative values

[b] Values are significantly lower than in group I

Results

The examinations revealed that 36 women in group I (vertical scar) and ten women in group II (inverted-T scar) had a resection weight below 500 g per breast, and there were four women in group I and six women in group II who had a resection weight beyond 500 g per side. These ten women were excluded as these numbers are too small to carry out a meaningful statistical analysis. Thus, a total of 46 women with a resection weight below 500 g were left for final analysis and completed their 1-year follow-up (Tables 3 and 4).

None of the women suffered from a comorbidity of Charlson [11]. In group II, significantly fewer women had taken hormonal contraception (Table 1), but there was no significant correlation between breast sensation and number of previous pregnancies, breast feedings, or smoking. There were no significant differences between the tested coordinates in the right and left breasts. Nonetheless, we did not average the two sides so as not to mix dependent (sides) and independent (women) values in the statistical analysis. For the sake of clarity in the tables, only the values of the right breasts are presented. There were also no significantly different thresholds in all tested sensible qualities concerning both groups preoperatively; yet, the values differed widely from normal to insensitive (Table 2).

Pressure

One year postoperatively, pressure sensation in the *nipple* showed an even greater variability than preoperatively from reduction to improvement of sensation. There was not only a higher number of normal values (25% in group I and 29% in group II) but also an increased number of nipples with loss of protective sensation (20% in group I and 14% in group II). These extreme values led to a markedly reduced mean sensation of the nipple in both groups with no significant difference between them. In the *areola*, there was also a broad range from reduction to improvement of sensation; yet, the mean values also showed a moderate reduction of sensation in both groups with no significant difference between the two. In the *quadrants of breast skin*, there was a surprising improvement of pressure sensation (70% normal in group I and 46% in group II). Yet, the percentage of loss of protective sensation had also increased (18% in group I and 5% in group II) but not as marked as in the nipple and areola region. Only in the lower quadrant of the skin in group II was pressure sensation significantly lower ($p=0.04$) than preoperatively and in group I, this being the only significantly different sensible value between group I and group II.

Vibration

Postoperatively, vibration was significantly reduced in both groups concerning the *nipple*. In group I, mean vibration of the *quadrants of breast skin* had clearly improved and slightly surpassed the vibration threshold of the *areola*. There was no significantly different change in vibration between the two groups.

Temperature

One year postoperatively, warmth sensation in the *nipple* and *areola* was significantly reduced to 85% and 84% in group I and to 71% and 79% in group II but was not significantly different between both groups. Very similarly, cold sensation in the *nipple* and *areola* was postoperatively reduced to below 80% in both groups. Concerning the *quadrants of breast skin*, the postoperative values of warmth and cold were similar to the preoperative values and also not significantly different between both groups.

Pain

One year postoperatively, pain sensation was increased in the *nipple* (group I 90% vs. group II 100%). In the *areola*, pain sensation was reduced in both groups to below 90%. In the *quadrants of breast skin*, pain sensation was increased in group I to 93% but not significantly altered in group II (87% vs. 86%) with no significant difference between group I and II.

Concerning the most sensitive part of the breast subjectively, maximum feeling was preoperatively attributed in both study groups to the nipple (76%) followed by the skin of the breast (13%) and the areola (11%). Postoperatively, none of the women in group I rated the sensation of the breast to be improved; yet, more than the half of women felt it was unaltered and just one third was reduced. In group II, sensation was either rated as improved or unaltered in two thirds of cases, and one third felt the sensation was reduced (Table 5).

Discussion

This study showed that 1 year after breast reduction with a superior pedicle technique in a short-scar (group I, vertical scar) and a long-scar version (group II, inverted-T scar) nipple, areola, and breast skin sensation was altered over a broad range. Yet, already preoperatively women had shown a broad range of sensation reaching from "normal" to "loss of protective sensation" concerning pressure and vibration. Compared to the preoperative values, postoperative sensation was either further reduced, unaltered, or improved.

Table 5 Subjective sensorial perception in women in % 1 year postoperatively

	Group I (n=36)				Group II (n=10)			
	Improved	Unchanged	Reduced	Hyperaesthetic	Improved	Unchanged	Reduced	Hyperaesthetic
Nipple	–	50	30	20	28.6	42.8	28.6	–
Areola	–	65	30	5	14.3	57.1	28.6	–
Skin	–	80	20	–	14.3	85.7	–	–

Both reduction and improvement of sensation were scattered among an even much broader range than preoperatively, reaching statistical significance here and there.

Although postoperatively, many more women had normal pressure sensation in the nipple than preoperatively in both groups (8.3% preoperatively vs. 25% and 29% postoperatively), mean sensation was markedly reduced throughout all qualities with the exception of pain, which was enhanced. Mean sensation in the coordinates of the areola was generally reduced in all qualities in both groups. Mean sensation in the quadrants of the skin was improved in terms of pressure and vibration in group I but only partly in group II (8.3% normal pressure preoperatively vs. 70% normal pressure in group I and 46% in group II postoperatively) where both qualities were markedly reduced in the lower quadrant of the skin. Interestingly, the significant reduction of pressure sensation in this quadrant occurred not only in comparison with the preoperative values but also in comparison with group I. This was the only significant difference in sensation between the two groups, representing the additional horizontal inframammary scar in the inverted-T group.

When comparing our sensation thresholds, pre- and postoperatively, with the literature, we found that most of the existing data was published on pressure thresholds, followed by vibration and temperature. Originally, these data stem from evaluation of pressure thresholds in the hand (for which the Semmes–Weinstein filaments were originally applied). What has been evaluated as "normal" values in the hands has been extrapolated to other parts of the body, including the breast and the nipple–areola. Compared with the hand, it seems that pressure thresholds are more scattered and generally higher on the breast, but vibration thresholds are similar. [18] Yet, pressure (slowly-adapting fibers) and vibration (fast-adapting fibers) are critical sensory requirements for breast feeding and, thus, should always be utilized both for the evaluation of breast sensation.

"Normal" preoperative pressure thresholds in breast coordinates have a broad spectrum. By far, the lowest values measured Terzis [13] with 3.38 g/mm^2 for the nipple and 3.76 g/mm^2 for the areola in a group of normal-breasted women. By far, the highest values in a series of ten A- or B-cup-sized female volunteers measured Slezak and Dellon [17] with pressure thresholds of 28.5 g/mm^2 for the nipple and 31.6 g/mm^2 for the areola which means already "diminished protective sensation" in the Semmes–Weinstein graduation (Table 2). These values of normal-breasted women are even higher than the preoperative pressure threshold values (>16 and <24 g/mm^2) in our patients with macromastia, where 80% of women wore a bra with a cup-sized D or greater.

In the literature, women with macromastia showed the same variety of different pressure values as the values of normal-breasted women, yet at a reduced level. Nonetheless, there seems to be a common consensus that there is an inverse relationship between breast size and sensation. This inverse relationship may be partly related to decreased innervation density resulting from a larger surface area relative to a constant number of nerve fibers. Other authors have postulated that large and heavy breasts produce a chronic nerve traction injury as a possible cause for the inverse relationship. This relationship was confirmed in a study to quantify the normal cutaneous sensitivity of the breast by Semmes–Weinstein filaments [16]. The highest values in women with "gigantomastia" (bra size D or greater) were recorded by Slezak and Dellon [17] with values from 34 to 44 g/mm^2 (loss of protective sensation) although the mean sternal notch to nipple distance was comparable to our group (29 vs. 28 cm in our group) indicating a very high interrater variability.

Apart from pressure, in a few studies, vibration threasholds were also measured. Concerning vibration thresholds, there is also a wide range in regard to what is considered as normal values. Slezak and Dellon [17] measured vibratory threasholds from 0.1 µm (areola) to 0.3 um (nipple) to 0.4 µm (skin) in their cup A- or B-sized women. On the other hand, in patients with macromastia, low values as 1.4 to 1.7 µm were stated as preoperative vibration threasholds [19]. Higher vibration threasholds were found in a group of gigantomastia [17] where the vibration thresholds were comparable to our group (7.6–8.4 µm vs. 4.5–8.0 µm). This means values of up to 80 timers higher than normal and shows once more the broad range of sensation threasholds in breasts.

Only few studies measured temperature and pain. Temperature was measured in all studies qualitatively, and there exists a certain agreement that the preoperative values for both warmth and cold should be 100% for the nipple, from 75% to 97% for the areola, and over 90% for the quadrants of the skin.

Pain sensation was measured quantitatively only by Terzis [13] who stated that the nipple is less sensitive to pain than the areola or the quadrants of breast skin. We made exactly the same findings with our qualitative measurements of pain where the nipple was the least sensitive part of the breast. This arrangement has probably allowed breastfeeding (and the survival of our species) to take place without undue discomfort for the mother [14].

When comparing the postoperative breast sensation of our patients with those in the literature, we found only a few similar studies. Whereas comparison was possible with superior pedicle techniques with a vertical scar, there were no comparable studies on a superior pedicle technique with an inverted-T scar. Hindrances of comparison were also studies with too few patients (three patients with a pedicled breast reduction (double vertical) and six patients with free nipple grafting in their groups [17]) or a differing postoperative observation time, mainly shorter, or the measurements were carried out by different tools, recently by computer-assisted instruments [20] or dermatomal somatosensory-evoked potentials [21]. One example of a short postoperative follow-up is the study by Wechselberger et al. [22] who tested 15 patients with an inferior pedicle technique by pressure and temperature stimuli 6 months postoperatively. Whereas their preoperative temperature values were comparable with our values, their postoperative values (warmth: nipple 50%, areola 57%, and skin 86%, cold nipple 81%, areola, and skin 88%) were strikingly low. A comparison with our much higher values 1 year postoperatively shows that the evaluation after 6 months can be rated rather as a temporary but not a final result.

Comparison of our vertical scar group results was finally possible to two studies. The first is a study by Greuse et al. [19], who published a report on breast sensation after Lejour mammoplasty with measurements of pressure, vibration, and temperature thresholds 12 months postoperatively in a group of patients, where less than 500 g of tissue per breast was removed, as in our group. Yet, the postoperative pressure thresholds of their group were by far higher than in our group and vibration thresholds were by far lower. A possible explanation for the different outcome values in the two studies of a vertical technique with a superior pedicle, apart from the known interrater variability, may be due to the fact that the vertical Lejour breast reduction is a different technique to ours. Whereas during the Lejour breast reduction, the lower quadrants are resected and the breast is widely undermined; in our (modified Lassus) technique, there is only a central resection with no undermining at all.

A second study where the alteration of breast sensation after five different techniques with superior, bipedicle, and inferior pedicles was examined 12 months after reduction also provides comparable data to our study [23]. Concerning the Lassus technique, the preoperative pressure values in the cited study in a group of ten women matched our group I, but the results 12 months postoperatively in our group of 36 women showed, by far, less sensory impairment and were quite comparable to the inferior pedicle techniques in that study where better sensation was attributed to the inferior or bipedicle techniques than the superior pedicle techniques alone.

These discrepancies might once more be due to different resection techniques, as every surgeon has their own style in reducing breasts within one method. Apart from interrater biases and instrumentation biases, the "intersurgeon" bias is probably one of the most important factors for the large range in sensation alterations after breast reduction within one technique, probably even more than the selection of any pedicle, may it be superior or inferior. This might lastly be the explanation that sensation in the nipple and areola was not significantly different reduced in our study with a short-scar and a long-scar method.

Conclusion

Both presented upper pedicle techniques of breast reduction: one with a short vertical scar and the other with a long, inverted-T scar led to a vast alteration of sensation in the nipple and areola 12 months after the operation. Yet, these differences were not significantly different between both groups. In the lower quadrant of the skin in group II, according to the longer scar, pressure sensation was significantly more diminished that in the shorter scar technique in group I.

Comparing the postoperative results of our techniques to those presented in literature, it seems that our upper pedicle breast reductions with short or long scars are techniques that do not reduce breast sensation more than other techniques with inferior or central pedicles.

Concerning the subjective appraisal of women, about 20% of women stated improved sensation in group II and more than 60% in group I and II stated an unaltered sensation in the breast 1 year after breast reduction.

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