



A retrospective quantitative assessment of breast sensation after lateral pedicle mammoplasty

W. Hefter^{a,b,*}, O.P. Elvenes^{a,b}, P. Lindholm^{a,b}

^aDepartment of Plastic and Hand Surgery, University Hospital of Tromsø, Norway

^bDepartment of General Surgery, Samariterhemmet's Hospital, Uppsala, Sweden

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Summary Preservation of sensitivity is one of the important objectives in reduction mammoplasty. The lateral or medial pedicle reduction mammoplasty technique aims to maintain superficial innervation of the breast. These superficial nerves are smaller and more variable compared with deep and larger nerve structures, which are excised during this procedure. An assessment of recovery of tactile sensitivity after lateral pedicle mammoplasty was performed retrospectively. One hundred and one women, operated on between the year 1985 and 2000, with a lateral pedicle mammoplasty, were reviewed. Using a standardised questionnaire, women reported on subjective changes in sensation after surgery, including time of recovery and the influence which surgery had on sensual function.

Fifty-nine of these women were tested 3-7 years after surgery. Touch sensitivity was measured using a set of 20 Semmes-Weinstein monofilaments. Erectile function was also tested. The mean pressure threshold for the areola region was 19.12 g/mm² and for the nipple 16.75 g/mm², which is better than in studies on inferior pedicle mammoplasty. In previous studies patients were tested earlier, which may explain this difference.

No correlation was found between sensitivity and resected tissue (for the areola $p = 0.88$ and for the nipple $p = 0.82$) or between sensitivity and age of patients (for the areola $p = 0.73$ and for the nipple $p = 0.80$).

There were individual differences in the results. It is speculated that variability in anatomy of superficial nerves might explain these differences.

Nearly all patients tested regained their erectile function. The majority of patients did not notice any change in their erogenous function. Twelve (12%) reported a post-surgical improvement of sensation. Nipples with partial loss of sensation persisted in 2% of the patients.

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The aim of breast reduction surgery is to provide relief without disturbing function. Anatomical studies suggest that a deep, large nerve branch, supplying the nipple-areola region should be preserved using the inferior pedicle technique¹⁻³ and it is for this reason that this technique has been most

*Corresponding author. Address: Department of Plastic and Hand Surgery, University Hospital of Tromsø, Styrmandsveien 30, Tromsø 9014, Norway.

E-mail address: odd.petter.elvenes@unn.no

frequently used in breast reduction surgery as well as in surveys concerned with changes of sensitivity.

Changes in postoperative breast sensitivity and its quantitative assessment have been a topical subject of investigation during the last decade.⁴⁻⁸ Most of these studies have been based on the inferior pedicle techniques of mammoplasty. Comparisons between the McKissock method and free areola-nipple graft⁸ and between inferior pedicle and free nipple-areola graft⁴ have been made and, more recently, comparisons between superior pedicle and inferior pedicle mammoplasty have been reported.⁹⁻¹⁰ To our knowledge a quantitative assessment of touch sensation following surgery based on the lateral pedicle technique have not been previously reported. Most of the previously cited studies have been based on results achieved a relatively short time following surgery, with only one report presenting data 1-year after surgery.¹¹

In this retrospective study, which is based on the lateral pedicle technique, the recovery of sensitivity was evaluated as a late result when the reinnervation and regeneration of nerves was assumed to be complete.

Knowledge about the distribution of nerves supplying the areola-nipple region and their course through the parenchyma of the breast is essential when considering protection of sensitivity. Anatomical studies based on a large numbers of dissections have described the most common and constant pattern of innervation and its variations.¹⁻³ However, there is still some controversy about the contribution and course of the different nerves. In all cases the nipple-areola region was found to be innervated by the fourth intercostal nerve, which is considered a very important sensory nerve for this complex. Sarhidi et al. observed that the fourth lateral cutaneous branch is divided into a superficial and a deep nerve. The deep, larger branch passed into the retromammary space on its course to the nipple. Moreover, they also reported some individual cases where the deep branch from the fourth lateral cutaneous nerve was absent. In these individuals the fourth anterior cutaneous branch was found to be divided and supplied the nipple with the deep branch. The course of this deep branch is retromammary and was similar to its counterpart from the lateral side.¹ Other authors^{2,12,13} have confirmed this course for the fourth cutaneous branch, but without the division. Wúringer et al. have even reported that the fifth intercostal nerve can give rise to the deep branch.³

Anatomical aspects. The sensory innervation of the nipple-areola complex is by the cutaneous branches of the second to sixth intercostal nerves.

Its surface is supplied from:

- the *lateral* side by the third to fifth lateral cutaneous branches
- the *medial* side by the second to sixth anterior cutaneous branches
- from the *deeper tissue* by the deep branch of fourth or fifth lateral cutaneous branch.

The *lateral cutaneous branches*, after penetrating the deep fascia in the midaxillary line, take an infero-medial course within the serratus fascia. At the lateral border of the pectoralis muscle they enter the breast gland and follow its' superficial fascia. Only the deep fourth or fifth branch continues within the fascia of pectoralis major (Fig. 1).

The *anterior cutaneous branches* penetrate the fascia in the parasternal line. After sending branches to the sternal skin, they take a lateral course through subcutaneous tissue, terminating in the medial side of the areola.

The cutaneous branches of both the lateral and medial side become more superficial, close to the skin, nearly to the areola. It is for this reason that de-epithelisation of pedicles should be performed with a very thin layer. All superficial branches converge on the areola, most of them between 8 and 11 o'clock and between 1 and 4 o'clock. This

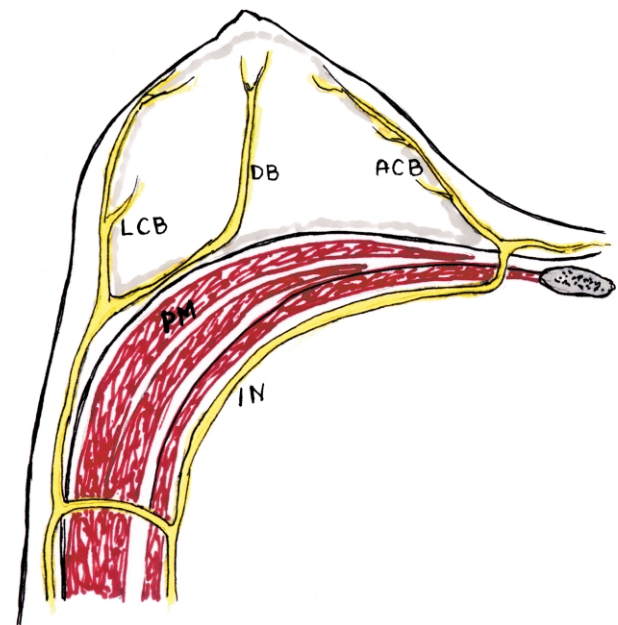


Fig. 1 The horizontal section of breast gland-schematic drawing. The course of fourth cutaneous branches and the course of deep branch divided are presented. LCB—lateral cutaneous branch, ACB—anterior cutaneous branch, DB—deep branch, IN—intercostal nerve, PM—pectoralis muscle.

fact should be considered when performing a para-areolar incision. The superficial and deep branches form a plexus at the base of the nipple.

Some of the anterior cutaneous branches will be preserved inside the medial pedicle if its base is not undermined from the pectoralis fascia close to the sternum. In similar fashion, some of the lateral cutaneous branches will remain intact inside the lateral pedicle (Fig. 2). Other superficial branches can regenerate in time and grow into the areola-nipple region from the surrounding skin or subcutaneous tissue.

The *deep branch* continues within the pectoralis fascia in the retromammary space, at a level, which is deeper than in the vascular plane.¹ In the mid-clavicular line, it takes a right-angle turn, passing through the mammary gland, in a direction towards the posterior surface of the nipple² (Fig. 1) This course explains the central position of the deep branch inside the inferior pedicle. Therefore, this branch could remain intact when using the inferior pedicle technique if the base of the pedicle remains attached to the fascia of the pectoral muscle.

This has been confirmed in clinical studies.^{6,9} When dissecting tissue excess around the inferior pedicle, care must be taken not to damage the pectoral fascia, especially laterally, at its base. The deep branch could be damaged during thinning of the inferior pedicle, which is an unnecessary step. From our own experience, even large and thick pedicles can be folded and transposed without thinning.

To protect the deep and superficial branches,

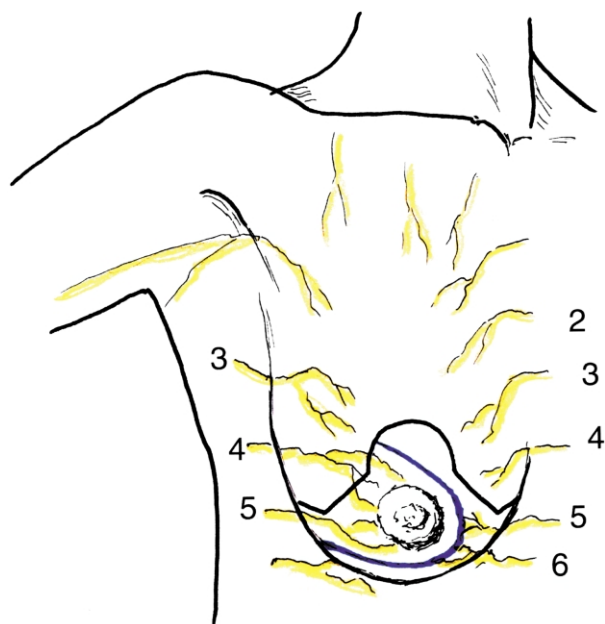


Fig. 2 The superficial innervation of areola-nipple complex related to lateral pedicle-schematic drawing.

undermining and excision of tissue close to the lateral border of the pectoral muscle (anterior axillary line) should be avoided. This is important when using the lateral or inferior pedicle techniques. There are few reports concerning autonomic innervation of the breast. These nerves follow the same course as the sensory nerves and innervate the smooth muscles of the areola-nipple region and the blood vessels.¹⁴

Patients and methods

One hundred and one women undergoing breast reduction in our two departments between the years 1985 and 2000 participated in the study. One senior surgeon performed the operation. The modified Strombeck's technique was performed¹⁵ (Fig. 3). The patients were operated on using the lateral pedicle technique. The description of the patient population and the way in which they were divided into groups was dependent on the weight of resected tissue and, is presented in Table 1. All patients were reviewed at least one but, in most cases, 3-15 years after surgery. Each patient filled out a questionnaire. The questions were designed according to multiple-choice principles. The data collected included the changes of sensitivity of the areola-nipple region, the time of its recovery and postoperative erogenous function. Other data collected included the patients degree of satisfaction, the cosmetic result, quantity of breast feeding before and after surgery, changing in patients social functioning and changes of pain-pattern after surgery but are not discussed in this paper. Four patients (4%) did not reply to the questionnaire and were not included in the study. Fifty-nine of 101 patients, living within one day's travel from one of the Departments (Tromsø), were examined and tested by authors at least 1 year but in most cases 3-7 years after surgery. An objective sensitivity of the areola-nipple region was measured using a set of 20 Semmes-Weinsteins monofilaments (North Coast Medical, Inc Morgsn Hill, CA).⁴⁻⁵ The monofilaments-nylon rods had varying diameters, which were labelled from the thinnest (1.65), to the thickest (6.65). These numbers equate to log 10 of the force in milligrams required to bend the monofilament. The testing started with the thinnest monofilament and continued with monofilament of increasing diameter. The finest monofilament sensed by the patient was used to determine the pressure threshold of each tested point. If the largest force (6.65) was not sensed, the area was regarded as being insensate. The results are

Table 1 The population of patients

Group	I	II	III	IV	Range (mean)
Amount of tissue resection g/side	<550	551-750	751-950	>950	
Number of patients (N)	41	19	19	22	101
Age at time of operation (years)	36.6 ± 1.7	36.2 ± 2.5	39 ± 1.0	43.8 ± 2.7	19-67 (38.4 ± 1.2)
Body mass index (kg/m ²)	25.7 ± 0.7	25.1 ± 0.9	26.7 ± 0.7	28.9 ± 1.0	21-36 (26.7 ± 0.4)
Sternal notch-nipple distance (cm)	28.5 ± 0.2	38.7 ± 0.4	31.6 ± 0.5	34.6 ± 0.6	22-44 (31 ± 0.3)
Resected tissue (g)	341 ± 15.0	619 ± 17.1	818 ± 17.7	1190 ± 72.5	10-2225 (729 ± 41)

expressed in g/mm² using a stress conversion table. Five points were tested on each breast on the areola region at 12, 3, 6 and 9 o'clock and on the centre of the nipple. The four measurements from the areola region were averaged to a single value. Each measurement was repeated three times for each site tested. The tests were performed at room temperature, with the patient in a sitting position with her head turned away to avoid visual contact with the tester and testing device. Erectile function was evaluated by stimulating the nipple with cotton wool and by lightly touching the nipple with a hand.

Statistics

All data were stored in a database (Microsoft Access 97, Microsoft Corporation, USA). Data in the figures, text and tables are expressed as mean ± standard error of the mean if not otherwise expressed. All statistical analysis was performed using SPSS 10.0 (SPSS 10.0©, SPSS Inc. Chicago, USA). A statistical significant level of $p < 0.05$ was accepted.

Results

Questionnaire

In 60 of the patients (59%), the subjective sensitivity of areola-nipple region returned to the initial, preoperative level. In 25 of 101 patients (25%) the sensation was mildly reduced, except in two, who reported about a 50% reduced sensation after surgery. Only 12 (12%) noticed improvement of sensation after surgery. The remainder of the patients (2%) did not answer this question. In nearly all of the patients reviewed, the subjective sensitivity returned between the second and 24th month after surgery. The time for recovery of sensation was 6 months for 20 (20%) and 12 months for 15 (15%) of the patients. The same patients experienced recovery of sensation early, after one month or late, some as late as between 24 and 90 months after surgery. Fifty-eight patients (57%) did not notice any changes in sensual function of nipple after the operation. Twelve (12%) reported improved sensual function following surgery.

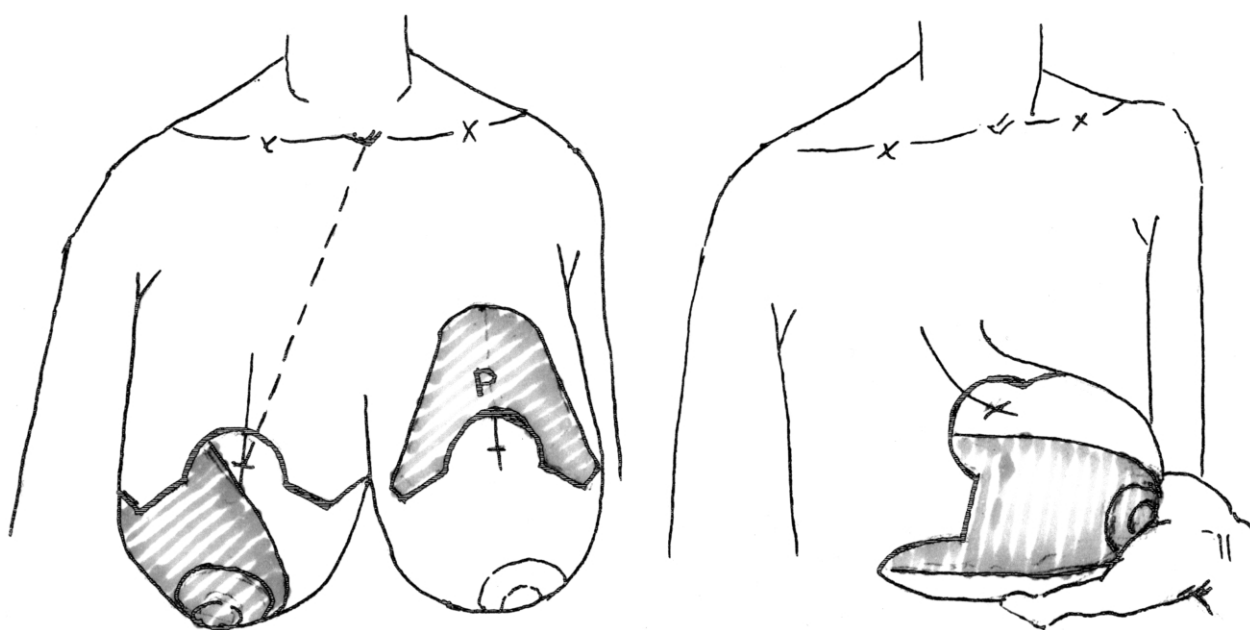


Fig. 3 Planning of the lateral pedicle. P—a standardised pattern.¹⁵

Table 2 Comparison between postoperative and the normal sensitivity of the breast

	Time after operation				Normal ^a
	6 weeks IP ⁶	12 months SP	6 months IP ⁹	3-7 years LP	
Nipple	19.3	28.5	39.0	16.7	3.4
Areola	31.5	47.4	47.0	19.1	3.8

Values represent the mean pressure threshold g/mm². IP—inferior pedicle, Robertson⁶ or Robbins technique⁹; LP—lateral pedicle, Strombeck's mammoplasty (present paper) and SP—superior pedicle, vertical mammoplasty.¹¹

^a From Terzis et al.⁷.

Elderly patients and those without a sexual partner in total 27 (27%), did not answer this question.

Sensitivity testing

In 59 patients we tested 107 breasts for sensitivity of the areola-nipple and for erectile function. The mean pressure threshold for the areola was 19.12 ± 1.4 g/mm² (range 2.53-119.39) and for the nipple was 16.75 ± 1.19 (mean \pm SEM) (range 2.53-68.29).

Two patients had partial loss of sensation of the areola-nipple region on one side (3%). The mean pressure threshold for group 4 for the areola was 17.55 ± 1.9 g/mm² (range 4.68-27.64) and for the nipple was 16.60 ± 2.1 g/mm² (range 4.93-27.41). In 20 patients (34%) the sensation returned to nearly the normal value for the breast⁷ and was for the areola and nipple in the range 2.53-8.77 g/mm².

Discussion

In our opinion the light pressure and crude touch test are regarded as adequate for testing the sensory physiology of the areola-nipple region. The 'Vitapulp'¹⁴ was the first method used to test light touch and can be regarded as being a precursor to the Semmes-Weinsteins monofilaments. However, this earlier method was not a quantitative one.

The mean postoperative pressure threshold reported in this study was lower (better sensitivity) than in previous studies^{6,9,10} (see Table 2). A possible explanation for this difference is that most of our patients were tested a relatively long time (3-7 years) after surgery, at which time the regeneration of nerves should be complete. There were considerable individual differences in the results, which were not related to the patient's age or weight of the resected tissue. In 34% of those tested the sensitivity returned to nearly normal values.⁷ Among these patients were younger subjects with excision of tissue up to 500 g and elderly

patients with resection ranging from 1400 to 1660 g per side. Surprisingly, one 56-year-old woman, who had the procedure performed for a second time, had the best possible sensitivity on all tested points (2.53 g/mm²). There was no relation between sensitivity and size of breast or between sensitivity and patient's age in the other patients tested. Poor sensation or insensate nipples, particularly on one side, is most likely a result of nerve injury during the surgical procedure.

None of the patients in group 4, with extreme hypertrophy/gigantomasty (tissue excision up to 2225 g per side) had insensate nipples or poor sensation of the areola-nipple region. These positive results are contrary to those of Gonzales, who showed a clear relation between insensate nipples and size of breast.⁵

The quantitative measurement of sensitivity is mainly for research purposes, however in women's daily lives the subjective sensitivity is more relevant.

Some individual patients required an unusually long time to recover their subjective sensation (4-7.5 years). However, after this time sensory function had returned to the initial, preoperative level. In some of the patients tested 1 and 3 years after surgery, the subjective sensation was regarded by them as still being in the progress of returning to normal.

None of the breasts reported by Courtiss and Goldwyn had fully recovered their sensation to the preoperative level 2 years after surgery.¹⁴

There is only superficial innervation remaining after mammoplasty using lateral, medial or superior pedicle technique. The deep branch is excised together with excess of tissue from the inferior part of the breast. The superficial branches are thinner, variable and not all of them terminate in the areola region.¹ The anterior cutaneous branches are shorter.² This variability in distribution to the areola-nipple and in the diameter and length of superficial nerves is suggested as being the reason for the differences in sensitivity and in the recovery times found in our study.

The deep branch, on the contrary, is bigger and

Table 3 Comparison of postoperative subjective and measured sensitivity of the breast, $n = 9$

Consecutive number	Tissue resection g/side	Subjective sensitivity		Pressure Threshold g/mm ²			
		Left	Right	Left areola	Left nipple	Right areola	Right nipple
1	635	Reduced	Same	14.83	4.93	8.83	4.93
2	750	Same	Same	33.85	27.28	27.28	27.28
3	450	Same	Reduced	12.44	16.11	14.27	16.11
4	450	Same	Same	5.53	5.53	2.53	2.53
5	450	Same	Same	15.40	27.87	4.39	18.35
6	625	Same	Same	18.35	18.35	18.35	18.35
7	840	Same	Same	2.53	2.53	4.93	4.93
8	240	Same	Same	4.93	4.93	6.85	4.93
9	1100	Reduced	Reduced	23.83	16.11	30.09	27.41

Patients who had given birth after surgery.

has a constant pattern.¹ This branch lies protected after careful inferior pedicle surgery. This was clearly demonstrated by Temple et al., who, already 2 weeks after surgery, showed a 50% improvement of preoperative sensitivity of the nipple-areola region with a further improvement after 6 weeks.⁶ This type of early 'improvement' of sensitivity indicates not only a preserved nerve but also possibly a release from preoperative traction. Other studies, based on inferior pedicle mammoplasty also reported an improvement of sensation after a short time (3-6 months).⁹ Gonzales reported unchanged values 17 weeks after surgery.⁵ None of the studies based on the inferior pedicle technique reported a recovery of sensitivity to nearly normal values for the breast.⁷ A nearly normal permanent recovery is more likely to be found if one uses the late results when determining sensation. Würinger et al. have introduced a new, advanced modification of inferior pedicle mammoplasty.¹⁶ Performing a large anatomical study on cadavers, they found new structures with a thin, horizontal septum carrying vessels and the deep branch of fourth or fifth intercostal nerve, the medial and lateral ligaments with respective superficial branches. This ligamentous system has also a suspensory function for the breast. These authors created a central pedicle containing all these structures. With cranial reduction of parenchyma, all innervation in the pedicle remains undisturbed. To confirm these results, only subjective sensitivity was assessed. However, a pressure threshold testing following this technique may have yielded more interesting results.

In our material the subjective rating of sensitivity was not always comparable with the measured one. Table 3 present nine women who had given birth after surgery. Patients no. 1, 4, 5, and 7 had different pressure thresholds on the right

and left areola-nipple region. However, only patient no. 1 was aware of this. Patient no. 3 had a compensatory, better subjective sensation on the left side. In this patient, a heavy, giant fibroadenoma was excised prior to mammoplasty on the same breast. The regeneration of nerves is not solely responsible for the quality of subjective sensitivity as with replanted fingers, the *re-education* of sensory function is possibly an important factor influencing the recurrence of sensation.⁸

In most of those tested it was possible to evoke an erectile reaction. Even patients with reduced sensitivity maintained erectile function. It has been previously reported that this function has an earlier recovery compared to the recovery of touch sensation in the areola-nipple region.¹⁴ Moreover, erectile function returned even in cases of free nipples grafts.⁴ This indicates a better or easier ability for regeneration of autonomic nerves in comparison to sensory ones.

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