



Functional Outcomes of Reduction Mammoplasty Assessed by the Neck Disability Index: A Retrospective Study with Long-Term Follow-Up

Uğur HOROZ¹, Uğur GÜNGÖR DEMİR², Ali Nail DEMİR³

¹Private Clinic, Clinic of Plastic, Reconstructive and Aesthetic Surgery, İstanbul, Türkiye

²University of Health Sciences Türkiye, Mersin City Hospital, Clinic of Physical Medicine and Rehabilitation, Mersin, Türkiye

³University of Health Sciences Türkiye, Mersin City Hospital, Clinic of Rheumatology, Mersin, Türkiye

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ABSTRACT

Objective: To evaluate the effect of reduction mammoplasty on neck-related disability using the neck disability index (NDI) and to assess its utility as a functional outcome measure in women with symptomatic macromastia.

Methods: This retrospective cohort study included 107 consecutive women who underwent reduction mammoplasty for symptomatic macromastia between January 2019 and December 2023. Demographic characteristics, operative details, postoperative complications, and NDI scores were analyzed. The mean age was 44 years, the mean body mass index was 27.3 kg/m², the mean resection weight was 1,283 g (range, 450-4,100 g), and the mean follow-up was 28 months (range, 4-48 months). Preoperative and postoperative NDI scores were compared.

Results: The mean NDI score decreased significantly from 39.7 preoperatively to 8.6 postoperatively, representing a 78.3% reduction in neck-related disability ($p<0.001$). Minor wound dehiscence occurred in 11 patients, while 6 patients required secondary wound closure. 1 patient developed a hematoma, 1 experienced partial nipple-areola complex necrosis, and 4 underwent revision reduction mammoplasty.

Conclusion: Reduction mammoplasty provides substantial and sustained improvement in neck-related disability among women with symptomatic macromastia. The marked reduction in NDI scores supports its role as a functional reconstructive procedure. The NDI is a practical patient-reported outcome measure for assessing functional recovery after breast reduction surgery.

Keywords: Reduction mammoplasty, macromastia, neck disability index, neck pain, breast hypertrophy, functional outcome

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Corresponding Author:

Uğur HOROZ

Private Clinic, Clinic of Plastic, Reconstructive and Aesthetic Surgery, İstanbul, Türkiye

✉ ugur_horoz@hotmail.com

ORCID ID: 0000-0003-4604-8934

INTRODUCTION

Macromastia is a common condition associated with substantial physical and psychosocial morbidity. Women with symptomatic breast hypertrophy frequently experience chronic neck, shoulder, and back pain, shoulder grooving, intertriginous skin disorders, physical limitations, and impaired quality of life. These symptoms often interfere with daily activities, occupational performance, physical exercise, and social participation.^{1,2}

The pathophysiology of musculoskeletal symptoms associated with macromastia is multifactorial. Excessive breast weight shifts the body's center of gravity anteriorly, leading to compensatory postural adaptations and increased mechanical loading of the cervical and thoracic spine.³ Previous studies have demonstrated

associations between breast hypertrophy and thoracic kyphosis, altered spinal alignment, postural imbalance, and increased biomechanical stress.⁴⁻¹¹ Over time, these biomechanical alterations may contribute to chronic neck and back pain, progressive postural deterioration, and degenerative changes of the spine.⁶⁻¹⁰

Reduction mammoplasty has gained wide acceptance as the treatment of choice for symptomatic macromastia and has proven to be effective in relieving musculoskeletal symptoms and improving physical function and health-related quality of life.^{2,3,6,8,10,11} Objective biomechanical investigations have further demonstrated reductions in spinal loading and improvements in functional performance following breast reduction surgery, reinforcing the reconstructive rather than purely aesthetic role of the procedure.³



Although numerous studies have evaluated pain relief and patient satisfaction after reduction mammoplasty, relatively few have assessed neck-specific functional impairment using validated patient-reported outcome measures.¹²⁻¹⁴ The neck disability index (NDI), originally developed by Vernon and Mior,¹² is one of the most widely accepted and extensively validated instruments for evaluating functional disability related to cervical musculoskeletal disorders.^{13,14} Unlike pain intensity scales, the NDI provides a comprehensive assessment of how neck symptoms affect activities of daily living and functional performance. Despite its widespread use in spine research, its application in reduction mammoplasty remains limited.

Therefore, the aim of the present study was to assess changes in neck disability in patients who underwent reduction mammoplasty using the NDI, and to explore long-term functional outcomes through interdisciplinary collaboration between the departments of plastic surgery and physical medicine and rehabilitation.

METHODS

Study Design and Patients

The retrospective cohort study involves consecutive patients who underwent reduction mammoplasty for symptomatic macromastia between 2019 and 2023. Medical records of patients who completed preoperative and postoperative diagnostic tests were reviewed. All participants who met inclusion criteria and did not meet any of the exclusion criteria were enrolled in the study. There were 107 female patients who qualified for the research. Those with incomplete sets of clinical records or absent evaluations of the NDI were excluded from the analysis.

The study followed the ethical guidelines of the Declaration of Helsinki. The anonymity of the participants was ensured, and all patient data were de-identified before analysis. The confidentiality of patient information was maintained during the study.

Multidisciplinary Evaluation

All patients were evaluated collaboratively by the departments of plastic surgery and physical medicine and rehabilitation. The patients were assessed clinically for neck pain, shoulder pain, upper back pain, postural complaints, and limitations.

Data Collection

Demographic and clinical variables were obtained from institutional records: age, body mass index (BMI), resection specimen weight, length of postoperative follow-up, and postoperative complications. The mean age of the patients is 44 years, and the mean BMI is 27.3 kg/m². The operative data included the total bilateral amount of resected breast tissue. The mean combined bilateral resection weight was 1,283 g, ranging from 450 g to 4,100 g.

Outcome Measure

Neck disability was assessed using the NDI, a validated patient-reported outcome measure widely used to assess patient-reported outcomes related to cervical musculoskeletal disorders.

The validated Turkish version of the NDI was used as a patient-reported outcome measure. The NDI comprises 10 items, each scored on a scale from 0 to 5, with a total score ranging from 0 to 50 that represents the degree of limitation in activities of daily living caused by neck complaints. The preoperative NDI scores were obtained as part of the standard preoperative assessment. The NDI scores used for analysis were obtained at the patient's most recent clinic visit, which was defined as the study endpoint.

Follow-up

The mean postoperative follow-up period was 28 months (range, 4-48 months).

Statistical Analysis

Statistical analysis was carried out using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA). For continuous variables, means and ranges are presented. Paired statistical analysis was used to compare the NDI values before and after the intervention. A p value of <0.05 was considered statistically significant.

Ethical Approval and Informed Consent

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. The research was carried out in a private clinic without an institutional ethics committee. Therefore, ethical approval was obtained from a Clinical Research Ethics Committee located in Ankara Bilkent City Hospital (approval number: E2-26-15707; date: 22 July 2026). Written informed consent for the surgical procedures was obtained from all patients. Additionally, written consent for the scientific use and publication of clinical photographs was obtained from all patients whose images appear in this manuscript. Patient records were retrospectively reviewed, and all data were anonymized before analysis.

RESULTS

Patient Characteristics

A total of 107 patients underwent reduction mammoplasty for symptomatic macromastia during the study period (Figures 1 and 2).

Their mean age was 44 years, and their mean BMI was 27.3 kg/m². The mean combined bilateral resection weight was 1,283 g (range, 450-4,100 g). Their mean follow-up was 28 months (range, 4-48 months). Patient demographics and clinical characteristics are detailed in Table 1.

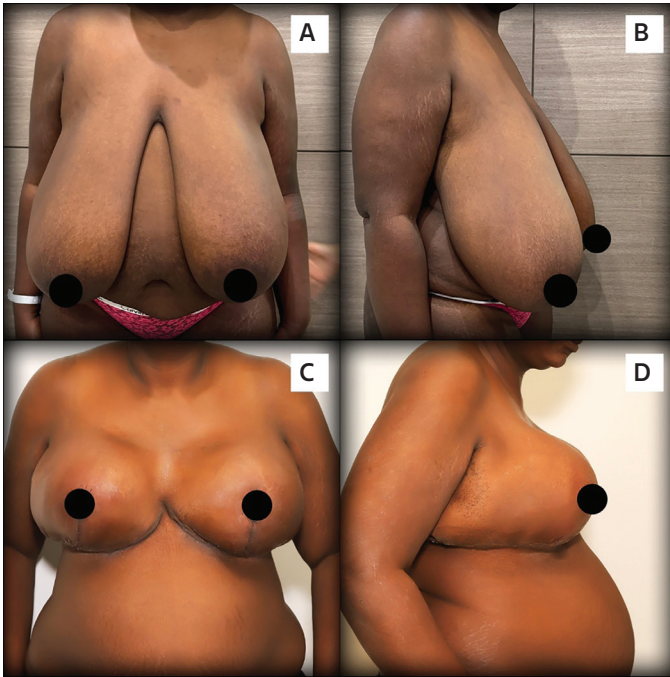


Figure 1. Representative preoperative and postoperative clinical photographs of a 46-year-old woman. (A, B) Preoperative anterior and right lateral views demonstrating symptomatic macromastia and severe breast ptosis. (C, D) Anterior and right lateral views obtained 9 months after reduction mammoplasty, demonstrating marked improvement in breast size, contour, symmetry, and nipple-areola complex position

Table 1. Demographic characteristics, follow-up duration, body mass index (BMI), and combined bilateral breast tissue resection weight of the 107 women included in the study

Variable	Value
Number of patients	107
Mean age (years)	44
Mean BMI (kg/m ²)	27.3
Mean follow-up (months)	28
Follow-up range (months)	4-48
Mean combined bilateral resection weight (g)	1,283
Combined bilateral resection range (g)	450-4,100

Table 2. Preoperative and postoperative neck disability index (NDI) scores demonstrating the effect of reduction mammoplasty on neck-related functional disability

Variable	Value
Preoperative NDI	39.7
Postoperative NDI	8.6
Absolute improvement	31.1
Relative improvement (%)	78.3
p value	<0.001

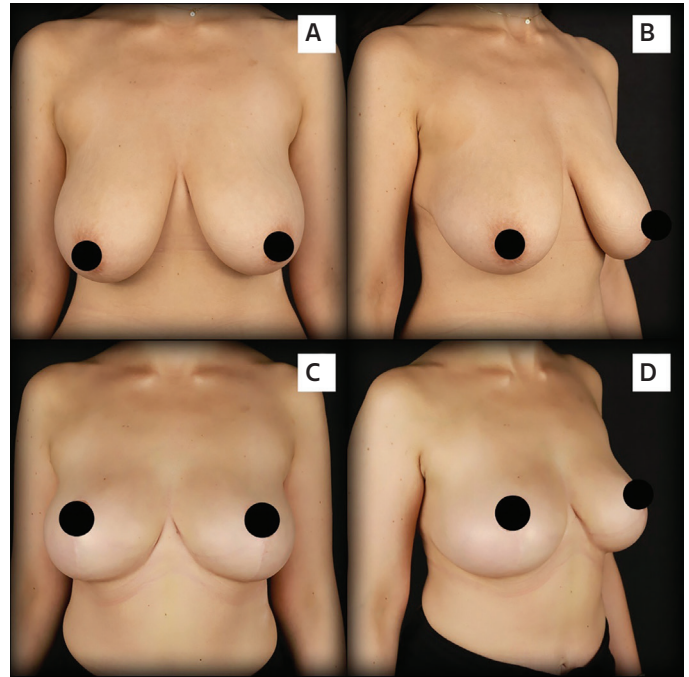


Figure 2. Representative preoperative and postoperative clinical photographs of a 28-year-old woman. (A, B) Preoperative anterior and right oblique views demonstrating symptomatic macromastia and breast ptosis. (C, D) Anterior and right oblique views obtained 2 years after reduction mammoplasty, demonstrating sustained improvement in breast size, contour, projection, symmetry, and nipple-areola complex position

Neck Disability Index Outcomes

The mean preoperative and postoperative NDI scores were 39.7 and 8.6, respectively.

The mean score improved by 31.1 points, representing a 78.3% improvement in neck disability.

Comparison of preoperative and postoperative scores demonstrated a statistically significant difference ($p < 0.001$). The detailed results of the NDI are presented in Table 2.

This result indicates a substantial reduction in neck-related disability and improvement in functional status following reduction mammoplasty. The significant decrease in the NDI score after the procedure is shown in Figure 3.

Postoperative Complications

Postoperative wound dehiscence, managed conservatively with local wound care, occurred in 11 patients (10.3%).

Six patients (5.6%) developed wound dehiscence requiring secondary suturing under local anesthesia. One patient (0.9%) developed a postoperative hematoma requiring intervention. Partial nipple-areola complex necrosis occurred in one patient (0.9%).

No cases of total nipple-areola complex loss were observed. Most complications were minor wound-healing problems managed conservatively or with secondary suturing. Postoperative complications are summarized in Table 3.

Secondary/Revision Procedures

Four patients (3.7%) underwent secondary revision reduction mammoplasty because they considered the postoperative breast volume to be larger than desired. These procedures were classified as secondary/revision procedures rather than postoperative complications.

No cases of total nipple-areola complex loss were observed.

DISCUSSION

The present study demonstrated a substantial and sustained improvement in neck-related disability following reduction mammoplasty. The mean NDI score decreased from 39.7

preoperatively to 8.6 postoperatively, representing a 78.3% reduction in disability over a mean follow-up of 28 months. These findings indicate that reduction mammoplasty provides not only effective symptom relief but also meaningful long-term functional recovery in patients with symptomatic macromastia.

Musculoskeletal complaints represent the primary indication for reduction mammoplasty in women with symptomatic breast hypertrophy. Netscher et al.⁷ reported that 81% of patients experienced neck and back pain, 77% experienced shoulder pain, and nearly half experienced limitations in daily activities attributable to breast size. Similarly, Brown et al.⁸ demonstrated significant postoperative improvements in neck, shoulder, and back pain, and all patients reported increased participation in physical activity. Our findings are consistent with these reports and further demonstrate that pain relief is accompanied by a marked improvement in neck-specific functional disability.

Several biomechanical mechanisms may explain these clinical improvements. Excessive breast weight shifts the body's center of gravity anteriorly, increasing mechanical loading of the cervical and thoracic spine and resulting in compensatory postural adaptations. Letterman and Schurter were among the first to suggest that excessive breast weight adversely affects spinal mechanics and cervical posture.¹¹ More recently, Lapid et al.⁹ and Michalik et al.¹⁰ demonstrated measurable changes in thoracic kyphosis, spinal alignment, and postural balance associated with increasing breast size. Although BMI also influences spinal posture, these studies support the conclusion that breast hypertrophy independently contributes substantially to musculoskeletal dysfunction.^{9,10}

Objective biomechanical evidence further supports the functional benefits of reduction mammoplasty. Foreman et al.³ demonstrated a 35% reduction in low-back compressive forces together with a 76% improvement in functional rating index scores following surgery. While their study primarily evaluated lumbar biomechanics, our findings extend this evidence by demonstrating a substantial improvement in cervical functional disability, as measured by the NDI. This distinction is clinically important because the cervical spine is frequently the primary source of symptoms in women with macromastia.

Recent clinical studies continue to reinforce the therapeutic value of reduction mammoplasty. Chinondira et al.² reported significant reductions in neck, shoulder, and back pain following surgery, emphasizing its effectiveness in improving functional status. Likewise, recent reviews have highlighted the cumulative effects of chronic spinal loading, postural compensation, and altered biomechanics as key contributors to persistent musculoskeletal symptoms in women with macromastia.¹

One of the principal strengths of the present study is the use of the NDI as the primary outcome measure. The present study contributes to the limited literature that specifically evaluates neck-related functional disability after reduction mammoplasty, using a validated neck-specific patient-reported outcome measure.

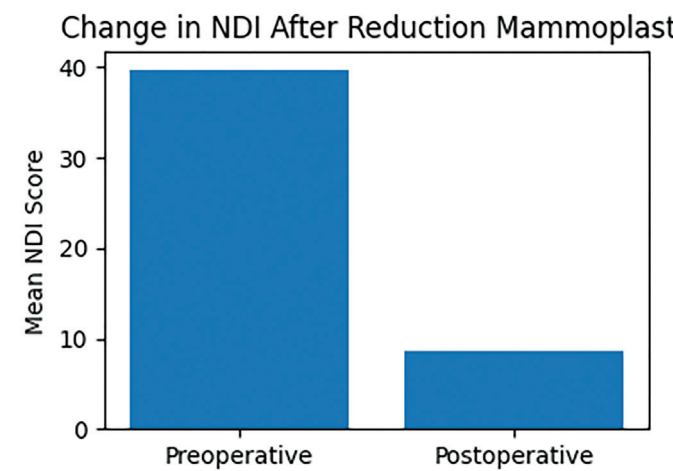


Figure 3. Change in neck disability index (NDI) after reduction mammoplasty. Comparison of mean preoperative and postoperative NDI scores following reduction mammoplasty. The mean NDI score decreased from 39.7 before surgery to 8.6 after surgery, corresponding to a 78.3% reduction in neck-related disability ($p<0.001$), indicating significant functional improvement

Table 3. Postoperative complications following reduction mammoplasty	
Complication	n (%)
Conservative wound dehiscence	11 (10.3)
Dehiscence requiring suturing	6 (5.6)
Hematoma	1 (0.9)
Partial NAC necrosis	1 (0.9)
NAC: Nipple-areola complex	

Although reduction mammoplasty has consistently been shown to reduce pain and improve quality of life, relatively few studies have evaluated postoperative outcomes using validated neck-specific functional instruments. Unlike studies primarily focused on pain relief, patient satisfaction, or general quality-of-life outcomes, our study provides a standardized assessment of cervical functional recovery. The NDI is one of the most extensively validated patient-reported outcome measures for assessing cervical disability and offers a more comprehensive evaluation of postoperative functional recovery than pain intensity alone.¹²⁻¹⁴ Furthermore, the multidisciplinary collaboration between the departments of plastic surgery and physical medicine and rehabilitation enabled a comprehensive functional assessment, thereby strengthening the clinical relevance of our findings.

The mean combined bilateral resection weight in our series was 1,283 g, reflecting a cohort with clinically significant macromastia. Previous investigations have suggested that symptom severity and postoperative improvement correlate more closely with functional impairment than with resection weight alone.^{2,3,6} These findings support the concept that surgical decision-making should primarily be guided by symptom burden and functional disability rather than by the amount of breast tissue expected to be removed.

The safety profile observed in our cohort was consistent with those reported in previously published reduction mammoplasty series. Most complications were minor wound-healing problems successfully managed with conservative treatment or minor revision procedures; major complications were uncommon. These findings further support reduction mammoplasty as a safe and effective reconstructive procedure when performed in appropriately selected patients.^{2,4-6}

Study Limitations

Several limitations should be acknowledged. First, the retrospective design may have introduced selection bias, particularly because the analysis was limited to patients who had complete preoperative and postoperative NDI assessments. Second, the absence of a control group limits causal inference. Third, postoperative NDI assessment was based on the most recent follow-up visit; the variability in follow-up duration (4-48 months) may have influenced the timing of the functional outcome assessment. Fourth, although the NDI provides a robust assessment of neck-related disability, additional validated breast-specific patient-reported outcome measures (such as the BREAST-Q), as well as generic quality-of-life questionnaires, were not routinely available for analysis. Finally, potential confounding effects of age, BMI, resection weight, and coexisting musculoskeletal conditions could not be fully evaluated within the retrospective study design. Nevertheless, the long-term follow-up and substantial magnitude of functional improvement support the clinical relevance of our findings.

Overall, the present findings support the concept that reduction mammoplasty should be regarded as a functional reconstructive procedure rather than merely an aesthetic intervention. In addition to improving breast appearance, the procedure provides substantial and sustained reductions in neck-related disability and improvements in functional capacity in women with symptomatic macromastia. These findings further emphasize the importance of considering symptom burden and functional impairment when evaluating candidates for reduction mammoplasty. Prospective studies incorporating standardized assessment intervals, breast-specific patient-reported outcome measures, and analyses of potential predictors of functional recovery are warranted to further clarify the long-term functional benefits of reduction mammoplasty.^{2,12-14}

CONCLUSION

Reduction mammoplasty resulted in a significant and sustained improvement in neck-related disability among women with symptomatic macromastia, with a 78.3% reduction in NDI scores over a mean follow-up period of 28 months. These findings reinforce the role of reduction mammoplasty as a functional reconstructive procedure that provides substantial long-term benefits beyond aesthetic improvement.

The NDI proved to be a practical and valuable patient-reported outcome measure for assessing functional recovery after reduction mammoplasty. Its incorporation into routine clinical practice may facilitate standardized outcome assessment and provide objective evidence supporting the medical necessity of breast reduction surgery.

Furthermore, a multidisciplinary approach involving specialists in Plastic Surgery and Physical Medicine and Rehabilitation may enhance preoperative evaluation, postoperative follow-up, and assessment of functional outcomes. Prospective studies incorporating disease-specific and quality-of-life instruments are warranted to further validate the role of the NDI in evaluating long-term outcomes after reduction mammoplasty.

Ethics

Ethics Committee Approval: The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. The research was carried out in a private clinic without an institutional ethics committee. Therefore, ethical approval was obtained from a Clinical Research Ethics Committee located in Ankara Bilkent City Hospital (approval number: E2-26-15707; date: 22 July 2026).

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Footnotes

Authorship Contributions

Surgical and Medical Practices: U.H., U.G.D., Concept: U.H., A.N.D., Design: U.G.D., A.N.D., Data Collection or Processing: U.H., A.N.D., Analysis or Interpretation: U.H., U.G.D., Literature Search: U.H., U.G.D., A.N.D., Writing: U.H., U.G.D.

Conflict of Interest: No conflict of interest was declared by the authors.

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