Intraoperative pulmonary function dynamics in adolescents undergoing reduction mammoplasty: A prospective case series

Itay Wiser MD PhD¹, Kritiy Mahon MD², Shirley Yaniv MD¹, Ella Ziv MHA MOCCH¹,
Narin Nard Carmel MD^{1,3}, Lior Heller MD^{1,2}

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BACKGROUND: Improvement of lung function following reduction mammoplasty has been previously reported among adult populations in the medical literature.

OBJECTIVES: To evaluate the intraoperative dynamics of pulmonary function in adolescents undergoing reduction mammoplasty.

METHODS: The present study is a prospective case series of female patients 13 to 18 years of age who underwent inferior pedicle reduction mammoplasty between November 20, 2006 and April 4, 2011. Documented variables included patient baseline characteristics, operation duration, muscle relaxant use and total breast tissue removed. Intraoperative pulmonary function data documented included: tidal volume, respiratory rate, peak inspiratory pressure, positive end-expiratory pressure, oxygen saturation percentage and pulmonary compliance. Differences in pulmonary function data were calculated as ratio between final and initial intraoperative values.

RESULTS: Twenty-six patients were included in the analysis. Mean ($\pm$ SD) age was 16.9 ± 1.1 years and mean body mass index was 28.9 ± 6.1 kg/m². Mean operation time was 218 ± 52 min, with average total bilateral breast tissue removal of 1810 ± 1065 g. Improvement in lung compliance was observed in 24 patients (92.3%; $P < 0.0001$). Mean intraoperative lung compliance improvement was 23.92% (95% CI 8.3% to 37%; $P = 0.001$).

CONCLUSION: Intraoperative improvement in lung compliance was observed in adolescent patients undergoing reduction mammoplasty.

Key Words: Adolescents; Breast reduction; Pulmonary compliance; Reduction mammoplasty

Bilateral breast reduction mammoplasty has become one of the most common procedures in plastic surgery (1). Women with macromastia commonly complain about chronic neck, shoulder and back pain, intertriginous rashes, painful brassiere strap grooving and spinal kyphosis. One of the common motivators for women to undergo breast reduction is to alleviate physical complaints as a result of the heaviness of their breasts, which may also limit their physical and social daily activities (2).

Reduction mammoplasty offers both aesthetic and functional benefits to women with macromastia. Recently, this operation has become more popular in adolescent populations, demonstrating safety and effectiveness. The rise in its popularity is attributed mainly to the functional and social disabilities associated with juvenile macromastia (1).

Major improvements in quality of life and subjective feeling of lightness and improvement in physical fitness are commonly described among patients undergoing bilateral breast reduction. Several studies seek a physiological basis, assessing the objective improvement of pulmonology function. These have reported an improvement in

La dynamique de la fonction pulmonaire peropératoire chez des adolescentes subissant une mammoplastie de réduction : une série de cas prospectifs

HISTORIQUE : Les publications médicales ont déjà fait état d'une amélioration de la fonction pulmonaire au sein de la population adulte après une mammoplastie de réduction.

OBJECTIFS : Évaluer la dynamique peropératoire de la fonction pulmonaire chez des adolescentes qui subissent une mammoplastie de réduction.

MÉTHODOLOGIE : Les chercheurs ont étudié la présente série de cas prospectifs de patientes de 13 à 18 ans qui ont subi une mammoplastie de réduction du pédicule inférieur entre le 20 novembre 2006 et le 4 avril 2011. Les variables observées incluaient les caractéristiques initiales des patientes, la durée de l'opération, l'utilisation de relaxants musculaires et la quantité totale de tissus mammaires extraits. Les données sur la fonction pulmonaire peropératoire observées incluaient le volume respiratoire, la fréquence respiratoire, la pression inspiratoire de pointe, la pression positive en fin d'expiration, le pourcentage de saturation en oxygène et la compliance pulmonaire. Les chercheurs ont calculé les différences dans les données sur la fonction pulmonaire entre les valeurs peropératoires finales et initiales.

RÉSULTATS : Vingt-six patientes ont participé à l'analyse. Elles avaient un âge moyen ($\pm$ ÉT) de $16,9 \pm 1,1$ ans et un indice de masse corporelle moyen de $28,9 \pm 6,1$ kg/m². La durée moyenne de l'opération était de 218 ± 52 min, et le retrait bilatéral total moyen de tissus, de $1\ 810 \pm 1\ 065$ g. La compliance pulmonaire s'est améliorée chez 24 patientes (92,3 %; $P < 0,0001$). L'amélioration peropératoire moyenne de la compliance pulmonaire s'élevait à 23,92 % (95 % IC 8,3 % à 37 %; $P = 0,001$).

CONCLUSION : On observe une amélioration peropératoire de la compliance pulmonaire chez les adolescentes qui subissent une mammoplastie de réduction.

postoperative pulmonary function in adult populations following reduction mammoplasty, relating it to improvement in the chest wall compliance (3,4). These studies, however, did not include adolescent patients, and have no documentation of the effect of the surgery on intraoperative pulmonary function.

The primary objective of the present study was to assess whether improvement in pulmonary dynamic compliance can be determined intraoperatively in adolescents.

METHODS

Study design and settings

A prospective case series of adolescent patients 13 to 18 years of age, who were scheduled to undergo reduction mammoplasty at Texas Children's Hospital (Houston, USA), between November 20, 2006 and April 4, 2011, was conducted.

The study was approved by the local institutional review board and the parents of each juvenile patient provided written informed consent. All patients were referred to a plastic surgery clinic by a pediatrician.

¹Department of Plastic Surgery, Assaf Harofeh Medical Center, affiliated to Sackler Faculty of Medicine, Tel-Aviv University, Tel-Aviv, Israel;

²Division of Plastic Surgery, Baylor College of Medicine, Houston, Texas, USA; ³Tel Aviv University, Sackler School of Medicine, Tel Aviv, Israel

Correspondence: Dr Itay Wiser, Department of Plastic Surgery, Assaf Harofeh Medical Center, Tzrifin, HaMerkaz, Israel 70300.

Telephone 972-54-4855528 / 972-54-4855528, fax 972-8-9779427, e-mail wiser125@gmail.com

TABLE 1
Baseline characteristics (n=26)

Age, years, mean $\pm$ SD	16.9 $\pm$ 1.1
Body mass index, kg/m ² , mean $\pm$ SD (min–max)	28.9 $\pm$ 6.1 (20.6–47.5)
Total breast tissue removed, g, mean $\pm$ SD	1810 $\pm$ 1065
Operation time, min, mean $\pm$ SD	218 $\pm$ 52
Use of muscle relaxant, n (%)	24 (92.3)
Histology, n (%)	
Normal	13 (50)
Fibrous changes	11 (42.3)
Pathology, n (%)	
Tubular adenoma	1 (3.8)
Fibroadenoma	1 (3.8)

max Maximum; min Minimum

The indication to perform a reduction mammoplasty was made by a plastic surgeon.

Exclusion criteria were the presence of any chronic health condition including diabetes, skin disorders, present use of immunosuppressive medication, history of keloids or hypertrophic scarring, degenerative or metabolic disorders, smoking and illicit drug use.

Data measurement

Patient demographics, including age, body mass index (BMI), operation date and bra size were obtained. Operation-related data included weight of tissue removed, tissue histology analysis, endotracheal tube used, type of muscle relaxant used and operation duration. Pulmonary function data were recorded during surgery while the patient was in supine position. Parameters included tidal volume (TV), respiratory rate, peak inspiratory pressure (PIP), positive end-expiratory pressure (PEEP), end-tidal carbon dioxide and oxygen saturation percentage. Pulmonary dynamic compliance was assessed using values of TV/PIP and TV/(PIP-PEEP). The intraoperative dynamics of pulmonary function data was represented by a ratio between final and baseline measurements in each parameter.

All measurements of pulmonary data were recorded every 15 min from the point of time of anesthesia induction and during the surgery. To match the pulmonary function measurement between the patients in relation to the effect of muscle relaxant, body position and stage of surgery, start values were defined as those recorded 30 min after anesthesia induction, whereas values recorded up to 30 min before the end of the surgery were defined as final values. All pulmonary function measurements included in the final analysis were those recorded when the patients were supine.

Treatment

All patients underwent reduction mammoplasty using the inferior pedicle technique.

Statistical analysis

Statistical data were analyzed using PASW, SPSS version 18 (IBM Corporation, USA). Comparison between start and end pulmonary function values was performed using the paired Student's *t* test. Significance of ratios difference from 1 (no change) was evaluated using a one-sample Student's *t* test for continuous variables and Pearson χ^2 test for categorical and binary variables. Correlation between explanatory and outcome measurements was assessed using Spearman's rank correlation coefficient test; $P < 0.05$ was considered to be statistically significant.

RESULTS

Patients characteristics

A total of 26 adolescent patients who underwent reduction mammoplasty during the study period were included in the final analysis. Mean ($\pm$ SD) age was 16.9 $\pm$ 1.1 years (range 13.2 to 18.3 years). Mean BMI was 28.9 $\pm$ 6.1 kg/m² (Table 1).

Figure 1) Histogram of pulmonary compliance improvement frequency

Mean operation time was 218 $\pm$ 52 min with average total bilateral breast tissue removal of 1810 $\pm$ 1065 g. Muscle relaxant was used in 24 of 26 (92.3%) patients (21 patients received rocuronium, three vecuronium and two did not receive any short-acting muscle relaxant). Intra- and postoperative complications were not noted in any of the patients. Normal histology was observed in 50% of patients, fibrous changes in 42.3% of patients, and one case of fibroadenoma and one case of tubular adenoma were reported (Table 1).

Intraoperative pulmonary function dynamics

Pulmonary function data dynamics are presented in Table 2. Improvement in lung compliance was observed in 24 patients (92.3%; $P < 0.0001$) (Figure 1). Mean improvement in lung compliance was 23.92% (95% CI 8.3% to 37%; $P = 0.001$). Mean TV/PIP improvement was 14 $\pm$ 21.4% ($P = 0.002$) (Table 3).

No significant correlation was found between pulmonary compliance ratio and BMI (CC -0.12 ; $P = 0.57$), breast tissue removed (CC -0.27 ; $P = 0.18$) and operation duration (CC -0.09 ; $P = 0.66$).

DISCUSSION

Our study describes 26 adolescent patients who underwent reduction mammoplasty. The results demonstrated a significant intraoperative improvement in the pulmonary compliance.

Past debates argued as to whether bilateral breast reduction mammoplasty should be classified as cosmetic or reconstructive. Recent studies have shown various functional improvement in patients undergoing reduction mammoplasty (5). The functional improvements are possibly attributed to the significant amount of tissue weight removed from the chest wall. The aim of the present study was to demonstrate the potential improvement via assessment of intraoperative pulmonary function during reduction mammoplasty.

Since 1958, various studies in the literature have addressed the correlation between the breast reduction operation and pulmonary function improvement. Initial studies were based on subjective data collected from patients who reported improvements in various aspects of daily life (6). Similar to our findings, recent studies also managed to provide objective assessments that showed statistically significant improvements in pulmonary function tests (4,7) as well as positive correlation between specimen weight resected and pulmonary functional improvement (8), via measurements pre- and postoperatively, and intraoperative pulmonary function dynamics following reduction mammoplasty.

Starley et al (7) reported postoperative improvement in peak expiratory and inspiratory flow rate in 19 women (mean age 34.9 $\pm$ 9.8 years,

TABLE 2
Intraoperative pulmonary function data

Intraoperative pulmonary function parameter	Start	End	P*
Tidal volume, mL	505±83	487±109	0.461
Respiratory rate, breaths/min	10±2	9±3	0.449
Peak inspiratory pressure, cmH ₂ O	20±4	18±4	0.004
Peak end-expiratory pressure, cmH ₂ O	5±1	5±1	0.043
Oxygen saturation, %	99±1	100±1	0.713
End-tidal carbon dioxide, mmHg	33±4	38±6	0.000
Tidal volume/peak inspiratory pressure	25.4±4.86	29.3±9.3	0.005
Compliance†	33.1±6.98	41.6±17.7	0.004

Data presented as mean ± SD unless otherwise indicated. *Comparison was performed using paired Student's t test (P is considered to be statistically significant at <0.05); †Compliance = tidal volume/(peak inspiratory pressure – peak end expiratory pressure)

mean BMI 27.6 kg/m², mean breast tissue excised 1546±678 g) following reduction mammoplasty. Measurements were taken preoperatively and six to eight weeks following surgery.

Sood et al (4) also documented results similar to those by Starley et al (7). They examined pre- and postoperative pulmonary function data in 44 women (mean age 36.7 years, mean BMI 31.4 kg/m², mean breast tissue excised 2228 g) undergoing reduction mammoplasty. Most of the patients presented with pulmonary complaints before surgery and reported significant improvement following surgery. Pulmonary function improvement was observed in peak expiratory flow (0.5 L/s improvement [P=0.015]), inspiratory capacity (0.04 L improvement; P=0.04) and maximal voluntary ventilation (6.26 L/min improvement; P<0.001) (4).

In the present study, we hypothesized that the improvement observed in the respiratory compliance can be attributed to the removal of the breast tissue and the weight excised off the chest wall. The present study was the first to measure the effect of reduction mammoplasty on pulmonary function intraoperatively.

Intraoperative observations further supported our hypothesis. The inferior pedicle reduction technique is based on removal of breast tissue at two steps: the central part of the breast is removed at an earlier stage while the medial and lateral inferior parts of the breast are removed at a later stage of the procedure. Intraoperatively, a sharp increase ('jump') was noted in the lung compliance, tightly correlated with the surgical removal of the breast tissue at the above two time points.

Elhusseiny et al (9) aimed to determine the relationship between reduction mammoplasty and pulmonary function. They found a significant difference between preoperative and postoperative oxygen saturation (P<0.01). Correlations between total weight of removed breast tissue to postoperative oxygen saturation and pulmonary function (forced vital capacity, forced expiratory volume in 1 s) and correlations between postoperative total breast volume and postoperative oxygen saturation and pulmonary functions (forced vital capacity, forced expiratory volume in 1 s, forced expiratory flow between 25% and 75% of vital capacity) were found. However, a statistically significant difference was not found between preoperative to postoperative pulmonary functions. The differences between the findings in the study by Elhusseiny et al (9) and the present study may be attributed to the timing of lung function measurement, age of the study participants and the weight of breast tissue excised.

The present study serves as an additional measurement to assess the hypothesis that reduction mammoplasty may improve pulmonary function.

Our study had several limitations. Due to its preliminary nature, the main limitation was the relatively small number of patients and lack of control group, which limit the external validity of the study results and conclusion. Nevertheless, the differences we found were of significant clinical nature, and highlight the need for a more comprehensive

TABLE 3
Pulmonary function data presented as ratio between end and start values

Pulmonary function parameter	Mean ± SD	P*
Compliance†	1.24±0.324	0.001
Tidal volume/peak inspiratory pressure	1.14±0.214	0.002
Tidal volume, mL	0.981±0.215	0.648
Respiratory rate, breaths/min	0.999±0.438	0.998
Peak inspiratory pressure, cmH ₂ O	0.902±0.160	0.005
Peak end-expiratory pressure, cmH ₂ O	1.08±0.181	0.035
Oxygen saturation, %	1.00±0.005	0.710
End-tidal carbon dioxide, mmHg	1.16±0.173	<0.001

*Calculated from one-sample t test, and 1 as reference value; †Compliance = tidal volume/(peak inspiratory pressure – peak end expiratory pressure)

clinical research. Moreover, the study population included in the present study was homogenous, healthy and nonsmoking, which may have contributed to the results.

Additional limiting factors associated with the study include the fact that a significant proportion of patients were given muscle relaxants and, despite the fact that short-acting relaxants were used, they may have affected chest wall compliance.

CONCLUSION

Our study describes 26 adolescent patients who underwent reduction mammoplasty. Twenty-four patients showed statistically significant improvement of pulmonary compliance as a result of reduction mammoplasty during the operation. These findings may serve as a complementary indicator for other comparative studies reporting an improvement of pulmonary function. We suggest future prospective studies including a larger sample as well as exploration of sustained beneficial correlation between intra- and postoperative pulmonary function after three to six months.

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