

Original research article

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Ant-waist surgery adversely affects lung function: a cross-sectional study

Aseel Aburub[1], Mohammad Z. Darabseh[2*], Rahaf Badran[3], Ala'a M. Shurrab[4], Anwaar A. Amro[1], Sean J. Ledger[5]

[1]Department of Physiotherapy, Faculty of Allied Medical Sciences, Applied Science Private University, Amman, Jordan; [2]Department of Physiotherapy, School of Rehabilitation Sciences, The University of Jordan, Amman, Jordan; [3]Department of Physiotherapy, Faculty of Applied Medical Sciences, Middle East University Amman, Jordan; [4]Department of Basic Medical Science, Faculty of Medicine, Al-Balqa Applied University, Al salt, Jordan; [5] Physiotherapy, School of Health, Medical and Applied Sciences, CQUniversity, Rockhampton, Australia

ABSTRACT

Background: Body contouring surgery for the removal of the 11th and 12th ribs is undertaken for aesthetic appeal in female and transgender populations. The potential adverse effects of the surgery on lung function and respiratory muscle strength have not been previously studied. Therefore, this study aimed to determine the effects of 'Ant-waist' surgery on lung function and respiratory muscle strength in individuals who had undergone surgery.
Methods: This was a cross-sectional study with two groups, an Anti-waist group who had undergone surgery and an age and gender matched control group. Participants performed lung function tests to determine measurements of FEV_1, FVC, FEV_1/FVC, PEF, MIP, and MEP. Independent t-tests were performed to determine between-group differences in outcomes and Pearson's correlation coefficients determined the relationship between lung function and respiratory muscle strength, and number of years since surgery.
Results: There was a significant between-group difference in FEV_1 (-0.83; 95%CI -1.30, -0.36; $p<0.001$), FEV_1%pred. (-34.91; 95%CI -48.92, -20.90; $p<0.001$), FVC%pred. (-22.73; 95%CI -32.84, -12.62; $p<0.001$), PEF%pred. (-44.18; 95%CI -61.52, -26.84; $p<0.001$) and MEP (-68.27; -102.48, -34.07; $p<0.001$). There were significantly large, negative correlations (r>0.5) between the number of years after surgery and FEV_1 ($p=0.002$), FEV_1%pred. (p=0.0001); and PEF%pred. (p=0.032).
Conclusions: This study has identified that aesthetic surgery for the removal of ribs 11 and 12 had a significant adverse effect on lung function and respiratory muscle strength in Jordanian females. The potential adverse effects should be carefully explained by surgeons to patients considering the surgery.

Keywords: respiratory; lung function; Ant-waist surgery; floating ribs removal surgery

Correspondence: Mohammad Z. Darabseh, PhD, Department of Physiotherapy, School of Rehabilitation Sciences, The University of Jordan, Amman, Jordan. Email: darabseh.moh@gmail.com.

Authors' contributions: AA, MZD contributed to the study conception. MZD, AA and RB designed and prepared the study. RB, AAA, and AMS collected the data. SL and AA analysed the data. MZD, AA and SL wrote the first draft of the manuscript. All authors commented on previous versions of the manuscript, read, and approved the final manuscript.

Ethics approval and consent to participate: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. (Ethical approval from the Research Ethics Committee at the Faculty of Allied Medical Sciences at Applied Science No: AMS-2024-3). Private University (Reference No: AMS-2024-3) was undertaken. Signed informed consents were obtained from the participants.

Consent for publication: Written informed consent was obtained from all individuals participating in the study and all authors in this study provided formal consent for publication.

Availability of data and material: Available upon request.

Conflict of interest: Authors declare no competing interests related to this paper.

Funding: No funding was received to conduct this study.

Acknowledgement: The authors would like to thank the participants of the study for their time and efforts.

Introduction

Perceptions of physical attraction and beauty may be influences by geographical location, ethnicity, culture, and demographic factors [1] and social media [2]. Consequently, body contouring surgery, a specialised field within plastic surgery has undergone significant advancements in recent years, influenced by the success of bariatric procedures, pharmacological interventions for patients experiencing substantial weight loss, and the refinement of lipomodelling techniques [3]. Numerous invasive and non-invasive procedures have been developed to enhance aesthetic appearance, such as correction of excess skin laxity and subcutaneous fat, which involves techniques such as liposuction and abdominoplasty [4]. These procedures refine the abdominal musculature and reduce waist circumference [3], whilst procedures such buttock augmentation involving liposuction, lipofilling, and intramuscular silicone implant placement are undertaken to achieve optimal buttock aesthetics [5].

The term "Ant-waist" has gained in popularity to describe the ideal waist-to-hip ratio for maximum aesthetic appeal, particularly in women and transgender populations, with post-surgical resection of the 11th and 12th rib (floating ribs) [5, 6]. A waist-to-hip ratio ranging from 0.65 to 0.70 has been reported to be the most highly attractive [1, 7]. Some individuals struggle to attain the desired waist-to-hip ratio after abdominoplasty and buttock augmentation surgeries due to inherent bony structures [5], therefore the surgical removal of the floating ribs to decrease waist-to-hip ratio may be considered [5].

The knowledge base related to the efficacy and safety of rib resection solely for aesthetic purposes is limited [6]. In a case-series report, Verdugo et al. [8], reported a low complication rate of two pneumothoraces in 104 patients who had undergone surgery across an 8-year period. However, only 10 of these patients had undergone exclusive rib removal surgery, with the majority undergoing a combination of resection, liposuction, and abdominoplasty.

A significant (p<0.01) post-operative decrease in forced vital capacity (FVC) has been reported in patients who have had multiple ribs removed during thoracic wall resection surgery for tumours [9]. Therefore, it is plausible that Ant-waist surgery may lead to respiratory complications due to several factors: 1) the floating ribs play a crucial role in protecting vital organs, including the lungs; 2) these ribs facilitate the expansion and retraction of the thoracic cavity during breathing as they are attachment sites for the external obliques, internal oblique, and transversus abdominis muscles that stabilise the thoracic cage and spine, 3) removal of the floating ribs alters the structural integrity of the rib cage, potentially impacting respiratory mechanics, such as decreased bucket handle movement [10].

Bucket handle movement contributes to the dynamic process of breathing by altering the dimensions of the thoracic cavity, allowing for effective ventilation of the lungs [10, 11]. During inspiration, bucket handle movement involves the lower ribs, but particularly the floating ribs, moving upwards and outwards, which increases the transverse diameter of the thoracic cage, effectively expanding the chest cavity laterally. The volume of the thoracic cavity increases, creating a negative pressure environment which facilitates the intake of air into the lungs [10]. Conversely, during expiration, the bucket handle movement reverses, with the lower ribs moving downwards and inwards, such that the transverse diameter of the thoracic cage decreases causing the chest cavity to contract laterally. The reduction in thoracic cavity volume increases the pressure within the lungs facilitating the expulsion of air [10, 11].

Surgical removal of the floating ribs may alter the mechanics of breathing and have an adverse effect on lung function. However, there are no published research that has assessed lung function or respiratory muscle strength in people who have undergone this surgery. Therefore, the aim of this study was to assess the effects of Ant-waist surgery on lung function and respiratory muscle strength.

Methods

Study design

A cross-sectional study with ethical approval from the Research Ethics Committee at the Faculty of Allied Medical Sciences at Applied Science Private University (Reference No: AMS-2024-3) was undertaken. The study included an age and gender matched Ant-waist group and control group.

Recruitment of participants

Participants in the Ant-waist group were recruited through plastic surgery clinics in Jordan. Additionally, an invitation to participate in this study was posted on social media (e.g. Facebook and Instagram) to enhance the recruitment strategy. Due to the limited published data on Ant-waist surgery, a power-calculation to determine sample size was not undertaken.

Inclusion and exclusion criteria

Participants in the Ant-waist group were included if: 1) they had undergone the surgical removal of the 11th and 12th ribs; 2) surgery was not less than six months before the start of the study; 3) aged 18 years and over. Exclusion criteria for both groups included smokers; pregnancy; diagnosed cardiac, respiratory, musculoskeletal, or neurological conditions; or the individual had undergone any other surgery that might limit their exercise capacity or ability to perform spirometry.

Outcome measures

Spirometry

The gold standard lung function test, spirometry, was assessed using a calibrated spirometer (BTL Spirometry, United Kingdom) and in accordance with the American Thoracic Society & European Respiratory Society (ATS/ERS) standardised guidelines [12]. The best of three consecutive maximal expiratory manoeuvres were used to obtain the forced expiratory volume in the first second (FEV_1), FVC and the FEV_1/FVC ratio [12]. Results were compared with Global Lung Initiative normative multi-ethnic reference equations for age 3-95 years [13].

Respiratory muscle strength

Respiratory muscle strength was estimated by measuring maximal inspiratory pressure (MIP) and maximum expiratory pressure (MEP) using a portable mouth pressure device (MicroRPM, Cardinal Healthcare, UK). Participants were instructed to maximally and forcefully exhale after a maximal inhalation manoeuvre [14, 15].

Statistical analysis

All raw data were digitally retrieved and exported into a Microsoft Excel® spreadsheet (Redmond, Washington, USA), with FEV_1 and FVC data converted to percentage predicted (%pred.) using GLI 2012 Desktop Software for Large Data Sets [16]. Data were transferred for statistical analyses using IBM® SPSS® Statistics 24.0 (Chicago, IL, USA). The Shapiro–Wilk Test ($p>0.05$) was used to assess for the normal distribution of data, and comparisons of between-group spirometry data were performed using independent t-tests [17]. Numerical data are presented as mean, standard deviation (SD), and 95% confidence intervals (95%CI), with statistical significance established as $p\leq0.05$, unless otherwise stated. To explore the correlations, if any, between lung function, respiratory muscle strength, and number of years since surgery, bi-variate correlational analysis was conducted using the Pearson's correlation coefficient (r), such that $r<0.10$ was considered a small effect, $r>0.10$ to $r<0.50$ considered a moderate effect size, and $r>0.50$ a large effect size [18].

Results

A total of twenty-two (n=22) female Jordanian participants were recruited, with eleven (n=11) participants allocated to the Ant-waist group and eleven (n=11) age and gender matched participants allocated to the control group. All data were collected between March 2024 - April 2024. Table 1 shows the anthropometric data of the groups.

Lung function

Table 2 shows that there were significant between-group differences in FEV_1, FEV_1%pred., FVC%pred., FEV_1/FVC and PEF%pred., with the Ant-waist group demonstrating the lowest scores.

Table 1. Anthropometric results for both groups (n=22).

Variable	Ant-waist group	Control group	Mean difference (95%CI)*	*p*
Age	33.27±2.69	33.27±2.69	1.64 (-2.54, -2.54)	0.99
BMI (kg/m^2)	20.16±1.59	22.26±3.12	1.39 (-0.24, 4.44)	0.07
Years since surgery	3.00±1.18	-		

*Ant-waist group minus control group.

Table 2. Differences between Ant-waist group and control group in spirometry results.

Variable	Ant-waist group	Control group	Mean difference (95%CI)*	*p*
FEV_1 (L)	2.73±0.50	3.56±0.55	-0.83 (-1.30, -0.36)	<0.001**
FEV_1%pred.	69.64±8.42	104.55±20.62	-34.91 (-48.92, -20.90)	<0.001*
FVC (L)	4.16±0.83	4.30±0.59	-0.14 (-0.79, 0.50)	0.65
FVC%pred.	82.64±8.39	105.36±13.71	-22.73 (-32.84, -12.62)	<0.001**
FEV_1/FVC	0.67±0.17	0.83±0.64	-0.15 (-0.27, -0.04)	0.01**
PEF (L)	404.55±120.87	478.91±147.12	-76.36 (-196.41, 43.68)	0.20
PEF%pred.	70.73±16.08	114.91±22.39	-44.18 (-61.52, -26.84)	<0.001**

*Ant-waist group minus control group; **statistically significant.
FEV_1, forced expiratory volume in one second; FVC, forced vital capacity; PEF, Peak expiratory flow.

Table 3. Difference in respiratory muscle strength results (mouth pressure) in both groups (n=22).

Variable	Ant-waist group	Control group	Mean difference (95%CI)*	*p*
MIP (cmH_2O)	109.18±25.40	104.18±25.40	5.00 (-20.52, 30.52)	0.69
MEP (cmH_2O)	70.45±11.71	191.18±39.52	-68.27 (-102.48, -34.07)	<0.001**

*Ant-waist group minus control group; **statistically significant.
MIP, Maximal inspiratory pressure; MEP, Maximal expiratory pressure; cmH_2O, centimetre of water.

Respiratory muscles strength

MIP was slightly higher in the Ant-waist group, but this difference was not significant. However, MEP was significantly lower ($p<0.001$) in the Ant-waist group, which may suggest greater respiratory muscle weakness (Table 3).

Correlations with years since Ant-waist surgery

The results of Pearson's correlation coefficient tests (Table 4) showed significant, negative, and large effects of number of years post-surgery and FEV_1 (p=0.002), FEV_1%pred. (p=0.0001); and PEF%pred. (p=0.032).

Discussion

This is the first study that has investigated the effects of Ant-waist surgeries on lung function and respiratory muscle strength, and the results showed that the surgery had a significant adverse effect on lung function and respiratory muscle strength. The study also showed that there were significant negative correlations between lung function and years since surgery in the Ant-waist group. These results suggest that that the negative impact of the surgery progresses with time and this impact should be explained to individuals considering this surgery.

It is difficult to draw comparisons due to the limited knowledge bank, however Hatano et al. [19], used

Table 4. Correlations between years since surgery and respiratory function in the Ant-waist group (n-11).

Variable		Years since Ant-waist surgery
FEV_1 (L)	*r*	-0.921*
	p	0.0001**
FEV_1%pred.	*r*	-0.813*
	p	0.002**
FVC (L)	*r*	-0.392
	p	0.233
FVC%pred.	*r*	-0.443
	p	0.172
FEV_1/FVC	*r*	-0.421
	p	0.198
PEF (L)	*r*	-0.394
	p	0.231
PEF%pred.	*r*	-0.646*
	p	0.032**
MIP (cmH_2O)	*r*	-0.067
	p	0.844
MEP (cmH_2O)	*r*	-0.238
	p	0.481

*Large effect size; **statistically significant.
FEV_1, forced expiratory volume in one second; FVC, forced vital capacity; PEF, Peak expiratory flow; MIP, Maximal inspiratory pressure; MEP, Maximal expiratory pressure; cmH_2O, centimetre of water.

a three-dimensional computer simulation model to evaluate the biomechanical relationship between the location of rib defects and loss of respiratory function using data from 10 participants commuted tomography scans. Hatano et al. [19], reported that that the loss of lung function was greatest in the lateral-inferior part of the thorax, where the floating ribs are located. The rationale being that during inhalation, the ribs elevate and the external intercostal muscles contract, to increase the transverse diameter of the lungs causing the bucket handle movement of the ribs [10, 11]. The absence of the 11th and 12th ribs would likely limit the ability to inhale to total inspiratory capacity, as was demonstrated in this cross-sectional study, with the ant-waist group recording significantly lower FVC.

In a 25-years retrospective study (1975-2000) of chest wall-resections and reconstruction, Mansour et al. [20] evaluated the outcomes of 200 patients to determine the most common complications of the surgeries. Pneumonia (14%), acute respiratory distress syndrome (6%), and infection/sepsis (5%) were the most common adverse events recorded, with lung function impairment resulting from rib defects also reported. These findings were in contradiction to those reported by of Chiu et al. [5], who reported the effects of the surgical resection of the floating ribs in 5 patients (n=3, female; n=2, transgender) had minimal impact on lung function and no adverse effects were observed. However, given the sample size of this study, caution should be applied when comparing the results to the larger Mansour et al. [20] study, particularly as the Chiu et al. [5] relied on commentary from qualitative patient questionnaires and a survey related to dyspnoea, and did not assess lung function or respiratory muscles strength.

Strengths and limitations

The strength of this study is that it is the first to demonstrate a clear negative relationship between lung function and respiratory muscle strength in women who have undergone surgical removal of the 11th and 12th ribs. The outcomes of this study may be useful to surgeons and other clinicians when discussing the potential adverse effects of the surgery. However, it is important to consider the limitations of this study as the sample size was small and limited to Jordanian females only, and pre-surgical data related to lung function and respiratory muscle function were unavailable. Therefore, generalisability to the wider population should be judiciously considered. Nevertheless, the results of this study would suggest that more research in this area is warranted, particularly focussed on determining the differences between pre- and post-surgical effects on lung function.

Conclusion

This study has identified that aesthetic surgery for the removal of the floating ribs had an adverse effect on lung function and respiratory muscle strength in Jordanian females. These findings are important as they may impact the decision-making of individuals considering this type of surgery, and the potential adverse effects should be carefully explained by surgeons. Further research is warranted, with a focus on multicentre and multi-national data so that robust comparisons can be made.

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Received for publication: 21 May 2024 - Accepted for publication: 6 June 2024

Licensee Mattioli 1885, Italy
Multidisciplinary Respiratory Medicine 2024; 19: 984
doi: 10.5826/mrm.2024.984