Original Article

The Effects of Lipoabdominoplasty with the Application of Intra-Abdominal Pressure and Respiratory Airway Pressure in Women: A Multicenter Prospective Study

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ABSTRACT

Background: Abdominoplasty surgery is associated with intra-abdominal pressure (IAP) and respiratory airway pressure (RAP) changes. We aimed to assess the impact of the lipoabdominoplasty on the simultaneous changes in the IAP and RAP and their predictive factors for the first time.
Methods: This prospective study was conducted on 30 women who underwent lipoabdominoplasty between November 2021 and November 2022 in Modares and 15- Khordad hospitals affiliated with Shahid Beheshti University of Medical Sciences, Tehran, Iran. Patients underwent lipoabdominoplasty by a surgeon with more than ten years of experience. RAP was measured based on P platue and P Peak three times (after anesthesia, after plication, and after surgery).
Results: The mean changes of IAP and RAP were significantly different based on the p peak and p plateau after anesthesia, plication, and surgery ($P<0.001$). Changes in IAP with BMI, degree of laxity, degree of plication, number of pregnancies, xiphoid to pubis distance, and 12th vertebra to ASIS distance were related. RAP (p peak and P platue) with a degree of laxity, degree of plication, number of pregnancies, IAP, xiphoid to pubis distance, and 12th vertebra to ASIS distance were related ($P<0.05$).
Conclusion: lipoabdominoplasty significantly affects changes in IAP and RAP after anesthesia, plication, and surgery. During lipoabdominoplasty, surgeons should simultaneously pay attention to the changes in both IAP and RAP from the beginning to the end of the surgery, especially in obese women with a history of multiple pregnancies and patients with severe laxity.

KEYWORDS
Lipoabdominoplasty; Women; Plication; Intra-abdominal pressure; Respiratory Airway pressure

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INTRODUCTION

Lipoabdominoplasty is rapidly promoted and popularized as an appropriate method to beautify the abdomen and solve skin laxity issues, wrinkles, and abdominal swelling. This surgery is commonly used as an effective method to improve body contouring, maintain a youthful physique, especially for older women, and remove excess skin from excessive weight loss, and it significantly improves patients' quality of life and self-confidence[1-3]. Lipoabdominoplasty has experienced various developments in recent decades and is not just a combination of abdominoplasty and liposuction. In 1985, Hakme introduced a new technique called mini- abdominoplasty which this technique included removing the oval of the suprapubic skin, plication of the supraumbilical and infra umbilical muscles, and liposuction on the abdomen and flanks[4]. It is estimated that over 800,000 people undergo abdominoplasty every year, making it the world's sixth most common cosmetic procedure[5]. The term lipoabdominoplasty was used for the first time in 2001 by Saldan to standardize abdominoplasty with selective weakening along the inner borders of the rectus muscles[6].

Lipoabdominoplasty, by maintaining and controlling the blood circulation and lymph vessels in the abdomen by the limited weakening of the abdominal flap, is associated with fewer complications than the older methods[7]. Like any other surgery, both abdominoplasty and lipoabdominoplasty procedures are prone to complications. According to the American Society of Plastic and Aesthetic Surgeons in 2004, the rate of local complications in these three methods of classic abdominoplasty, lipoabdominoplasty, and abdominoplasty was 20%, 10.3%, and 13.5%, respectively. Rates of systemic complications were below 0.1% for all methods[8]. But this surgery is still considered one of the challenges of plastic surgery. Pulmonary complications (such as atelectasis) and intraabdominal pressure are some of the most common surgical complications[9]. The exact prevalence of increased intra-abdominal pressure (IAP) and respiratory airway pressure (RAP) after lipoabdominoplasty has not been reported, and its incidence is influenced by many factors, including gender, age, patients, body mass index (BMI) before surgery surgical technique, and the surgeon's skill[10, 11].

An increase in IAP can cause damage to the internal organs of the abdomen and increase mortality after surgery. Also, increased RAP can cause respiratory complications, including dyspnea, hypoxia, and respiratory infections[12]. Based on our search, no study has investigated IAP and RAP in abdominoplasty surgery simultaneously. In addition, IAP and RAP are not systematically measured after lipoabdominoplasty surgeries, and many cases of increases in IAP and RAP are not diagnosed or reported. Therefore, it is very important to evaluate the incidence rate and identify the factors affecting it because it can lead to early diagnosis, early treatment measures, and improvement of surgery outcomes[13]. We aimed to assess the APP's effect on the simultaneous changes in the IAP and RAP and their predictors.

METHODS

The Ethical Board of Shahid Beheshti University of Medical Sciences approved this prospective study (Ethical code: IR.SBMU.MSP.REC.1401.082).

In this study, 43 women who underwent lipoabdominoplasty were evaluated sequentially in Modares and Pazdeh Khordad hospitals affiliated with Shahid Beheshti University of Medical Sciences, Tehran, Iran between November 2021 and November 2022. After checking the inclusion criteria, 30 women were enrolled. Sampling was done by the available method. Before entering the study, informed consent was obtained from all participants. lipoabdominoplasty was performed routinely for all candidate lipoabdominoplasty, and the researcher only recorded and collected the findings during and after the operation and did not perform any intervention on the patients.

The inclusion criteria included women candidates for lipoabdominoplasty, age above 18 years, and informed consent to participate in the study. The history of respiratory diseases, patients with asthma and COPD, patients with laparotomy abdominal surgery with a midline incision, smoking (daily consumption of at least one cigarette per day), patients with untreated viral infections including viral hepatitis (B and C) and HIV, unwillingness and lack of cooperation to participate in the study were exclusion criteria.

Demographic characteristics and clinical findings before surgery (age, BMI, Distance from xiphoid to pubis (cm), Distance from vertebra 12 to ASIS, The distance around the Hip from ASIS, Waist, number of pregnancies, plication rate, degree of laxity, systolic and diastolic pressure) were measured and recorded by the researcher using a checklist. Changes in IAP and RAP were recorded for both P Plute and P Peak three times, including: before anesthesia, after plication, and after surgery. The trends of changes in both indices were examined in time intervals.

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Measurement IAP

The IAP was measured by an electric transducer (transducer) through Foley catheter No 16 while the patient was supine. If there was no muscle contraction in the abdominal area, 25 milliliters of saline were injected into the bladder, then the electrical transducer was placed in the mid-axillary area, and IAP was measured. During and after the surgery, maximum RAP and IAP were again measured and recorded. All findings were measured and recorded by a plastic surgeon and anesthesiologist. All patients underwent surgery by a plastic surgeon with more than ten years of experience.

Statistical analyses

The SPSS 22 statistical software (IBM Corp., Armonk, NY, USA) was used in the analysis of the data. Descriptive statistics (frequency and percentage) were used to provide qualitative variables. The mean and standard deviation were used to report quantitative variables and mean IAP and RAP changes. The Shapiro- Wilk test was used to check the normality of quantitative variables (IAP and RAP). The repeated measures test was used to check the average changes of the results in the time intervals after the lipoabdominoplasty if the variable distribution was normal. If it was abnormal, the Friedman test was used. Linear regression was used to check the predicting factors of IAP and RAP changes. To control confounding variables, multivariate linear regression analysis was used. The effect size was reported with the β and in the 95% confidence interval (95% CI). A *P*-value less than 0.05 was considered the significance level of statistical tests.

RESULTS

Demographics and clinical findings

Thirty patients completed the study. The mean age at the time of surgery was 42.93 ± 7.14 years. The median age was 42 years and ranged from 28 to 57 years. The mean BMI was 28.13 ± 1.86 kg/m2. The degree of laxity was 3, with 63.3% of the patients. The plication rate in 53.3% of patients was 4. The number of pregnancies in 90% of patients was less than two live births (Table 1).

The trend of IAP and RAP (p plute and p peak) changes in time intervals

The trend of IAP changes was significantly different after anesthesia, plication, and surgery ($P<0.001$). The mean IAP changes after surgery and after plication were significantly higher than after anesthesia ($P<0.001$) (Figure 1). The trend of changes in RAP in both the p peak and p plateau was significantly different after anesthesia, plication, and surgery ($P<0.001$). The mean p peak and p plateau changes after surgery were significantly higher than after plication and anesthesia ($P<0.05$) [(Table 2)(Figure 2)].

Predictive factors of IPA and RAP changes

The results of multivariate linear regression analysis showed that the mean BMI, degree of laxity, plication rate, number of pregnancies, the distance from xiphoid to pubis, and the distance from the 12th rib to ASIS were significantly related to pressure changes ($P<0.05$) (Table 3). Also, the degree of laxity, the plication rate, the number of pregnancies, IAP, the distance between the xiphoid to the pubis, and the distance from the 12th rib to ASIS were significantly related to RAP changes ($P<0.05$) (Table 4).

DISCUSSION

Several studies have reported IAP and RAP changes during and after abdominoplasty surgeries [11, 13, 14]. While the changes of each of these can be accompanied by the change and exacerbation of other changes, the simultaneous changes of both without regular monitoring during surgery can aggravate the complications of surgery and its outcomes. To our knowledge, no study has examined the IAP and RAP changes and their impact on others simultaneously. Therefore, in this study, we evaluated the effects of lipoabdominoplasty on IAP and RAP and their predictive factors in 30 women. According to the results of our study, more than half of the patients were less than 42 years old. The mean BMI in most patients was higher than 28 kg/m^2. Laxity was greater than 3 in more than two-thirds of patients. The trends of IAP changes were significantly different after anesthesia, plication, and surgery, so the mean IAP reached its highest level after surgery. Also, the process of p peak and p plateau changes

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Table 1: Distribution of demographic characteristics and clinical findings of patients

Variable	30 subjects (Mean±SD)	Range
Age (yr)	42.93±7.14	28,57
BMI (kg/m²)	28.13±1.86	24,31
Distance from xiphoid to pubis(cm)	32.70±1.46	30,36
Distance from vertebra 12 to ASIS	12.43±1.25	10,15
The distance around the Hip from ASIS	109.63±6.22	100,124
Waist	97.67±6.33	90,115
Degree of laxity		-
• 2	9(30%)	
• 3	19(63.3%)	
• 4	2(6.7%)	
Plication Rate		-
• 2	2(6.7%)	
• 4	16(53.3%)	
• 5	6(20%)	
• 6	5(16.7%)	
• 8	1(3.3%)	
Number of pregnancies		-
• 1	6(20%)	
• 2	21(70%)	
• 3	2(6.7%)	
• 4	1(3.3%)	

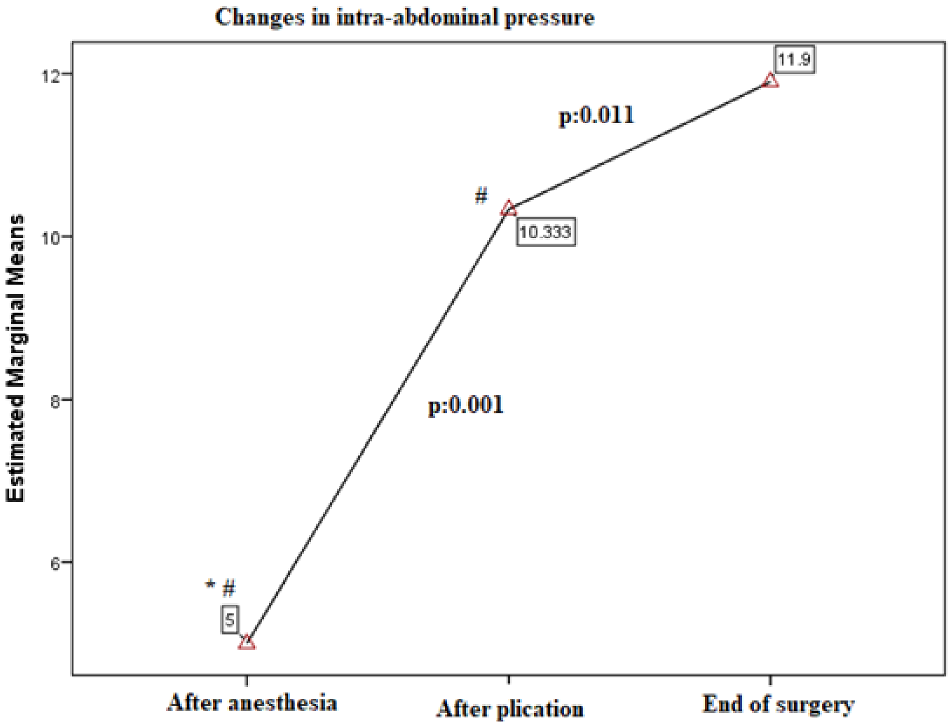

Figure 1: Comparison of IAP changes after anesthesia, after plication and end of surgery

* Significance of changes end of surgery compared to other two times, # Significance of changes after plication compared to other two times

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after anesthesia, after plication, and at the end of surgery was significantly different. The mean IAP significantly increased with increasing mean BMI, the degree of laxity, increasing plication rate, and increasing number of pregnancies. At the same time, the IAP decreased with increasing distance from the xiphoid to the pubis and increasing distance from the 12th rib to ASIS. The mean p peak and P plateau increased significantly with an increasing degree of laxity, increasing plication rate, an increasing number of pregnancies, and mean IAP. In contrast, their mean decreased with increasing distance from the xiphoid to the pubis and from the 12th rib to ASIS. These findings are consistent with research in this area [11,14].

Al-Basti et al., [13] evaluated IAP changes after total abdominoplasty in 43 obese women with multiples and showed that IAP significantly increased after surgery compared to before surgery, which was consistent with the results of our study.

RT Pillai et al., [(11)], by comparing the effect of mesh plastic and peeling of the abdominal wall on the IAP changes during and after the operation of 34 patients (17 patients in each group), showed that the majority of patients were women, and the mean IAP in each group after the surgery was significantly higher than before the surgery, which was in line with the results of our study. No significant difference was observed for the average IAP, either during or after the operation, in the two groups. The increase in IAP immediately after surgery was related to the mean BMI, which was consistent with the results of our study[14].

Our study showed the increase in mean IAP had the greatest effect on the increase in RAP. Talisman et al., [14] by measuring changes in IAP during abdominoplasty with plication and the correlation of these changes with the immediate postoperative recovery period in 18 patients (17 women and one man), showed that the IAP was significantly related to the RAP so that after the surgery, the risk of respiratory distress was significantly higher in patients who had a pressure above 20 cm H2O, which was consistent with our results. MA Rodrigues et al., [15] by examining the respiratory function and IAP after abdominoplasty with plication on 18 women, showed that Respiratory function and spirometry values decreased significantly after surgery, which

Table 2: Comparison of mean IPA and RAP after anesthesia, after plication and end of operation

Variable		Time			*P* value
		After anesthesia	After plication	End of surgery	
IAP (cm H2O) (Mean±SD)		5.0±1.74	10.33±3.35	11.9±3.60	0.001
RAP	P Peak	16.63±1.71	22.03±3.66	23.33±4.2	0.001
	P Platue	13.9±1.71	18.83±3.45	19.93±3.9	0.001

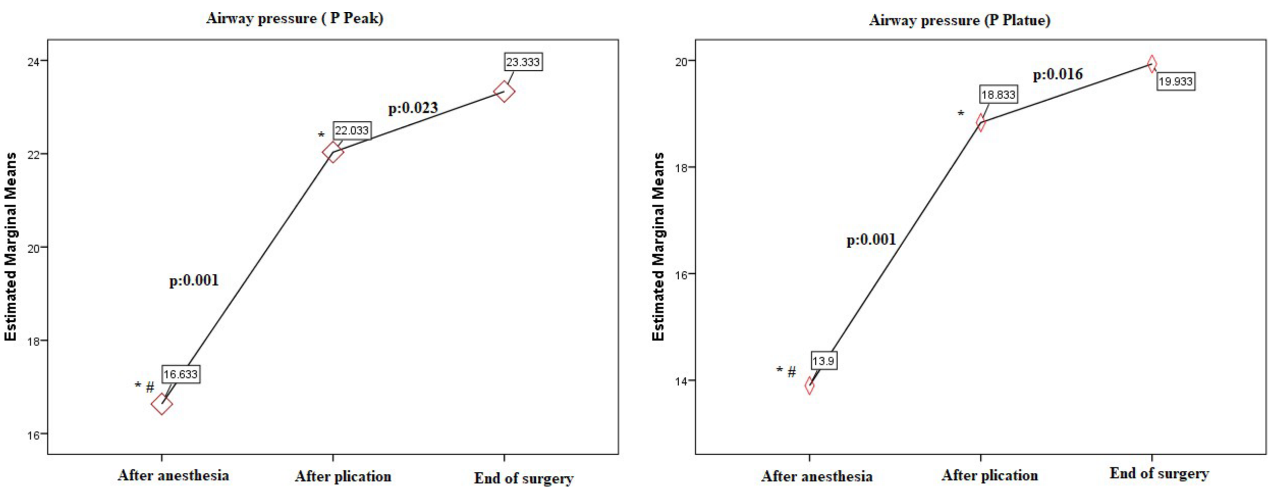

Figure 2: Comparison of p peak and p plaute changes after anesthesia, after plication and end of surgery
* Significance of changes end of surgery compared to other two times, # Significance of changes after plication compared to other two times

Table 3: Predictive factors of IAP changes

Variable	β	95% CI	*P* value
BMI (Kg/m²)	0.28	0.11,0.46	0.014
Distance from xiphoid to pubis(cm)	-0.29	-0.47,-0.11	0.012
Distance from vertebra 12 to ASIS	-0.35	-0.51,-0.17	0.001
Degree of laxity	0.42	0.16,0.68	0.024
Plication Rate	0.28	0.1,0.47	0.016

Table 4: Predictive factors of p peak and p plaute changes

Variable	β	95% CI	*P* value
	P peak		
IAP rate	0.64	0.49,0.86	0.001
Distance from xiphoid to pubis(cm)	-0.37	-0.59,-0.15	0.001
Distance from vertebra 12 to ASIS	-0.35	-0.54,-0.13	0.004
Degree of laxity	0.27	0.1,0.45	0.033
Plication Rate	0.38	0.16,0.60	0.022
Number of pregnancies	0.33	0.12,0.55	0.036
	P Plaute		
IPA rate	0.62	0.47,0.85	0.001
Distance from xiphoid to pubis(cm)	-0.39	-0.63,-0.16	0.006
Distance from vertebra 12 to ASIS	-0.36	-0.56,-0.18	0.009
Degree of laxity	0.28	0.11,0.46	0.029
Plication Rate	0.41	0.18,0.64	0.012
Number of pregnancies	0.35	0.14,0.57	0.017

was consistent with our results. In this study, unlike the results of our study, no significant relationship between IAP and RAP was observed, which can be justified due to the difference in the sample size of the two studies; the sample size examined in our study was higher than in this study. In line with the results of our study, Fluhr et al., [16] by investigating the effects of lipoabdominoplasty on diaphragm movements and lung function in 32 women, showed that the lipoabdominoplasty had short-term negative effects on diaphragm movements and respiratory- pulmonary function. Galdino et al., [17] by examining the changes in IAP and RAP before and after abdominoplasty surgery in 22 patients, showed that the mean IAP increased from 11 to 12 before surgery to 16 cm H_2O after surgery, which was consistent with the results of our study. Also, they showed that abdominoplasty with plication causes a significant difference in airway and intra-abdominal pressure, which was in line with the results of our study. Tercan et al., [18] in a prospective study with 14 patients, showed that abdominoplasty was significantly related to RAP. Their study showed the same as ours; the distance between Distance xiphoid and pubis was significantly related to RAP. There were strengths and weaknesses in our study that should be pointed out. The most important weakness of this study was the short-term follow-up of patients after surgery in terms of IAP and RAP changes and related complications. The design of prospective studies with long-term follow- up can estimate the results and evaluate pressure changes over time more accurately. Our study had many strengths, the most important of which included: the simultaneous evaluation of changes in IAP and RAP in three periods after anesthesia, after plication, and end of surgery in a suitable sample size of patients for the first time. This study evaluated the relationship of many factors to changes in the RAP and IAP.

CONCLUSION

Lipoabdominoplasty significantly affects changes in IAP and RAP at different times of surgery (after anesthesia, after plication, and after surgery). During lipoabdominoplasty, surgeons should simultaneously pay attention to the changes in both IAP and RAP from the beginning to the end

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of the surgery, especially in obese women with a history of multiple pregnancies and patients with severe laxity.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

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