



# Abdominoplasty, seroma formation and duration of hospitalisation: comparative analysis and outcome of 112 consecutive lipoabdominoplasties performed using progressive tension sutures

Umar Daraz Khan<sup>1</sup>

Received: 17 June 2018 / Accepted: 8 April 2019 / Published online: 17 April 2019  
© Springer-Verlag GmbH Germany, part of Springer Nature 2019

## Abstract

**Background** There are conflicting reports that early mobilisation and outpatient-based surgery is associated with higher prevalence of seroma formation. Current comparative retrospective study was carried out to establish whether ambulatory surgery and early mobilisation has an impact on any higher incidence of seroma formation.

**Methods** A retrospective analysis of 112 cases of consecutive lipoabdominoplasties with progressive tension sutures was carried out. Patients were divided into groups A, B and C.

**Results** Group A included 27 patients and were operated as ambulatory cases, with mean age of  $36.1 \pm 6.98$  years and mean BMI of  $23.8 \pm 3.02$ . Mean tissue excised was  $592 \pm 373$  g, mean volume of lipoaspirate to abdomen was  $352 \text{ cc} \pm 158$  and mean 1st 24-h drainage was  $26.9 \pm 17.24$  cc. No patient had seroma. Group B included 68 patients who stayed one night with a mean age of  $40.6 \pm 11.36$  years, mean BMI of  $27.4 \pm 5.34$ , tissue excised was  $863 \pm 544$  g, mean volume of lipoaspirate to abdomen was  $649 \text{ cc} \pm 510$  and mean 1st 24-h drainage was  $52.1 \pm 58.8$  cc. No patient had seroma. Group C included 17 patients who stayed in for two nights as inpatients. Mean age was  $38.8 \pm 9.66$  years, mean body mass index (BMI) of  $27.0 \pm 4.06$ . Tissue excised was  $927 \pm 434$  g, mean volume of lipoaspirate was  $563 \text{ cc} \pm 316$ . Mean 1st and 2nd 24-h drainage was  $80.1 \pm 44.55$  cc and  $64.8 \pm 42.4$  cc respectively. No patient had seroma.

**Conclusions** Based on the study design, it is possible to conclude that early ambulation most likely did not contribute to seroma formation diagnosed by clinical examination alone in this series.

Level of Evidence IV. Risk/prognostic study.

**Keywords** Abdominoplasty · Seroma · Lipoabdominoplasty · Progressive tension sutures · Quilting sutures

## Introduction

Abdominoplasty is a commonly performed procedure. Recent advances and modifications in technique and intraoperative management have enhanced the safety of the patient and transformed clinical outcome of the procedure. Consequently, there have been fivefold increase in procedures performed from

34,000 in 2006 and a 50% increase from 114,929 in 2010 to 181,540 in 2016 [1–3]. The procedure is now the third most common aesthetic surgical procedure as compared to being 4th in 2015 [3, 4]. Abdominoplasty, as a body contouring procedure, is not a risk-free operation. Both, systemic and local complications, are undesirable and unwelcoming for patients as well as surgeons. The serious and potential life-threatening systemic complications known are deep venous thrombosis (DVT) and pulmonary embolism [5]. The use of graded compression stockings and intraoperative and postoperative intermittent pneumatic compression (IPC) has resulted in a low incidence of venous thromboembolism (VTE) even without the use of chemoprophylaxis [6]. Serious local complications include seroma formation and flap necrosis that may alter the course of recovery and outcome of surgery.

✉ Umar Daraz Khan  
Mrumarkhan@aol.com; [www.re-shape.co.uk](http://www.re-shape.co.uk)

<sup>1</sup> Reshape Clinic, Reshape House, 2-4 High Street, West Malling, Kent ME19 6QR, England

The incidence of flap necrosis has been reported in up to 4.9% of cases where as incidence of seroma may occur in up to 26% of patients [7, 8]. Of these two local complications, seroma has been looked into frequently and extensively [9, 10]. The use of fibrin sealants [11–13], preservation of Scarpa's fascia [14, 15], association of liposuction [8], extent of flap undermining [16], introduction of quilting [17–19], progressive tension sutures (PTS) [20] and possible role of thermic injury using monopolar [21] or bipolar electrocautery [22] are the salient topics and techniques discussed in literature. This increases understanding of the process and helps to reduce the incidence of this, once commonly seen, complication. Anatomy of hypogastric and epigastric lymphatic channels, its distribution, drainage and the role played in the prevention of seroma has been outlined in detail [14]. Despite of the various observations, works, techniques and modifications described to understand the cause and to prevent seroma, limited undermining of the abdominal skin flap and application of PTS to prevent shearing of abdominal wall are the two most salient modifications that has completely changed the outcome and safety of the procedure [16, 17, 20, 23]. Despite these developments, seroma formation still remains a topic of interest for many surgeons. The body of evidence has clearly indicated the efficacy of PTS and its role in prevention of seroma [8, 17, 19, 20]. However, in an era of evidenced-based medicine, there is limited information available on seroma formation in lipoabdominoplasties with limited undermining and PTS when performed as an inpatient- or outpatient-based ambulatory procedure. A current single surgeon study demonstrates that when PTS are used in lipoabdominoplasty with limited supraumbilical undermining, the procedure can be carried out as an ambulatory patient without any added risk of seroma formation as compared with patients hospitalised for one or two nights, having had the same procedure.

## Methods

A retrospective analysis of 112 cases of consecutive lipoabdominoplasties, performed by a single surgeon, was carried out. All procedures were carried out using single technique over a period of 11 years (October 2006 to March 2017).

### Inclusion criteria

Only those patients were included in the study who were class I and II category, according to the American Society of Anaesthesia, had undermining of the skin flap up to the umbilicus and supraumbilical undermining was limited to preserve lateral row of perforators arising from deep superior epigastric artery. All included patients had liposuction done to the anterior abdominal wall with umbilical relocation, PTS

placed and had a single size 10 suction drain placed before skin closure.

### Exclusion criteria

Patients with previous history of abdominoplasty, abdominal liposuction or previous abdominal surgery resulting in abdominal scarring were excluded from the study.

The patients were divided into three groups on the basis of their stay in the hospital. The selection of duration following abdominoplasty was entirely based on the changes in the trend of the author's clinical practice for the years included in the study. In the earlier part of the practice, patients were routinely staying for two nights as a routine in earlier part of the study which was changed to single night. For the last few years, surgery is performed almost entirely as outpatient-based ambulatory procedure.

Group A included day cases, group B single-night stay and group C patients had two-night stay patients.

### Surgical technique

#### Preoperative preparation

Preoperative assessment was performed 2 weeks before surgery for routine checks and methicillin-resistant *Staphylococcus aureus* screening. Smokers were informed to quit smoking 2 weeks before surgery. All surgeries were performed under general anaesthetic. Prior to surgery, electrocardiography was performed in patients of 50 years or older and blood samples were taken for full blood count, grouping and cross matching. All premenopausal female patients had pregnancy test done on the day of surgery in order to exclude pregnancy.

#### Preoperative markings

All patients had preoperative markings done in standing position. Inferior incision is placed 6–7 cm above the clitoral hood or base of the penis with skin at maximal stretch and extending 7–8 cm horizontally on either side before changing its direction up and laterally towards anterior superior iliac spine. The lateral limit of the incision varies and is normally limited to the lateral end of the skin fold, when present.

#### Anaesthesia and positioning

All procedures are performed under full general anaesthetic with laryngeal mask and muscle relaxation with arms extended and supported on arm boards at an angle less than 90°. Endotracheal intubation is done only in patients who are going to be placed in prone position for liposuction of their hips and flanks. Intravenous antibiotics and intermittent pneumatic compression (IPC) are routinely used.

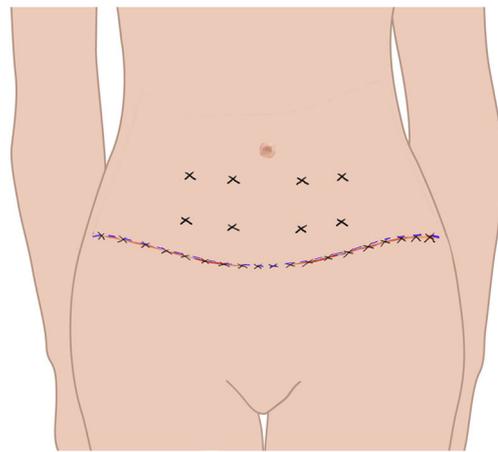
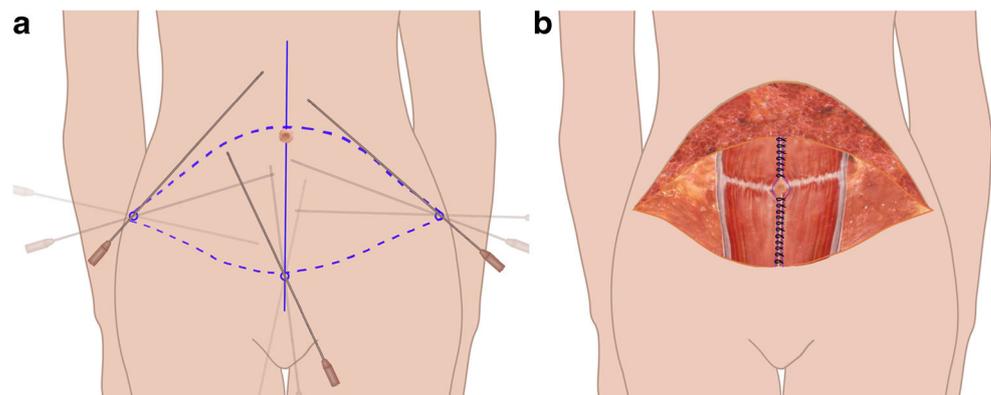
## Infiltration

Fluid for infiltration is prepared using 1000 cc normal saline, 30 cc 1% lidocaine and 1 mg of adrenaline 1:1000. Abdominal wall is infiltrated with 300 to 400 cc, on each side, using 2-mm blunt tipped infiltration needle mounted on a 50-cc Luer Lock syringe. Also 15 ml of 1% xylocaine with adrenaline I: 100,000 is infiltrated along the incision lines.

## Liposuction, dissection and procedure

Liposuction is performed superior and lateral to the umbilicus using wet technique with 4-mm cannula, using suction-assisted liposuction. Liposuction is performed superficial and deep to Scarpa's fascia (Fig. 1a). Limited liposuction is performed inferior to the umbilicus as this part of the skin flap is excised as a routine. Skin is incised and the flap is raised just superficial to deep abdominal fascia using diathermy forceps on cutting mode. Honey combing of the abdominal wall flap created by liposuction helps to identify and visualise perforators for a prospective haemostasis. The dissection is continued upward to the level of umbilicus and laterally to the lateral limit of the incised skin in a curvilinear manner. Umbilicus is marked, incised and isolated. Supraumbilical dissection is limited medial to the lateral row of deep superior epigastric artery, exposing medial part of the rectus-abdominis and releasing linea alba's tethering effect on skin. Rectus divarication, when present, is repaired. To prevent strangulation of the base of the stump of the umbilicus, supraumbilical and infraumbilical sections of rectus plication is performed separately in two parts, using continuous size 0 Ethibond (Fig. 1b). Second layer of plication is performed using 0 Vicryl interrupted buried sutures. Now operating table is flexed, excess skin is marked and skin is excised. Skin flap is pulled down and medially, on average two rows of progressive tension sutures are placed, each with two or three sutures on either side (Fig. 2). No progressive tension sutures are placed above the umbilicus in the midline. One size 10 suction drain is placed

**Fig. 1** a Suction-assisted lipectomy using 4 mm cannula. b Rectus plication performed separately above and below umbilicus



**Fig. 2** Application of progressive tension sutures (PTS). Two rows of PTS applied, each with four sutures

and intraoperative low molecular weight heparin is given as a routine. Blood loss was estimated by weighing swabs.

## Closure

Closure is performed in two layers using 2–0 Vicryl sutures that include Scarpa's fascia and dermis and 4–0 Monocryl intradermal sutures. Wounds are dressed with steri strips, light adhesive dressing and Marena Velcro AB3 abdominal binder.

## Postoperative instruction

Patients are continued with IPC and GCS are continued until patients discharged, postoperative chemoprophylaxis is continued only in selected cases. Once comfortable, patients are encouraged to mobilise with body in forward flexion. One- and two-night stay patients had their drains removed before their discharge from the clinic. For the clinical assessment of seroma formation, patients are followed up again in 2 weeks, 2 months and 4 months and at least for a minimum of 6 months' time. No radiological imaging is performed to assess the presence of seroma.

## Statistical analysis

Data feeding and analysis was done using computer package SPSS (Statistical Package for Social Services) Version 16.0. The results were given in the text as Mean  $\pm$  SD (standard deviation) for quantitative/continuous variables, numbers and percentages for qualitative/categorical variables. Analysis of variance (ANOVA) was used for statistical significance of difference between groups for quantitative variables and chi-square/Fisher exact test was used for statistical significance between groups for qualitative/categorical variables. In all statistical analyses, only  $p$  value  $< 0.05$  were considered significant.

## Results

From October 2006 to March 2017, a total of 112 consecutive patients fulfilled the criteria for data analysis and were divided into group A, group B and group C, on the basis of their length of stay in hospital.

**Group A** This group had 27 patients who were discharged 6–8 h following surgery. The mean age of the patients was  $36.1 \pm 6.98$  years (range 23–49) with a mean BMI of  $23.8 \pm 3.02$  kg/m<sup>2</sup> (range 19.2–31.1) and 6 (22.2%) were smokers. The group, mean weight of the tissue excised was  $592 \pm 373$  g (range 97–1650), mean total volume of lipoaspirate to abdomen was  $352 \pm 158$  cc (range 150–700).

**Fig. 3** a, b Preoperative views of a 36-year-old woman with abdominal skin redundancy and loss of breast volume following multiple pregnancies. c, d Postoperative pictures taken 12 months following her abdominoplasty and breast augmentation performed as a day case



No patient had infection, wound breakdown, seroma, haematoma, DVT, pulmonary embolism (PE), readmission to hospital or death. Of these day cases, 19 (70.3%) had at least one more procedure done simultaneously and 21 (77%) had rectus plication (Fig. 3a–d, Tables 1 and 2).

**Group B** The group had 68 patients who stayed for a night. The mean age of the patients was  $40.6 \pm 11.36$  years (range 20–68) with a mean BMI of  $27.4 \pm 5.34$  kg/m<sup>2</sup> (range 19.2–49.9) and 12 (17.6%) were smokers. The mean weight of the tissue excised was  $863 \pm 544$  g (range 76–2500), mean total volume of lipoaspirate to abdomen was  $649 \pm 510$  cc (range 80–2400). No patient had seroma, haematoma, DVT, PE, readmission to hospital or death. Of 68 patients in this group, 47 (69%) patients had at least one other procedure done and 33 (48%) had rectus plication (Fig. 4a–e, Tables 1 and 2).

**Group C** The group included 17 patients who stayed in for two nights as inpatients. In this group, mean age of the patients was  $38.8 \pm 9.66$  years (range 24–60) with a mean body mass index (BMI) of  $27.0 \pm 4.06$  kg/m<sup>2</sup> (range 19.8–34.9) and 3 (17.6%) were smokers. In this group, mean weight of the tissue excised was  $927 \pm 434$  g (range 100–2092), mean total volume of lipoaspirate to abdomen was  $563 \pm 316$  cc (range 100–1000). No patient had seroma, haematoma, DVT, PE, readmission to hospital or death. Of 17 patients in the group, 8 (47%) patients had at least one another procedure performed and 7 (41.1%) had rectus plication (Fig. 5a–d, Tables 1 and 2).

## Data analysis

There was no statistical difference between three groups when age ( $p$  value 0.161) smoking status ( $p$  value 0.869), number of revision surgeries ( $p$  value 0.378), wound break down ( $p$  value 0.722), infection ( $p$  value 0.340) and tissue excised ( $p$  value

0.056) were analysed. Blood loss was significantly less in group B than C ( $p$  value 0.045). The first 24-h drainage was significantly less in group A than group C ( $p$  value 0.025). Suction lipectomy performed was significantly less in group A as compared to group B. BMI of group A was significantly lower when compared with group C and group B. Statistical analysis for seroma formation could not be performed as all three groups had 0% rate of its occurrence. Similarly, there was no statistical difference in wound breakdown and infection rate. However, there was 0% wound breakdown or infection in group A. There was no haematoma, DVT, PE, deaths or readmissions in all three groups. There was no statistical difference in the number of secondary procedures performed in three groups ( $p$  value = 0.197). Rectus plication was performed in 77% of outpatient-based ambulatory cases (group A) as compared to patients who stayed in for one night (group B, 48%) or two nights (group C, 41%) and the difference was statistically significant ( $p < 0.01$ ).

## Discussion

The two most unwelcoming local complications following abdominoplasty are wound dehiscence and seroma formation. Seroma being less troublesome but more commoner of the two complications and frequently requires multiple aspirations [8]. Less common but more serious local complications arising from seroma are skin flap necrosis and pseudocyst formation [7, 22, 24]. Pseudocyst or pseudobursa formation is a chronic seroma, requiring its complete excision as a revision surgery [22, 24]. Skin flap necrosis if small, can be treated conservatively; however, large areas of dehiscence or necrosis may often require secondary procedures.

Causes for seroma following abdominoplasty are many and have been delineated in earlier studies. These causes include

**Table 1** Patient's and procedure characteristics in three subgroups

|  | Group A ( $n = 27$ )                        | Group B ( $n = 68$ )          | Group C ( $n = 17$ )          | $p$ value  |
|--|---|-------------------------------|-------------------------------|------------|
| Age (years) range (Mean $\pm$ SD)              | 23–49 ( $36.1 \pm 6.98$ )                   | 20–68 ( $40.6 \pm 11.36$ )    | 24–60 ( $38.8 \pm 9.66$ )     | 0.161      |
| BMI (kg/m <sup>2</sup> ) range (Mean $\pm$ SD) | 19.2–31.1 ( $23.8 \pm 3.02$ )* <sup>†</sup> | 19.2–49.9 ( $27.4 \pm 5.34$ ) | 19.8–34.9 ( $27.0 \pm 4.06$ ) | 0.006      |
| Smoker   | 6 (22.2%)                                   | 12 (17.6%)                    | 3 (17.6%)                     | 0.869      |
| Revision                                       | 1 (3.7%)                                    | 4 (5.9%)                      | 2 (11.8%)                     | 0.378      |
| Wound breakdown                                | –   | 4 (5.9%)                      | 1 (5.9%)                      | 0.722      |
| Infection                                      | –   | 1 (1.5%)                      | 1 (5.9%)                      | 0.340      |
| Seroma   | –   | –                             | –                             | –          |
| Haematoma                                      | –   | –                             | –                             | –          |
| DVT/PE   | –   | –                             | –                             | –          |
| Readmission                                    | –   | –                             | –                             | –          |
| Rectus plication                               | 21 (77%)                                    | 33 (48%)                      | 7 (41.1%)                     | $p < 0.01$ |
| Multiple procedures                            | 19 (70.3%)                                  | 47 (69%)                      | 8 (47%)                       | 0.197      |

**Table 2** General characteristics of procedures performed in three subgroups

|  | Day cases ( <i>n</i> = 27) | Group B ( <i>n</i> = 68) | Group C ( <i>n</i> = 17)  | <i>p</i> value |
|--|----------------------------|--------------------------|---------------------------|----------------|
| Tissue excised (g) (Mean $\pm$ SD)     | 97–1650 (592 $\pm$ 373)    | 76–2500 (863 $\pm$ 544)  | 100–2092 (927 $\pm$ 434)  | 0.056          |
| Lipoaspirate (cc) (Mean $\pm$ SD)      | 150–700 (352 $\pm$ 158)*   | 80–2400 (649 $\pm$ 510)  | 100–1000 (563 $\pm$ 316)  | 0.027          |
| Blood loss (g) (Mean $\pm$ SD)         | –                          | 6–180 (36.8 $\pm$ 40.95) | 10–144 (63.6 $\pm$ 38.45) | 0.045          |
| Drainage 1st 24 h (ml) (Mean $\pm$ SD) | 10–60 (26.9 $\pm$ 17.24)   | 5–280 (52.1 $\pm$ 58.8)  | 10–170 (80.1 $\pm$ 44.55) | 0.025          |
| Drainage 2nd 24 h (ml) (Mean $\pm$ SD) | –                          | –                        | 10–30 (64.8 $\pm$ 42.4)   |                |

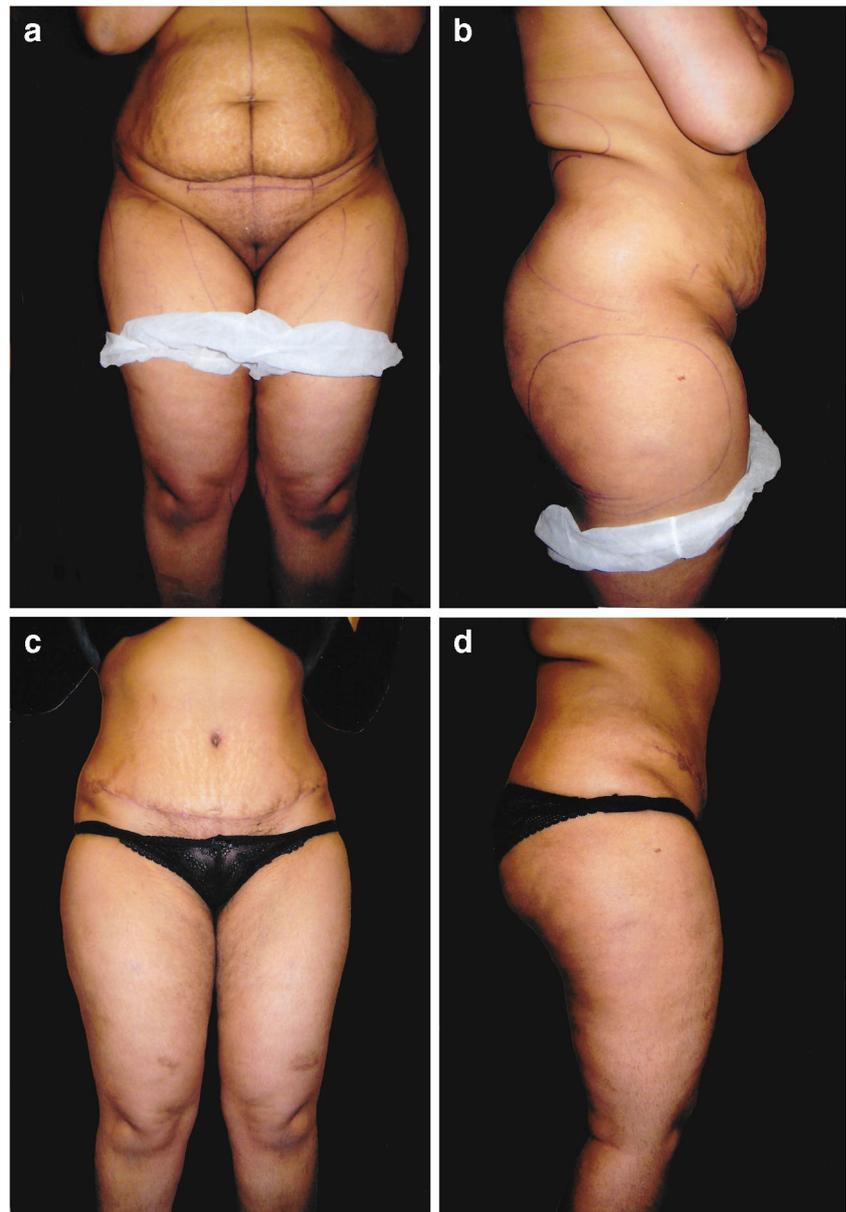
thermic injury either in the form of ultrasonic liposuction [21] or monopolar diathermy [22] and for this reason, bipolar diathermy or sharp dissection has been recommended [22]. However, the use of monopolar diathermy forceps on cutting mode has shown no untoward effects [8, 21, 25]. Similarly, the use of pressure garments plays an important role in reducing seroma formation by supporting and exerting pressure on skin externally and adjustable Velcro wraparound pressure garments have been reported to perform better than non-adjustable elasticated pressure garments [8]. Anatomy of abdominal wall lymphatic, their channel distribution, its

drainage pattern and role of lymphatic in prevention of seroma has been discussed in detail by Lauren and Pascal [14]; however, suprapubic incision down to rectus sheath in hypogastric region, without preservation of Scarpa's fascia, has shown no disadvantage or increased seroma formation in author current or previous published work, establishing and reinforcing the strength and value of PTS. [8, 25] Even though seroma is now almost preventable, abdominoplasty and seroma formation are still hard to separate. Abdominoplasty for body contouring is not a new procedure but addition of quilting sutures or its more popularised modification, PTS, has revolutionised the

**Fig. 4** a, b Preoperative views of a 36-year-old mother following three pregnancies resulting in loss of her breast volume along with moderate abdominal skin redundancy. c–e Postoperative pictures taken 1 year following breast augmentation using 350-cc textured round cohesive gel silicone implants and abdominoplasty. Patient stayed for one night in hospital after her surgery



**Fig. 5** **a, b** Preoperative views of a 24-year-old young woman who was very conscious of abdominal skin redundancy and thigh lipodystrophy. **c, d** One year following abdominoplasty and suction lipectomy of outer and inner thighs. Patient stayed for two nights in the hospital

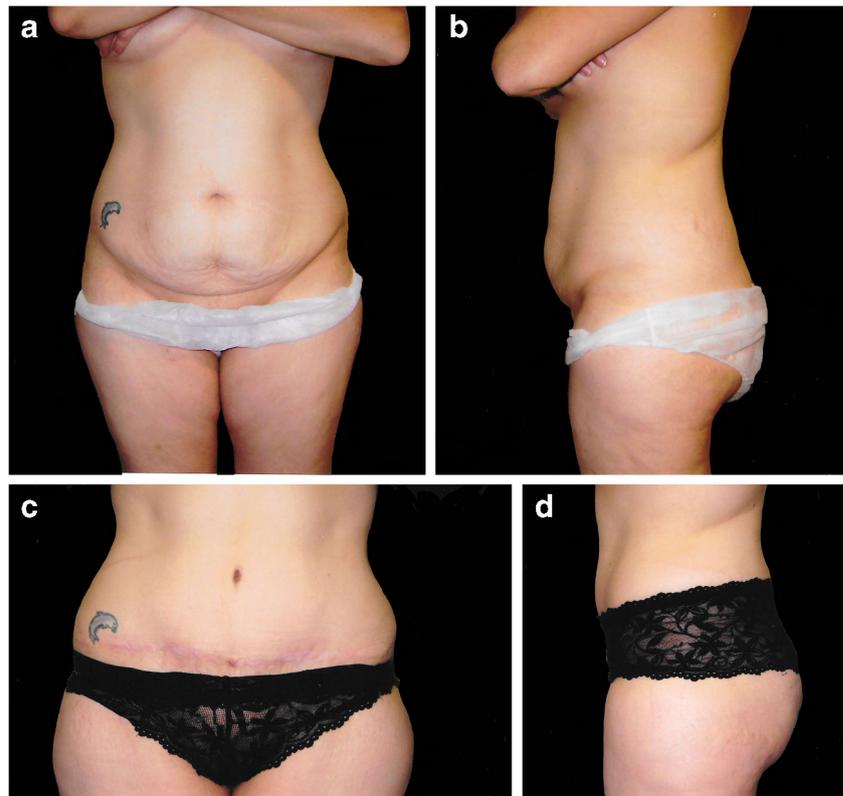


prevalence of seroma formation [17, 20, 23]. Safety of the skin flap, early recovery and ease of the procedure is mainly attributed to the introduction of lipoabdominoplasty with limited supraumbilical undermining. The procedure allows unhindered blood flow through perforators arising from the deep superior epigastric artery as demonstrated by Dr. Graf [26]. The modification has completely changed the earlier concept of vascular anatomy of the abdominal wall and planning of surgery [25, 27, 28]. Surgery is now frequently performed as office-based ambulatory procedure without any added risk to patient or recovery from procedure [29–32].

Interestingly, earlier studies have shown a relationship between early ambulation and development of seroma. Antonetti and Antonetti observed a rise of seroma from 9.6 to 24% when long-term hospitalisation was changed to short term and

outpatient-based abdominoplasty with drains. In their later part of the series, it was demonstrated that PTS alone brought down the rate of seroma to 1.7% when the procedures were done as ambulatory procedures and without drains [32]. Wallner and Beer reported duration of immobility and its impact on the seroma formation. A rise in occurrence of seroma formation was reported when patients were mobilised early after 24 h as compared to mobilisation started after 48 h [33]. Dr. Moliver et al. in the article on safety in office-based full abdominoplasty reported an incidence of 19.4% rate of postoperative seroma even when drains were used [30]. When lipoabdominoplasty was performed with limited supraumbilical dissection as outpatient-based procedure, a high seroma rate of 23.5% was noted by Levesque et al. [29]. Almost all of these studies compared different

**Fig. 6** **a, b.** Preoperative views of a 36-year-old woman with abdominal skin redundancy following and breast loss of volume following multiple childbirths. **c, d.** Postoperative pictures taken 15 months following her abdominoplasty and breast augmentation performed as a day case



techniques when they looked into the development of seroma in relation to time of mobilisation and duration of hospitalisation as opposed to author current study, where the same technique was used and only duration of hospitalisation was compared.

Development of seroma, whether clinically present or not, also has been investigated using ultrasound imaging that showed collection of fluid in 42.8% of the patients; of these, 16% were large collections. The procedure involved standard abdominoplasty without quilting sutures or PTS and timing of the ultrasound was not mentioned in the study either [34]. A more recent and interesting ultrasonic comparative study between lipoabdominoplasty alone, abdominoplasty with progressive tension sutures and abdominoplasty alone was performed in which all patients had limited supraumbilical dissection, with or without PTS. Ultrasound screening done at 2 and 3 weeks showed significantly higher seroma formation in patients who had abdominoplasty alone without PTS. Group of patients who had abdominoplasty with PTS showed no seroma formation either at 2- or 3-week screening. However, lipoabdominoplasty alone showed seroma in 10% of the patients at 3-week stage [35]. A similar reduction in seroma rate was reported when abdominoplasty and lipoabdominoplasty with or without PTS were compared confirming that prevention of shearing of anterior abdominal flap over abdominal muscular wall, achieved by the use of progressive tension sutures,

alone and alone, is responsible for prevention of seroma formation [8, 25].

The span of the current study, as described in the technique, is 11 years. In the beginning, the author kept all his patients for two nights as a routine; however, the use of progressive tension sutures and limited supraumbilical dissection consistently resulted in decreased drainage and quicker and early mobilisation without seroma. Continued data collection with clinical observation led to the reduction of two-night stay to one night and now mostly done as outpatient-based ambulatory cases (Fig. 6a-d). The current practice is entirely based on clinical observations and supported by data. Currently, patients stay overnight only if they chose to do so, are ASA class II, have travelled a long distance to clinic for surgery or have long multiple surgeries requiring added nursing care.

Pollock and Pollock in their first article defined the technique in a smaller series and performed full abdominoplasty with limited supraumbilical dissection. All had anterior abdominal wall liposuction performed at the same time and all stayed as overnight cases. There were no drains used and no seroma formation or skin flap necrosis was reported [23]. Their subsequent larger series reported a seroma rate of 0.1% and 10.7% had revisions but none were related to seroma or PTS [2]. PTS stabilises skin flap over the rectus sheath and abdominal musculature preventing the shearing or rubbing of flaps on rectus sheath and abdominal musculature [8]. The volume of evidence suggests that this is the main

and only reason for seroma prevention obviating the need for the use of drains as reported by Pollock and Pollock in their first article. Similar prospective and follow-up articles indicated that the prevention of seroma does not need the use of drains following abdominoplasty [1, 4, 18, 36]. For cost-effectiveness and time-efficiency reasons, the author has used 2–0 Vicryl absorbable sutures for PTS throughout. Other surgeons have used barbed sutures, with or without drains noting similar effects [37, 38].

In the current series, chemoprophylaxis is routinely used for the prevention of VTE in addition to GCS and IPC. There was no effect on the incidence of haematoma, seroma, drainage volume or change in the management of drain removal policy. In an article published by Lista et al. [6], no chemoprophylaxis was given to their patients with only one (0.2%) incidence of VTE. All were managed with GCS and IPC [6]. Despite the volume of evidence suggesting that in the presence of PTS there is no need to place drains [2, 18, 23, 36, 38, 39], and even though the reported use of drains may result in additional scarring, discomfort and/or restriction in mobility, the author has continued to use single drain, without great inconvenience to the patients or their mobility.

### Strength and weaknesses of the study

This study is a comparative analysis of the cases performed by a single surgeon, where a single technique and with same instrumentation was carried out. Similar preoperative and postoperative protocol was used and all patients were assessed preoperatively and managed postoperatively using the same protocol by the surgeon himself. The weakness of the analysis is that it is a retrospective and not a prospective study and the results shows a significantly lower BMI for day cases or in other words bias towards outpatient-based ambulatory patients. There was no control group in the study as all three groups had similar technique used for abdominoplasty and the only difference was the duration of hospitalisation. However, a prospective double-blind controlled study would be recommended far (for) stronger and robust results and to exclude any preoperative bias for patient selection.

### Conclusion

Based on the study design it is possible to conclude that early ambulation most likely did not contribute to seroma formation diagnosed by clinical examination alone in this series.

**Compliance with ethical standards** 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.

The research involved the collection or study of existing data, records. The investigator records the data in an anonymous manner such that subjects cannot be identified directly or through identifiers linked to the subject. For this type of retrospective, anonymous data analysis and study, no ethics committee approval was sought.

**Conflict of interest** Mr. Umar Daraz Khan declares that he has no conflict of interest.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

**Patient consent** Patients provided written consent for the use of their images.

**Funding** The author has not received research funding for this manuscript.

### References

1. Stevens WG, Spring MA, Stoker DA, Cohen R, Vath SD, Hirsch EM (2007) Ten years of outpatients abdominoplasties: safe and effective. *Aesthetic Surg J* 27:269–275
2. Pollock TA, Pollock H (2012) Progressive tension sutures in abdominoplasty: a review of 597 consecutive cases. *Aesthetic Surg J* 32:729–742
3. American Society for Aesthetic Plastic Surgery. 2016 statistics, <http://www.surgery.org/sites/default/files/ASAPS-Stats2016.PDF>. Accessed 21 August 2017
4. Macias LH, Kwon E, Gould DG, Spring MA, Stevens G (2015) Decrease in seroma formation after adopting progressive tension sutures without drains: a single surgery centre experience of 451 abdominoplasties. *Aesthetic Surg J* 36:1029–1039
5. Grazer FM, Goldwyn RM (1977) Abdominoplasty assessed by survey, with emphasis on complications. *Plast Reconstr Surg* 59: 513–517
6. Somogyi RB, Jamil A, Shih JG, Lista F (2012) Venous thromboembolism in abdominoplasty: a comprehensive approach to lower procedural risk. *Aesthetic Surg J* 32:322–329
7. Dillerud E (1990) Abdominoplasty combined with suction lipoplasty: a study of complications, revisions and risk factors in 487 cases. *Ann Plast Surg* 25:333–338
8. Khan UD (2008) Risk of seroma with simultaneous liposuction and abdominoplasty and the role of progressive sutures. *Aesthet Plast Surg* 32(1):93–100
9. Seretis K, Goulis D, Demiri EC, Lykoudis EG (2017) Prevention of seroma formation following abdominoplasty: a systemic review and meta-analysis. *Aesthetic Surg J* 37:316–323
10. Jabbour S, Awaida C, Mhaweji R, Habre SB, Nasr M (2017) Does the addition of progressive tension sutures to drain reduce seroma incidence after abdominoplasty? A systemic review and meta-analysis. *Aesthetic Surg J* 37(4):440–447
11. Kulber DA, Baciliou N, PED, Gayle LB, Hoffman L (1997) The use of fibrin sealant in prevention of seromas. *Plast Reconstr Surg* 99(3):842–849
12. Lee K-T, Mun G-H (2015) Fibrin sealants and quilting sutures for prevention of seroma formation following latissimus dorsi muscle harvest: a systemic review and a meta-analysis. *Aesthet Plast Surg* 39:399–409
13. Nasr MW, Jabbour SF, Mhaweji RI, Elkhoury JS, Slelati FH (2016) Effect of tissue adhesive on seroma incidence after abdominoplasty: a systemic review and meta analysis. *Aesthetic Surg J* 36(4):450–458

14. Le Louran C, Pascal JF (2010) The high-superior-tension technique: evolution of lipoabdominoplasty. *Aesthet Plast Surg* 34(6):773–781
15. Koller M, Hintringer T (2012) Scarpa fascia or rectus fascia in abdominoplasty flap elevation: a prospective clinical trial. *Aesthet Plast Surg* 36(2):241–243
16. Saldanha OR, De Souza Pinto EB, Matos WN Jr et al (2003) Lipoabdominoplasty with selective and safe undermining. *Aesthetic Plast Surg J* 27:322–327
17. Baroudi R, Ferreira CAA (1998) Seroma: how to avoid it and how to treat it. *Aesthetic Surg J*. 18:439–441
18. Arantes HL, Rosique RG, Rosique MJF, Melega JM (2010) The use of quilting sutures in abdominoplasty does not require aspiratory drainage for prevention of seroma. *Aesth Plast Sur* 34:102–104
19. Sforza M, Husein R, Andjelkov K, Rozental-Fernandez PC, Zaccheddu R, Jovanovic M (2015) Use of quilting sutures during abdominoplasty to prevent seroma formation: are they really effective. *Aesthetic Surg J*. 35(5):574–580
20. Mladick RA (2001) Progressive tension sutures to reduce complications in abdominoplasty. *Plast Reconstr Surg* 107:619
21. Kim J, Stevenson TR (2006) Abdominoplasty, liposuction of the flanks, and obesity: risk factors for seroma formation. *Plast Reconstr Surg* 117:773–779
22. Zecha PJ, Missoten FEM (1999) Pseudocyst formation after abdominoplasty – extravasations of Morel-Lavallee. *British j of Plast Surg* 52:500–502
23. Pollock H, Pollock T (2000) Progressive tension sutures: a technique to reduce complications in abdominoplasty. *Plast Reconstr Surg* 56:14–20
24. Keramidas EG, Rodopoulou S, Khan UD (2006) Pseudocyst formation after abdominoplasty combined with liposuction: a case report and review of the literature. *Eur J Plast Surg* 28:400–402
25. Khan UD (2012) Seroma formation following abdominoplasty: a retrospective clinical review following three different techniques. *Eur J Plast Surg* 35(4):299–308
26. Saldanha O (2006) Lipoabdominoplasty, vol II, 1st edn. Dilivros, Rio de Janeiro, pp 87–91
27. Huger WE Jr (1979) The anatomic rationale for abdominal lipectomy. *Am Surg* 45:612
28. Matarasso A (1995) Liposuction as an adjunct to a full abdominoplasty. *Plast Reconstr Surg* 95:829–836
29. Levesque AY, Daniels MA, Polynice A (2013) Outpatient lipoabdominoplasty: review of the literature and practical considerations for safe practice. *Aesthetic Surg J*. 33(7):1021–1029
30. Gray S, Gittleman E, Moliver CL (2012) Safety in office-based full abdominoplast. *Aesthetic Surg J*. 32(2):200–206
31. Egrari S (2012) Outpatient-based massive weight loss body contouring: a review of 260 consecutive cases. *Aesthetic Surg J*. 32(4):474–483
32. Antonetti JW, Antonetti AR (2010) Reducing seroma in outpatient abdominoplasty: analysis of 516 consecutive cases. *Aesthetic Surg J* 30(3):418–427
33. Beer GM, Wallner H (2010) Prevention of seroma after abdominoplasty. *Aesthetic Surg J*. 30(3):414–417
34. Mohammad JA, Warnke PH, Stavrakys W (1998) Ultrasound in the diagnosis and management of fluid collection complications following abdominoplasty. *Ann Plast Surg* 41:498–502
35. Di Martino M, Nahas FX, Barbosa MV, Montecinos Ayaviri NA, Kimura AK, Barella SM, Novo NF, Ferreira LM (2010) Seroma in lipoabdominoplasty and abdominoplasty: a comparative study using ultrasound. *Plast Reoconstr Surg* 126(5):1742–1751
36. Epstein S, Epstein MA, Gutowski KA (2015) Lipoabdominoplasty without drains or progressive tension sutures: an analysis of 100 consecutive patients. *Aesthet Surg J*. 35(4):434–440
37. Warner JP, Gutowski KA (2009) Abdominoplasty with progressive tension closure using a barbed suture technique. *Aesthet Surg J*. 29:221–225
38. Isaac KV, Lista F, McIsaac MP, Ahmad J (2017) Drainless abdominoplasty using barbed progressive tension sutures. *Aesthet Surg J*. 37(4):428–429
39. Khan S, Teotia SS, Mullis WF, Jacobs WE, Beasley ME, Smith KL, Eaves FF, Finical SJ, Watterson PA (2006) Do progressive tension sutures really decrease complications in abdominoplasty? *Ann Plast Surg* 56:14–20

**Publisher's note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.