

# Ligating Perforators in Abdominoplasty Reduces the Risk of Seroma

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## Abstract

**Background** Seroma formation, a common complication of abdominoplasty, can cause patient discomfort and inconvenience. This study aimed to compare seroma rates after ligation and diathermy of large abdominal perforating vessels during abdominoplasty.

**Methods** Consecutive patients undergoing abdominoplasty with epigastric undermining between 2004 and 2011 were studied. Body mass index (BMI), age at operation, smoking history, preoperative weight loss, operative details, perioperative fluid infiltration, concomitant abdominal liposuction, ligation of perforators by clips, suture or diathermy, use of quilting sutures, weight of tissue removed, postoperative drainage, inpatient stay, and seroma rates were recorded. Statistical analysis was undertaken using the unpaired *t* test, Fisher's exact test, the Mann–Whitney *U* test, and Kendall's tau-b test.

**Results** The study included 90 patients. The incidence of seroma was significantly lower among the patients who had perforators ligated (4/60, 6.7 %) than among those who had diathermy (10/30, 33 %) ( $p = 0.002$ , Fisher's exact test). Seroma formation was significantly associated with a higher BMI, (27.45 vs. 25.16 kg/m<sup>2</sup>;  $p = 0.025$ , *t* test) but not with preoperative weight loss. Postoperative fluid drainage did

not differ significantly between ligated and diathermied perforators ( $p = 0.716$  Mann–Whitney *U* test).

**Conclusions** Use of ligation by clip or suture rather than by diathermy to ablate large abdominal perforators significantly reduced the incidence of seroma among abdominoplasty patients.

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**Keywords** Abdominoplasty · Complications · Seroma · Ligation · Ligaclips

## Introduction

Abdominoplasty is a popular aesthetic procedure, with more than 3,000 procedures performed by British Association of Aesthetic Plastic Surgeons members (BAAPS) in 2010. The most common complication is seroma formation, with an incidence of 8–39 % [7, 11, 12]. The reported risk factors include obesity [10, 11], smoking [8], and concomitant liposuction [11].

This study was stimulated by a clinical observation that patients undergoing deep inferior epigastric artery perforator flap surgery (DIEP) tended to have low seroma rates. A recent metaanalysis comparing DIEP and abdominoplasty found similar rates of complications except that the incidence of seroma was four times higher after abdominoplasty [13].

Although the causes of seroma are multifactorial, it is clinically noticeable that fluid collections are more common and persistent after lymph channel disruption. We hypothesized that ablating large perforators by ligation

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with suture or clips (in DIEP) rather than by diathermy (in abdominoplasty) may better seal the accompanying lymphatics, thereby reducing the incidence of clinically significant seroma.

This study aimed primarily to ascertain whether clipping or tying the perforators in abdominoplasty reduces the incidence of seroma compared with ablating the perforators with diathermy. The secondary aim of the study was to determine whether ligating the perforators reduced total drainage, hospital stay, complications, and number of early postoperative clinic visits.

## Methods

The study group consisted of independent sector patients cared for by two plastic surgeons in the West Midlands, UK. The first surgeon (O.G.T.) had ligated large perforators in abdominoplasty using suture or clip ligation since 2003. The second surgeon (A.P.) initially used diathermy to ablate all perforators, but in an attempt to reduce the incidence of seroma, changed to using clip ligation for large perforators in April 2010. Large perforators were defined as those of sufficient caliber to provide adequate perfusion to a DIEP flap.

Consecutive patients were identified from prospectively collected databases kept independently by the two surgeons. Hospital coding data also were searched for all patients coded as having undergone an abdominoplasty procedure. All consecutive patients between June 2003 and January 2011 were included in the study. The study population consisted of men ( $n = 5$ ) and women ( $n = 85$ ) who had undergone abdominoplasty with epigastric undermining. The techniques included were standard abdominoplasty with transposition of the umbilicus, extended abdominoplasty, and circumferential body-lifts. Miniabdominoplasty and panniculectomy cases were excluded from the study.

We compared the outcomes for two groups: patients who had diathermy ablation of large abdominal perforating vessels (30 by A.P.) and those who had suture or clip ligation (47 by O.G.T., 13 by A.P.).

The data recorded from the case notes are shown in Table 1. A clinically significant seroma was defined as abdominal fluid collection after discharge from the hospital that required needle drainage. Data were held in a password-protected database after identifiable data had been removed.

Statistical analysis was undertaken using the unpaired  $t$  test, Mann–Whitney  $U$  test, Fisher's exact test, and Kendall's tau-b. Repeat analysis was undertaken after control was used for confounding factors such as use of quilting sutures, body mass index (BMI), and weight of tissue excised. A power calculation was performed. The power of the study was 86 % for detecting a difference between a 5 % rate and a 30 % rate at the 5 % significance level.

**Table 1** Data recorded from case notes

1. Patient factors	BMI, age at operation, smoking history
2. Preoperative weight loss recorded in four groups	(1) Massive weight loss (>45 kg), (2) large weight loss (20–44 kg), (3) no large weight loss (<19 kg), (4) unrecorded
3. Operative details	Perioperative fluid infiltration, concurrent abdominal or flank liposuction, ligation of perforators by clips or diathermy, use of quilting sutures, weight of tissue removed
4. Postoperative findings	Fluid drainage during the inpatient stay, abdominal complications, length of hospital stay
5. Postdischarge findings	Incidence of clinically significant seroma, number of additional clinic visits to manage seroma (excluding initial postoperative appointment)

## Results

During the study period, 90 patients underwent abdominoplasty, and all were included in the study. Most of the patients had undergone a standard abdominoplasty ( $n = 83$ ), but 5 patients had received circumferential body-lifts, whereas 2 had received extended abdominoplasty.

The operative technique was similar in the two groups. Diathermy was used for dissection of the abdominoplasty plane. Diathermy settings were used that allowed meticulous hemostasis (usually 35 for coagulation and 35 for cutting), with a spray character of the current. Closed suction drains were used in each case. The surgeon who used sutures or clips routinely (O.G.T.) also used perioperative infiltration (1 l of Hartman's solution, 1 ml of 1:1,000 adrenaline, 40 ml of 1 % lidocaine).

Both surgeons plicated the rectus sheath when required and infrequently used quilting. Both surgeons left drains in place until drainage was less than 30 ml in the previous 24 h.

For the purpose of analysis, the patients were divided into two groups according to the management of the large abdominal perforators. In the clips group, large abdominal perforators were ligated with suture ties (Vicryl; Ethicon Endo-Surgery (Europe) GmbH, Norderstedt, Germany) or Ligaclips (Ethicon Endo-Surgery (Europe) GmbH). In the diathermy group, the perforators were ablated with cauterizing diathermy (Table 2).

Clinically significant seroma occurred in 14 patients. Seroma was significantly less common when clips were used to ablate perforators (4/60) than when diathermy was used (10/30;  $p = 0.002$ , Fisher's exact test). However, seroma rates were not reduced to zero, indicating that other factors may have a role in its development including preoperative infiltration, extent of dissection, weight of tissue

**Table 2** Characteristics of the study groups

	Clips	Diathermy	<i>p</i> value
Total patients	60	30	
Median age: years (range)	41 (22–67)	38 (22–73)	0.20 <sup>a</sup>
Median BMI: kg/m <sup>2</sup> (range)	25 (20–31)	27 (18–37)	0.08 <sup>a</sup>
Preoperative weight loss: <i>n</i> (%)			
Massive (> 45 kg)	3 (5)	2 (7)	1 <sup>b</sup>
Large (20–45 kg)	15 (25)	4 (13)	0.28 <sup>b</sup>
Smokers: <i>n</i> (%) <sup>c</sup>	7 (12)	4 (13)	1 <sup>b</sup>
Median postoperative drainage: ml (range)	125 (<50–1,360)	125 (<50–1,380)	0.78 <sup>a</sup>
Seroma: <i>n</i> (%)	4 (7)	10 (33)	0.002 <sup>b</sup>

<sup>a</sup> Mann–Whitney test<sup>b</sup> Fisher's exact test<sup>c</sup> Before surgery, five in the clips group and four in the diathermy group stopped**Table 3** Operative techniques, hospital stay, and postoperative clinic visits

	Clips	Diathermy	<i>p</i> value
Liposuction	12/60 (20 %)	2/30 (7 %)	0.13 <sup>a</sup>
Preoperative infiltration	47/60 (78 %)	1/30 (3 %)	<0.001 <sup>a</sup>
Quilting	6/60 (10 %)	0/30 (0 %)	0.17 <sup>a</sup>
Median weight excised: g (range)	1,036 (230–4,341)	1,395 (490–3,715)	0.009 <sup>b</sup>
Rectus placcation	46/60 (77 %)	13/30 (43 %)	0.002 <sup>a</sup>
Median hospital stay: days (range)	2 (1–7)	2 (1–5)	0.426 <sup>c</sup>
Postdischarge seroma	4/60 (7 %)	10/30 (33 %)	0.002 <sup>a</sup>
Median extra clinic visits to manage seroma for those with seroma: <i>n</i> (range)	2 (1–4)	5 (3–6)	0.039 <sup>c</sup>

<sup>a</sup> Fisher's exact test<sup>b</sup> Mann–Whitney test<sup>c</sup> Kendall's tau-b

excised, concomitant liposuction, and surgical technique. These factors are discussed in the following section.

The diathermy group showed a trend toward greater volumes of postoperative fluid drainage (mean 226 vs. 183 ml), but this did not reach statistical significance ( $p = 0.716$  Mann–Whitney test). No patient had prolonged immobilization. All were discharged at a mean of 2.3 days (clips) and 2.4 days (diathermy) postoperatively.

Age and preoperative weight loss (defined in Table 1) did not vary significantly between the clips and diathermy groups. Preoperative weight loss was not significantly associated with postoperative seroma formation (massive weight loss:  $p = 0.577$ ; large weight loss:  $p = 0.274$ , Fisher's exact test). For 12 patients, preoperative weight loss was not recorded. If this group had been assumed to have no massive or large weight loss, a significant association still would not have been observed ( $p = 1.000$  and  $0.178$ , respectively).

#### Confounding Factors (Table 3)

Although the mean BMI did not differ significantly between the two groups, the patients with seroma had a higher BMI (27.45 kg/m<sup>2</sup>) than those who did not (25.16 kg/m<sup>2</sup>;  $p = 0.025$ , *t* test).

When patients who had quilting or concomitant liposuction were excluded from the analysis, the rate of seroma remained significantly lower in the clips group ( $p = 0.004$  excluding patients with quilting and  $p = 0.007$  excluding patients who underwent concomitant liposuction). Moreover, the surgeon who changed his practice during the study acted as an internal control. His operative technique remained the same except for ligation of perforators rather than their ablation with diathermy. This single change in practice reduced the rate of seroma among his patients from 10 in 30 patients (33 %) to 2 in 13 patients (15 %). He noted an ongoing reduction in the incidence of seroma after the study period.

The weight of tissue excised was significantly higher in the diathermy group than in the clips group ( $p = 0.02$ ). However, when control was used for this difference in the statistical analysis, the rates of seroma remained significantly lower in the clips group than in the diathermy group ( $p = 0.03$ ).

The effect of preoperative infiltration could not be separated from the use of clips because it was the standard practice of the surgeon who used clips routinely (O.G.T.). He observed an even lower incidence of seroma (2/47, 4 %). In this group, two very mild abdominal swellings were noted several months postoperatively, which were asymptomatic and required no intervention.

### Management of Seroma and Complications (Table 3)

Every patient attended at least one postoperative review appointment. When those with seroma were compared, the clips group patients required a mean of 2.25 additional visits compared with 4.70 additional visits in the diathermy group ( $p = 0.039$ ). A greater number of postoperative visits were required in the diathermy group, suggesting slower resolution of the seroma.

Surgical revisions were performed at the patients' request and included scar revision ( $n = 9$ ), umbilical revision ( $n = 3$ ), and correction of "dog ears" ( $n = 7$ ). The complications recorded were infection treated with antibiotics ( $n = 2$ ), delayed healing ( $n = 3$ ), and hematoma ( $n = 1$ ). Complications were not significantly associated with revisions and the use of clips (14 complications in 10/56 patients) or diathermy (11 complications in 6/30 patients) ( $p = 0.78$ , Fisher's exact test).

### Discussion

Seroma is four times more common after abdominoplasty than after DIEP flap surgery according to a metaanalysis comparing early complications (16.1 vs. 3.7 %) [13]. We hypothesized that the surgical method of ligating large perforators may differ between these two operations, which may account for the difference in seroma rates. With DIEP flaps, potential perforators often are left intact until the flap is raised. The chosen perforator is dissected free of the muscle, and only after this are the redundant perforators ligated. In abdominoplasty, perforators frequently are ablated with diathermy, creating a burn, which produces an inflammatory response and may increase the chance of seroma development.

In other anatomic areas, lymphovascular control with diathermy is related to a statistically significant higher short-term complication rate compared with ligaclip usage. Lymphocele, the principal complication, can result in delayed wound infection and breakdown [14].

Although the seroma risk reduction may be due in part to prolonged postoperative immobilization in DIEP flaps [3], we speculate that clipping or ligation may better seal the perforators and the accompanying lymphatics, thereby contributing to reduction of seroma. This hypothesis is supported by anatomic studies of the DIEP flap, which have shown that lymphatic channels perforate the fascia to run adjacent to the inferior epigastric arteries [6]. A recent anatomic study found upper and lower abdominal collectors above Scarpa's fascia, immediately below the subdermal plexus [15]. However, the anatomic connections of lymphatics between the superficial and deep systems have not been defined. Controlled clinicopathologic studies will

add further evidence for the anatomic variations and may refute or support our hypothesis. Such studies are planned but are outside the remit of this initial observational report.

The evidence provided by our study supports but does not prove our hypothesis because the seroma rates were significantly lower ( $p = 0.002$ ) in the group that had Ligaclips or ties used to ligate perforators (7 %) than in the group that had perforators ablated by diathermy (33 %). Furthermore, the patients with seroma in the clips group required significantly fewer postoperative visits (2.25) than those in the diathermy group (4.7;  $p = 0.039$ ). Diathermy may occlude blood vessels more permanently than lymphatics as the coagulation cascade initiates thrombus, which occludes the vessels. The lymphatic channels do not contain blood, so occlusion with diathermy may be more temporary than with ligation, thereby contributing to an increased rate of seroma.

Although consecutive patients were identified in a prospective manner, data collection was performed retrospectively, and patients' records demonstrated some heterogeneity in relevant aspects of surgical technique. To standardize the patient groups as much as possible, statistical significance was reviewed after procedures shown to reduce seroma rates were excluded. Quilting [2, 4] was used occasionally, but when excluded, our results remained significant ( $p = 0.004$ ). Concomitant liposuction may increase the likelihood of postoperative seroma [7], but when patients undergoing liposuction were excluded, our results remained significant ( $p = 0.007$ ). Although the weight of tissue excised was significantly higher in the diathermy group, when control was used for this in the statistical analysis, the results retained statistical significance ( $p = 0.03$ ).

Various operative maneuvers shown to reduce seroma such as progressive tension sutures [1, 2] and fibrin adhesion products [2, 16] were not used in this study and therefore did not act as confounding factors. Postoperative immobilization was similar in the two groups (2.3 vs. 2.4 inpatient days), and although prolonged immobilization has been shown to reduce seroma [3] perhaps by reducing shearing forces, it was not practical or desirable in this study due to the thromboembolic risks and the expense of a prolonged hospital stay.

The use of preoperative infiltration could not be separated from the use of ligation because one surgeon used both of these techniques routinely. Some evidence exists to show that preoperative infiltration reduces intraoperative blood loss and immediate postoperative drainage in breast reduction [5, 9], but no effect of infiltration on subsequent seroma has been recorded in the literature. It is assumed that the effects of infiltrated epinephrine and local anesthetic would have resolved within 48 h after infiltration, so it is thought unlikely that this intervention would affect

postdischarge seroma rates. However, an effect cannot be excluded in this study due to the close correlation between the use of ligation and preoperative infiltration.

However, the internal control in our study showed that a simple change in a single element of operative technique (using Ligaclips instead of diathermy for ablation of abdominal perforators) reduced the rate of seroma from 10 in 30 cases (33 %) to 2 in 13 cases (15 %).

## Conclusion

A recent metaanalysis has demonstrated that the rate of seroma is four times higher with abdominoplasty than with abdominal free flap surgery. We found that ligating the abdominal perforators in abdominoplasty reduced postoperative seroma rates compared with diathermy ablation ( $p = 0.002$ ). This finding has not been reported previously. We hypothesize that ligation seals lymphatics better than diathermy. Anatomic studies and a prospective randomized trial of abdominoplasty or other procedures with a high seroma rate would further support our hypothesis and may help reduce the rate of seroma and the postoperative burden for both the patient and the surgeon.

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**Conflict of interest** The authors declare that they have no conflicts of interest to disclose.

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