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The Safe Evolution of Liposuction into Liposculpture

Ali Juma, Jamil Hayek and Simon Davies

Abstract

Liposuction was described in the 1920s & popularised in 1977 by Illouz. He developed smaller diameter blunt cannulas. To add safety he also developed the wet technique to reduce blood loss. Tumescence anaesthesia described by Klein in 1987 made large volume liposuction safer allowing for more refined body contouring through significantly minimising blood loss. Liposuction journey started as mechanical debulking that evolved over the last 4 decades into a refined high definition body contouring and proportioning surgery, thus making sculpturing a shape of figurine possible. To achieve such high definition body sculpting technology including Laser, and Vaser not only added safety, however, they also achieved outcomes that cannot be matched with the older methods of liposuction, under local anaesthesia. In this chapter we aspire to discuss the journey of how liposuction evolved into body contouring surgery with large volume lipo-aspirates yet more safely.

Keywords: Liposuction, Liposculpture, High definition body contouring surgery, Laser, Vaser, Tumescence, Safety

1. Introduction

Liposuction was described in the 1920s & popularised by Illouz in 1977. He developed smaller diameter blunt cannulas. He developed the wet infusion technique to reduce blood loss, thus adding safety.

Tumescence local anaesthesia described by Klein in 1987 made large volume liposuction safer allowing for more refined body contouring through significantly minimising blood loss without the risk of general anaesthetic. Furthermore the surgery could be carried out as a day case.

Liposuction journey started as mechanical debulking that evolved over the last 4 decades into a refined high definition body contouring and proportioning surgery. Thus making sculpturing a shape of figurine possible.

To achieve such high definition body sculpting technology including Laser, and Vaser not only added safety, however, they also achieved outcomes that cannot be matched with the older methods of liposuction, under local anaesthesia.

In this chapter we aspire to discuss the journey of how liposuction evolved into body contouring surgery with large volume lipo-aspirates yet more safely. We will also share with you our philosophy in patient selection and surgical outcomes.

2. The history of liposuction

Liposuction is defined as a technique in cosmetic surgery for removing excess fat from under the skin by suction. In this section we have focused on the history of evolution of this procedure since its inception, however, we excluded all the techniques, which originated early in the 20th century including excision or curating of adipose tissue [1, 2].

More than 4 decades elapsed when in 1975 a father and son cosmetic surgery team developed the technique of liposuction by introducing a cannula attached to a suction machine. In so doing they produced consistent results with lower risks [3].

Illouz in 1977 innovated modified liposuction blunt end cannulas of smaller diameter. He used cannulas of varied sizes thus extending the technique to the entire body. He injected saline and hyaluronidase into the fat prior to suctioning, allowing for hydro-dissection; hence reducing trauma to other tissues. This was the advent of the wet technique [4, 5].

Although initially the evolution in liposuction was related to the refinement of the blunt end cannulas the surgery was performed under general anaesthetic and in some instance without injecting fluid to hydro-dissect, which lead to significant blood loss in the lipo-aspirate.

The main evolution in the last 4 decades, however, has been with the anaesthesia and the composition of the fluid injected allowing the surgery to be performed under local anaesthetic with sedation and later also excluding sedation. This was popularised by Klein in 1987 using large volumes of very dilute local anaesthetic allowing for larger volume of lipo-aspirate and under local anaesthetic only [1, 2, 6–8].

Klein's infusion mixture included 0.05% Lidocaine, 1:1000,000 epinephrine and 10 mls of 8.4% bicarbonate per litre of saline. He also demonstrated that a large volume of this diluted mixture was safe, however, it also significantly reduced bleeding. Bleeding was a problem when using other techniques [6–8]. The tumescent technique meant less hospitalisation, reduced costs and risks to the patient even for large volumes of lipo-aspirate [9].

Liposuction uses a vacuum pump (a suction machine), however, in 1988 Toledo in Brazil used disposable syringes on which can be fitted blunt end cannulas. This technique allowed for more precision and refinement in liposuction in addition to usability of the fat to transfer. This gave the cosmetic surgeon choice; the vacuum pump assisted liposuction was used for large volumes and for more refined liposuction the syringe system was used [10, 11].

In 2006 laser assisted liposuction using coherent light to deliver energy preferentially targeting fat cells was a new advancement in liposuction surgery. The laser caused rupture of the adipocyte membrane releasing oily content into the extracellular matrix. The laser energy also leads to neocollagen formation and remodelling with reorganisation of the dermis. The fluid produced in this process was then aspirated using blunt end cannulas and a vacuum pump [12, 13].

Ultrasonic liposuction was first introduced in 1992 by Zochhi; it created an alternative to conventional blunt cannulas suction. The aim was to ease the surgeon workload, shorten surgical time, improve results of liposuction, and use smaller cannula, thus reducing tissue trauma and protecting important structures like the neurovascular bundles [14].

The ultrasonic technology required the tumescent technique to combine with the technology for safer outcomes. Titanium probes were used to deliver ultrasonic energy, followed by liposuction.

Refinement of ultrasound energy delivery using VASER technology (vibration amplification of sound energy at resonance), was first reported by Jewell on the clinical application of a third generation ultrasound device that deliver utilised

pulsed low power ultrasound with high efficiency using different size small diameter strong titanium probes [15].

The energy applied to the tissues was approximately one-quarter that of previous devices, while the pulsed mode reduced heat generation. Expanded applications of VASER lipolysis and liposculpture include treatment of the male and female breast, face and neck; fibrous body areas (trunk and back), in addition to combined excisional body contouring procedures of all types [16].

Colombian plastic surgeon Alfredo Hoyos presented a vast improvement in technique in 2003 at a national Colombian meeting. Hoyos innovated the high definition liposculpture HDL [17].

Hoyos elaborated that the nomenclature liposculpture is not simple fat removal, but an artistic approach designed to sharpen the anatomy of the muscles through the skin. VASER high definition liposculpture combines technology and technique unlike mechanical liposuction it reduces trauma to blood vessels, achieve better result, and removes superficial and deep fat. This allows for high levels of finesse in sculpting the human-form three-dimensional anatomy thus sharpening the body muscles details at the same time [17].

3. Infiltration techniques evolution

3.1 The dry technique

Fournier described the dry technique of liposuction in 1983, however, due to the significant volume of blood loss in the lipoaspirate reaching 20-40%, the technique has fallen out of favour [18].

3.2 The wet technique

Illouz introduced this technique and it included infiltrating 200–300 cc of infusate fluid regardless of the volume to be aspirated. The blood loss in the lipoaspirate was reduced to 8-10% [4, 5].

The wet technique evolved by introducing the addition of epinephrine further reducing the blood loss in the infranatant of the lipoaspirate as a result of the vasoconstriction of vessels, this blood loss was 4-8% [19].

3.3 The superwet technique

The superwet technique meant injecting 1 cc of infusion to 1.5 cc of lipoaspirate; Fodor 1986 described this technique. The technique meant the blood loss in the lipoaspirate was reduced to ~1%. [20].

3.4 The tumescent technique

Klein, a dermatologist, introduced the tumescent technique, which lead to significant advances in performing liposuction and later liposculpture including high definition body contouring under local anaesthetic as day cases. The lipocrit was low at 1%, which is not unlike the superwet technique. The tumescent technique was popularised in 1990s [9].

The tumescent infiltration technique uses the skin turgor and its colour change to white as end points on the volume injected in the area of liposculpture, allowing for larger volumes to be removed than other wetting solutions. The infusate to lipoaspirate is usually 2-3:1. It uses a mixture of 50 cc of 1% Lidocaine infiltrated in 1 litre

of normal saline, 1 cc of 1:1000 adrenaline with 10 cc of 8.4% sodium bicarbonate solution, the later helps reduce the pain at infiltration. The pH of normal saline is 5; adding bicarbonate makes it less acidic and leaves less ionised Lidocaine outside the cell for absorption [21].

This means large volume of dilute Lidocaine with concentration of up to 35 mg/kg can be injected into the fat. This is much higher than the toxic doses when injecting undiluted Lidocaine mixture at 7 mg/kg. An added advantage of the tumescent infiltration is decreased need for intravenous fluid replacement [21].

It is of grave importance to consider the estimated volume to be removed when performing aspiration of fat. Hence, in our experience although we use the tumescent mixture of infusate; however, we tend to use infusate to lipoaspirate ration of 1:1, i.e. the superwet technique.

In our experience using the superwet technique equates to less fluid load, lower risks of local anaesthetic toxicity at diluted concentrations of Lidocaine not exceeding 35 mg/kg and limiting the infusate to no more than 4-5 litre for lipoaspirate of 4 litres.

When infusing large volumes and aspirating large volumes for example 3 litres or more one must replace for each ml of aspirated fat ~2 mls of fluid in the first 24 hours. For example in a case of 3 litres injected for 3 litres aspirated; it is estimated that ~20% of the injected fluid will be removed with the lipoaspirate. This will leave 2.4 litres in the extracellular space warranting a total fluid volume replacement of 3.6 litres in the first 24 hours.

It is important to stress that in such large volume lipoaspiration, urine output should be monitored for the first 24 hours, adding safety to the patient management.

4. Progressing from mechanical liposuction to energy delivery liposculpture

Liposuction in a large number of countries in the world is the most popular cosmetic surgical procedure. It is safe with pleasing cosmetic immediate visible results, which improve with the passage of time. In our experience in all liposuction and liposculpture techniques although results are immediate; however, they continue to improve for 6 months following the procedure, and the patients are counselled accordingly.

The evolution of liposuction into liposculpture was facilitated by advancement in technology from the early manual devices using vacuum and blunt cannulas into energy delivery machines including Laser and VASER.

4.1 Mechanical liposuction (SAL)

The 1980s and 1990s saw the introduction of three types of mechanical liposuction.

Suction assisted liposuction is a traditional method of liposuction using a blunt small cannula connected to a pressurised vacuum machine. Through a small incision the fluids infiltrated and the cannula inserted to extract the fat by high-pressure vacuum connected through suction tubing made of either polyvinylchloride or silicone [22].

The suction pump has two different performance diameters, maximum vacuum and maximum flow rate. The canisters come in different sizes from 250 ml to 3000 ml and can be reusable or disposable. Big choice of suction cannulas with different sizes, different function and all are reusable [22].

The procedure can be done under local anaesthetic depending on the area treated. It is less tiring than the syringe liposuction and faster for the surgeon to remove fat, however, it risks trauma to blood vessels and nerves.

Although (SAL) can remove the superficial fat, this comes at higher risks to the skin and its blood supply. Bruising and potential of longer recovery are also risks that have to be considered in this technique.

4.2 Syringe assisted liposuction (SaL)

Syringe liposuction technique (SaL) with blunt cannulas to extract the fat by syringe generated negative pressure and the syringe is single use [23].

The syringe technique can be slow and tiring for the surgeon to treat large areas. That is why it is recommended in treating small areas [23]. One of its advantages; it can be done under local anaesthetic as a day case or even an outpatient surgery.

The syringe technique is safe procedure; however, it has limitations. These include difficulty extracting superficial fat in addition to being challenging in treating secondary liposuction because of the resistance as a result of scar tissue [23].

4.3 Power assisted liposuction (PAL)

PAL implements either circular or reciprocating quick movements cannulas to aspirate fat. Mechanical cannula extracts the fat with small incision and shorter surgical time making it less tiring [24].

The power assisted liposuction technology was getting very popular for fat extraction and body contouring procedures. The vibrating cannula during the fat extraction makes it easier and less challenging in extracting more fibrous fat [24].

The power assisted liposuction technology has improved the surgeon's experience especially in large volume liposuction, fibrous areas, secondary work including in more superficial tissue planes. Surgeons fatigue and time is decreased during the procedure thus speeding the rate of fat extraction delivering good results for patients wishing body contouring [25].

Added benefits of PAL include intraoperative pain reduction, less swelling, and faster recovery. Fat harvested is 45% faster compared to suction assisted liposuction and syringe liposuction [26].

Another advantage of PAL is using the medinorm self-contained tank and the tubing system that guarantees the sterility. The whole system is latex free, and the harvested fat is less bloody than the manual liposuction and almost pure yellow colour making it useful for fat transfer [27].

In summary the PAL system is a convenient, fully sterile, time saving method to aspirate fat in various part of the body. This fat can also be used to transfer in other parts of the body. Furthermore donor site morbidity is minimised; and as time is saved it becomes less tiring for the surgeon and safer for the patient.

5. Energy delivered liposculpture (EDL); compared to traditional liposuction

The revolution of power-assisted liposculpture has changed both surgeon and patient's life. Over the last 20 years two energy delivery technology were invented released on the market. Energy delivery is divided into Laser and Vaser technology.

6. Laser and the Vaser systems

6.1 Laser lipolysis (LL)

Laser lipolysis technology was popularised following studies on the interaction between the laser and adipose tissue [28]. Laser assisted liposuction technology is one of the most advanced treatment of lipodystrophies and irregularities of adipose tissue. The laser beam preferentially targets the adipose tissue with which it keeps a direct contact [28].

Laser action causes the breakdown of the adipocyte membrane and releases the oily content into the extracellular fluid. It can cause neocollagen formation and remodelling with reticular dermis reorganisation [29, 30].

Laser technology has advantages and disadvantages compared to traditional liposuction and other energy delivered technology. The most common advantage is patient's quick recovery. Due to liquefaction of the fat and small laser probe size; less effort from the surgeon warranted to melt and remove the fat.

Some surgeons when treating small areas like submental, knees, thighs avoid aspirating the melted fat, further limiting direct tissue trauma. An important advantage seen in the early postsurgery stage is skin tightening related to laser energy delivery [31, 32]. Disadvantage of laser-assisted lipolysis is that the fat cannot be used for transfer following extraction. Skin burns have also been reported with Laser use [31, 32].

6.2 VASER liposculpture (VLs)

VASER energy delivery technology enabled the surgeon to melt, debulk large areas of fat including superficial fat layer, therefore creating high definition of muscles around the body (abdomen, back, arms and legs). It is imperative to avoid over-resection of fat and spare 1 cm of fat thickness from the deep dermis to avoid deep tissue scarring and irregularities [33, 34].

A Colombian plastic surgeon, Alferdo Hoyos, developed a significant improvement in the Vaser liposculpture technique adding a new approach to body contouring. He termed this High Definition Liposculpture (HDL). Dr. Hoyos defined his technique not just as a simple liposuction or fat removal, but as an artistic approach to sculpt the body and define the surface anatomy.

Vaser body sculpture technology allows the surgeon to go well beyond the simple fat removal of fatty bulges, and to use it as a sculpting tool to create the ideal profile [35].

VASER and high definition liposculpture allows great cosmetic outcomes with reduced trauma to the soft tissue and blood vessels. VASER assisted HDL breaks down the fat and allows it to be prepared for the surgeon to sculpt muscular anatomy in great details through gentle extraction aspiration, which cannot be achieved with traditional liposuction [36–38].

The combination of VASER and HDL can be challenging and more time consuming than traditional liposuction. It is important to keep in mind that VASER technology as in Laser technology adds one extra stage when compared to traditional liposuction; the emulsification of fat. High definition Three-dimensional sculpting, however, adds yet a further step namely the removal of the superficial fat [39].

Combining VASER with power assisted liposculpture-using Microair or Power-X systems atraumatically debulk the fat making it a less effortful and safer task [40]. Another advantage of the Vaser is the safety of the superficial emulsification and extraction of the fat from the subdermal lamellar layer to define relevant anatomy

for each muscle group. As the subdermal plexus of vessels is not significantly affected with VASER or the PAL system, this in our opinion is a major component in safeguarding the skin blood supply allowing for further refinement in superficial fat extraction and three-dimensional body sculpting.

Vaser liposculpture technology, however, is time-consuming when used for treating large areas. Hence, we recommend it to be performed by an experienced team, and perhaps when possible more than one team working in harmony. Having an experienced team/teams adds safety, reduced surgical time, reduces surgeon's fatigue and makes for excellent patient outcomes.

It must be taken into consideration in all the techniques described in the sections above, that patient's selection is crucial in achieving the best results as much as the surgeon's experience and skills are of profound importance.

6.3 Our philosophy and liposculpture

Body contouring and three-dimensional sculpture surgeons are a self-selecting group who aspire to achieve excellence. This a commonality shared with artists who create 3 dimensional figurines.

It is important not to be bogged by the different names given to three-dimensional sculpturing of a human figure; however, the emphasis should be put on patient selection, safety, developing and refining skills. Embracing new advances in technology, is important, however, must come with appropriate training keeping patient safety at all times. We as plastic surgeons must stay true to form, and aspire to achieve more yet maintain a high level of safety and excellence in clinical outcomes.

Our philosophy is simple we use the relevant technology from traditional mechanical liposuction to energy delivery liposculpture based on what the patient and we wish to achieve.

For small areas like in submental fat removal we favour traditional syringe liposuction with fine cannulas (**Figure 1**).

When it comes to debulking and three-dimensional liposculpting we favour combining VASER, and a power assisted devices including Power-X and/or Microair for a safe, time efficient and excellent body contouring cosmetic outcomes (**Figures 2 and 3**).



Figure 1.
A 57-year-old female underwent syringe liposuction with 2 mm cannula for her neck. The figure shows preoperative and 3 months postoperative results.



Figure 2.
A 36-year-old female BMI 28 underwent VASER body contouring and liposculpture. Figure shows preoperative and 7 months postoperative results.



Figure 3.
A 38-year-old female patient, BMI 29.5 underwent VASER body contouring, and body sculpture. The figure shows preoperative and 6 months postoperative results.

More importantly we perform a large number of the cases under local anaesthetic with or excluding sedation. This facilitates a quicker patient recovery, removing the risks of general anaesthetic yet maintaining a high level of safety.

Our choice of infiltration is normal saline 1 litre, 50 mls of 1% Lidocaine, 1:1000 1 mg of adrenaline with 10 mls of 8.4% bicarbonate to reduce the acidity of the local anaesthetic and normal saline. Tranexamic acid one gram is given intravenously 30 min prior to surgery and 4 hours after induction to reduce bruising, bleeding, and possible haematomas post op. The total dose of Tranexamic acid for the first 24 hours is 2-3 grams.

We use a ratio of infusate to lipoaspirate of 1:1, effectively the superwet technique, however, using a tumescent fluid mixture and we allow for 15-20 minutes of time prior to commencing the treatment. Accepting that BAAPS, ASPS, ASAPS limit the lipoaspirate volume to 5 litres per session; however, in our practice and based on our philosophy and experience we limit the lipoaspirate to 4 litres in any one sitting for safety reasons with an infusate of up to 4 litres. Hartmann's solution is another choice for the infusion mixture instead of normal saline as it is less acidic with a lesser sodium load thus reducing fluid overload in large volume liposuction. We do not exceed a Lidocaine dose of 35 mg/kg and we do not exceed an adrenaline dose of 0.07 mg/kg.

7. Patient selection and peri-operative management

We consider the BMI is one of the main factors in patients' selection and the choice of surgery to achieve safest and best results. We adhere to a BMI of 30 kg/m² or less for liposuction and body contouring. For high definition body contouring and three-dimensional sculpting our choice of BMI is 26 kg/m² or less. The patients are ASA I-II (American Society of Anaesthetist classification); smoking must stop 4 weeks before surgery, and 3 weeks after. Non-steroidal anti-inflammatory drugs must stop usually 48-72 hours before surgery.

We ask patients to stop certain herbals, which increase bleeding 2-3 weeks prior to surgery. The combined contraceptive pill and HRT are stopped 4-5 weeks before surgery and not commenced for 3 weeks after. All patients undergoing abdominal contouring undergo pre-operative ultrasound investigation.

TED stocking are used to reduce risk of deep vein thrombosis in addition to intraoperative compression boot in all cases. In long procedures low molecular weight heparin is used until the patient is deemed fully mobile.

Seamless compression garments are used in all liposuction patients; however, when we perform three-dimensions high definition liposculpture we add appropriate soft padding to help maintain the contouring where it was created. The garments are worn for 4-6 weeks. The patients also undergo manual lymphatic drainage for the first 3 post-operative weeks.

Since COVID-19 pandemic the patient is asked to shield with the appropriate period, which differs between countries and a PCR antigen test carried out 2-3 days prior to surgery. Following the surgery we ask the patient to shield for a period of 10 days too.

If the patient has been vaccinated then we allow 10 days prior to surgery; however, if the patient has a positive COVID-19 test we defer the surgery for a minimum of 8-12 weeks and repeat the PCR test.

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