PROCEDURES IN COSMETIC DERMATOLOGY
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11 Ultrasound–assisted Lipoplasty

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INTRODUCTION AND HISTORY OF THE PROCEDURE

Traditional suction-assisted lipoplasty (SAL) refers to a minimally invasive technique for removing fat in reconstructive and aesthetic surgery. Over the last several years, liposuction has consistently ranked as the most frequently performed cosmetic procedure. While liposuction is extremely popular, there is much interest in altering elements of the technology as well as developing new technology to make the procedure safer for patients and more effective, more predictable, and less fatiguing for the surgeon (Box 11.1).

Ultrasonic systems have been used for more than 25 years in many surgical procedures, including cataract surgery, neurosurgery, and general surgery. In the late 1980s and early 1990s Scuderi and Zocchi pioneered the application of ultrasonic energy to fat emulsification and removal. The objective of applying ultrasound technology was to increase the tissue selectivity, making the aspiration more 'fat-specific'. This technique is referred to as ultrasound-assisted lipoplasty (UAL). Ultrasound applied internally to fat breaks down fat cells by three separate mechanisms:

1. Ultrasonic lysis of cells and micromechanical damage caused by these sonic pulsations
2. Microcavitation phenomena, whereby expansion of cellular components proceeds until cells rupture, releasing their contents into the extracellular milieu
3. Conversion of ultrasonic energy and forces of friction into heat, which is transferred into the surrounding tissues

The first-generation UAL device was produced by the SMEI Company of Italy. It consisted of smooth, solid probes operating at a frequency of 20 kHz. In response to the introduction of this new technology, a joint task force of the American Society for Aesthetic Plastic Surgery, the American Society of Plastic and Reconstructive Surgeons, the Lipoplasty Society of North America, the Aesthetic Surgery Education and Research Educational Foundation, and the Plastic Surgery Educational Society, convened on September 7, 1995 to evaluate the merits, safety, and efficacy of ultrasound-assisted liposuction. The Ultrasound-assisted Lipoplasty Task Force reviewed all of the literature on UAL, and came to the following conclusions:

- UAL was safe in the hands of trained practitioners
- UAL had to be carried out in a wet-tissue environment
- Practitioners need to protect the skin entrance of the cannula against burns due to friction
- Cannula passage should be slower and more deliberate than typical of suction-assisted lipectomy
- With superwet or tumescent infiltration, blood loss was minimized
- If the cannulas are not kept in constant motion or removed immediately from the patient, burns can occur
- Ultrasound-assisted lipectomy may produce superior results in comparison to conventional aspiration in areas of fibrous adipose tissue
- In obese patients, a greater volume of fat can safely be removed with UAL vs conventional suction lipectomy
- UAL may produce less user fatigue than traditional suction lipectomy
- UAL is not a replacement for traditional suction-assisted lipectomy
- A learning curve exists between UAL and traditional liposuction techniques
- As with traditional liposuction techniques, close proximity of the cannula tip to the dermis must be avoided to help prevent postoperative skin sloughing.

Given these findings, the Task Force offered teaching courses consisting of both didactic and hands-on training.

UAL continued to improve with the availability of two new devices in the late 1990s. These are the LySonix 2000 and the Mentor Contour Genesis. The LySonix system operated at a frequency of 22.5 kHz and utilized a hollow cannula that emulsified and immediately aspirated the fat.

Box 11.1 Historical development of ultrasound-assisted lipoplasty

- 1950s: Balamuth describes the use of ultrasonic instruments for removal of dental plaque
- 1969: Kelman applied vibrating metal probe to phacoemulsification surgery
- 1974: Cavitron ultrasonic surgical aspirator (CUSA) applied to neurosurgery for tumor removal
- 1980s: Ultrasonic instruments developed for cutting and coagulation use in laparoscopic surgery
- 1990s: Scuderi and Zocchi pioneered the application of ultrasonic energy to fat emulsification and removal
- 1990s: First-generation UAL device produced by the SMEI Company, Italy; frequency 20 kHz
- 1995: Ultrasound-assisted Lipoplasty Task Force confirms safety of UAL and establishes guidelines for training
- 1990s: Second-generation UAL devices Mentor Contour Genesis (27 kHz) and LySonix 2000 (22.5 kHz) produced
- 2001: Third-generation UAL Vibration Amplification of Sound Energy at Resonance (VASER) (37 kHz) produced by Sound Surgical Technologies
- 2002: Jewell reported that the pilot clinical study showed VASER-assisted lipoplasty (VAL) was superior to second-generation devices
- 2000s: Multiple authors and speakers report on expanded use of ultrasonic devices

The Mentor system operated at a frequency of 27.0 kHz and used a hollow cannula system similar to the LySonix. These are referred to as second-generation devices. While an improvement over the SMEI device, there were several issues with these second-generation devices. The probe tips were significantly larger than the suction cannulas, therefore requiring incisions up to 1 cm. The probes were somewhat inefficient, generating excessive heat which can be attributed to post-procedural seromas and burns. Finally, simultaneous aspiration may remove the wetting solution, which does function to buffer the heat generated by the device.

In 2001, a third-generation ultrasonic system was introduced by Sound Surgical Technologies. This device is referred to as the VASER for Vibration Amplification of Sound Energy at Resonance (Fig. 11.1). VASER-assisted lipoplasty (VAL) has minimized and/or eliminated known complications from the earlier generations of UAL devices. The VASER system operates at a frequency of 37.5 kHz. VASER utilizes small-diameter solid probes (2.2–3.7 mm) with a grooved tip design (Fig. 11.2). This design offers increased efficiency when compared with previous probes, resulting in greater tissue specificity and decreased collateral tissue damage (Fig. 11.3). The grooved design allows for better control of the ultrasonic energy to effectively target soft, medium, and fibrous tissues. Different diameter probes provide versatility for precisely emulsifying small volumes of fat in delicate areas or rapidly debulking larger volumes (Fig. 11.4). VASER also introduced the concept of pulsed delivery of ultrasonic energy. This reduces the amount of energy delivered to the tissue by as much as 50% compared with first- and second-generation devices (Fig. 11.5). Finally, the VASER system

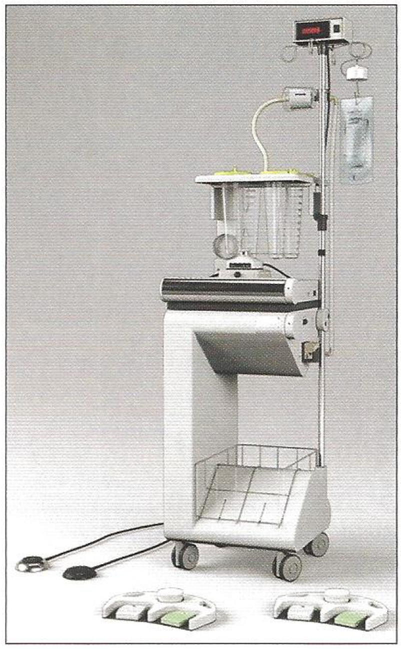

Figure 11.1 VASER System (Courtesy of Sound Surgical Technologies LLC)

Figure 11.2 LySonix 2000, Mentor Contour Genesis, and VASER probes

Figure 11.3 Tissue selectivity of ultrasonic energy (Courtesy of Sound Surgical Technologies LLC)

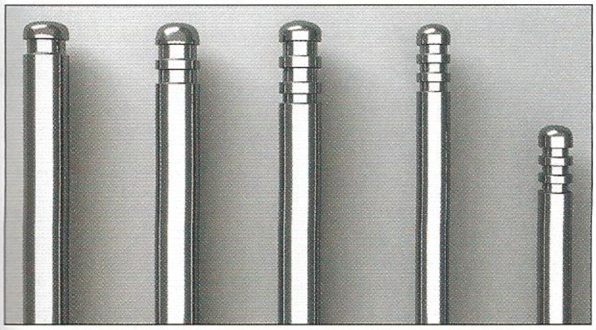

Figure 11.4 VASER grooved probes (Courtesy of Sound Surgical Technologies LLC)

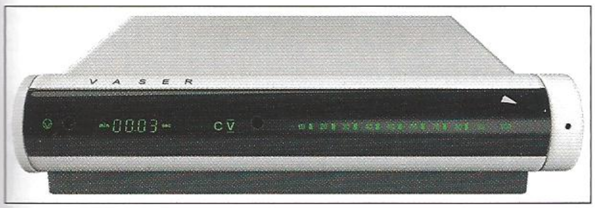

Figure 11.5 VASER console unit (Courtesy of Sound Surgical Technologies LLC)

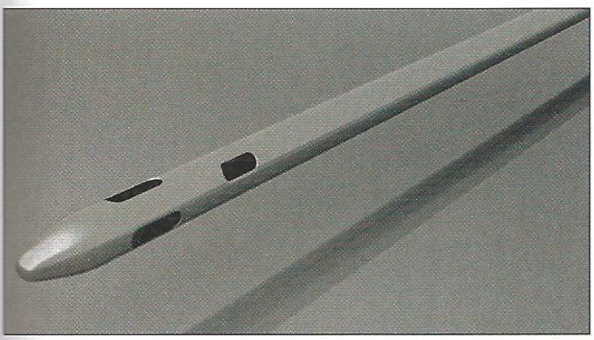

Figure 11.6 VentX aspiration cannula (Courtesy of Sound Surgical Technologies LLC)

offers balanced-ported cannulas which are less aggressive, resulting in decreased bruising and post-procedural pain, as well as quicker aspiration of the emulsified fat (Fig. 11.6). Currently, approximately 20% on liposuction procedures are performed ultilizing ultrasonic energy.

• Indications

UAL is indicated for use in all primary lipoplasty procedures. In particular, it has proven to be especially useful in areas of dense or fibrotic tissue. Improvements in technology provided by the VASER system have also expanded its use to delicate areas once felt to be off-limits to UAL, such as the face, neck, arms, and knees. In addition, it has expanded the use of liposuction to procedures that previously required excisional surgery. Some authors and users have reported greater skin tightening with UAL compared with SAL. A recently performed contralateral study showed statistically significant skin retraction with VAL compared with SAL. The technique has seen a wide range of applications including cervicofacial rejuvenation, aesthetic body contouring, Madelung's disease, Cushingoid-related 'buffalo-hump' deformities, HIV-associated lipodystrophy, revision of free flap reconstructions after fat necrosis, and gynecomastia, and minimal scar breast reductions.

• Patient selection

As with all aesthetic surgery, proper patient selection is vital in obtaining a successful result in lipoplasty, whether SAL or UAL is utilized. The ideal candidates include younger patients with good skin tone, minimal history of weight fluctuations, and adequate nutritional status. In these patients, good to excellent results are predictably obtained. Poor candidates for lipoplasty procedures include older patients with loose skin, the massive weight loss patient, the patient with stretch marks, and an inadequate nutritional status. These individuals are best served with excisional surgery to obtain the best results.

There is another group of patients which does not exactly fit into one of these two well-defined groups of patients. This group has excess fatty tissue and questionable skin quality. This skin laxity may be due to age, fluctuations in weight, pregnancies, or sun damage. Prior to UAL, most of these patients required standard excisional procedures to obtain the best outcomes. UAL and particularly VAL have expanded the criteria for liposuction candidates and changed the way these patients are approached. As a result of improvement in skin retraction attributable to the ultrasonic energy, these individuals may need smaller scars and in some cases no excisional component to procedures. In addition, VAL is more frequently combined with excisional surgery.

OPERATIVE TECHNIQUE

• Preoperative preparation

PREOPERATIVE PHOTOGRAPHS

Preoperative photographs should be taken of all patients. These are important in planning the procedure. Preoperative imaging techniques are very useful in ensuring a patient has realistic expectations of the procedure. These photos should be displayed in the operating room as treatment areas tend to become distorted without the effect of gravity. Finally, these preoperative photos as well as the postoperative photos can be used to accurately demonstrate the result of the procedure to the patient and can be extremely useful as a learning tool for the surgeon.

MARKINGS

Preoperative markings are made with the patient in the standing position, so that the effects of gravity can be appreciated, and that the surgeon has 360° access for assessment and marking. Typically, curvilinear markings are used to denote the topography and contour of the areas to be addressed. Pre-existing contour irregularities are identified and marked. Markings should be as detailed as possible, as problem areas may disappear when the patient is placed on the operating table and the effect of gravity is no longer present. The planned access incisions are marked in locations that will allow for maximal coverage of the treatment area. The use of ultrasonic energy has decreased the need for cross-tunneling and reduced the number of required access sites. With the VASER probes' relatively small diameters, the access sites are similar in length to those used in traditional SAL procedures. When placing bilateral access sites in the same treatment area, such as the epigastrium or upper back, the sites are slightly staggered to avoid scars located in the same horizontal line. Scars located along the same horizontal line tend to draw more attention. Finally, the patient is asked to confirm the areas marked are correct and any changes can then be made.

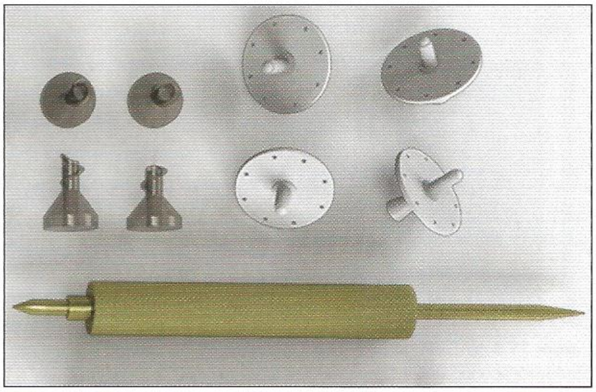

Figure 11.7 Skin protectors (top left). Skin protectors for delicate skin (top right)

Figure 11.8 Emulsified fat collected from port site, fat collected from aspiration

PATIENT POSITIONING

Once situated on the operating table, the patient is positioned appropriately with areas of pressure identified and padded. The patient is positioned for ease of access to the areas to be treated, which may require stirrups, armboards, beanbags, pillows, etc. In some cases, repositioning from prone to supine may be necessary, with re-prepping and draping. Once positioned, the entire areas to be addressed are prepped thoroughly, and draped widely so that the surgeon has an adequate vantage point from which to judge symmetry, contour, and overall effectiveness of the procedure. In unilateral cases, the contralateral side should also be prepped and exposed in the surgical field to ensure symmetric results. Preoperative photos should be placed nearby for easy and frequent reassessment of the patient's initial appearance. Prior to making the incisions, the access sites should be reassessed to verify the probes and cannulas can be passed in the correct vectors without obstruction by the armboards, table, or other operating room equipment.

• Technique

Ultrasound devices are used following the infiltration of the wetting solution. Care is taken to protect the skin at the access site by using a skin port (Fig. 11.7). With the VASER system, the appropriate-sized probe is chosen: larger-diameter probes for larger volume areas and smaller ones for smaller areas. In addition, the number of grooves on the probe is chosen: one groove for fibrous tissue; three grooves for the least fibrous fatty tissue. A power setting is chosen based on the type of tissue and proximity to the skin. The probe is passed through the area to be treated evenly and in a slow fluid motion. The probe is passed from the deeper tissue to the more superficial tissue. Care should be taken to continuously move the probe and to avoid direct end contact with the dermis. The probe should be passed through the tissue until a lack of resistance is noted. A safe rule is to apply the ultrasonic energy for no longer than 1 min for each 100 mL of wetting solution used. Once a surgeon becomes experienced with the ultrasonic device, the amount of time can be increased safely.

When skin retraction is a major concern the power settings may be lowered, the ultrasound device placed in the pulsed mode, and the probe passed just beneath the dermis. This technique will assist in maximizing skin retraction and avoiding complications.

Following application of the ultrasonic energy, aspiration is performed in standard fashion. The surgeon will find increased ease in aspirating, less fatigue, quicker aspiration of similar volumes when compared with SAL, and a decreased need for cross-suctioning (Fig. 11.8).

RESULTS

• Complications: prevention and treatment

UAL has all the complications seen with traditional liposuction, as well as several unique to the ultrasonic energy. Reported complications of UAL include: seroma, induration, alteration in sensation, burns (access site), distant burns (end hits), skin necrosis, cellulitis, pigmentary changes, and prolonged swelling. A review of the literature showed second-generation devices to have a 7.9% complication rate. A pilot study of the third-generation VASER device which included 77 patients showed no complications. Several steps can be taken to minimize the complications associated with ultrasonic energy. Ensuring adequate and uniform tumescent infiltration prior to beginning the lipoplasty can decrease the incidence of thermal injury, as well as help the surgeon obtain uniform contour correction, reduce bleeding, postoperative bruising, and fluid shifts. Seroma is minimized by proper patient selection and by avoiding longer applications of ultrasonic energy in susceptible areas. Gingrass found the abdomen to be the most common site of seroma formation and there was a trend towards longer ultrasound application in abdominal seromas. She theorized that this could be the result of the greater denudation of fat from fascial surfaces with prolonged ultrasonic energy application, with subsequent development of seroma. Compressive garments and possibly early use of prescription-strength NSAIDs may also decrease the risk of seroma formation.

Despite the additional potential complications, UAL is considered a safe procedure with an associated low risk of serious complications (**Fig. 11.9**).

• Postoperative care

Postoperative care of the UAL patient is similar to that of the traditional liposuction patient. The access sites are loosely approximated with one or two sutures, allowing for drainage of fluid. The access sites are covered with ABD pads to absorb the draining fluid. A compressive garment is applied on the operating room table. All patients are seen in the office on postoperative day 1. The compressive garment is removed and the patient is examined for signs of seroma, hematoma, and marks caused by the compressive garment itself. If marks are seen, the garment is adjusted if possible; otherwise it is removed. It is recommended that the compressive garment be worn 24 h a day for the first 2 weeks, then daily during their most active time for the next 2 weeks. Lymphatic massage is offered weekly, beginning 2 weeks following the procedure. Patients are counseled that they will not see their final result for 2–3 months following the procedure. The patient is instructed to limit physical activity for 2 weeks following the procedure. Physical activity such as exercise and heavy lifting can usually be resumed 4 weeks after the procedure. Of course, close follow-up with the surgeon is important to help identify or prevent potential complications.

CONCLUSIONS

As a result of UAL, and in particular the advancements of VAL, additional applications of liposuction are now considered. VAL used in combination with excisional surgeries such as brachioplasties, thighplasties, abdominoplasties, and even rhytidectomies result in superior results. VAL has also been used to 'down-stage' certain procedures. For example VAL of the breast combined with excisional surgery has allowed for decreased scarring by converting a vertical breast reduction to a periareolar reduction (**Fig. 11.10**). Hoyos and Millard have developed a high-definition procedure which utilizes a multiplanar application of the VASER to enhance skin retraction and regional muscle group definition. Additionally, the technology is being applied to fat harvesting for autologous fat transfer. Ultrasound-assisted lipoplasty has been shown to be a safe technology that consistently obtains excellent results.

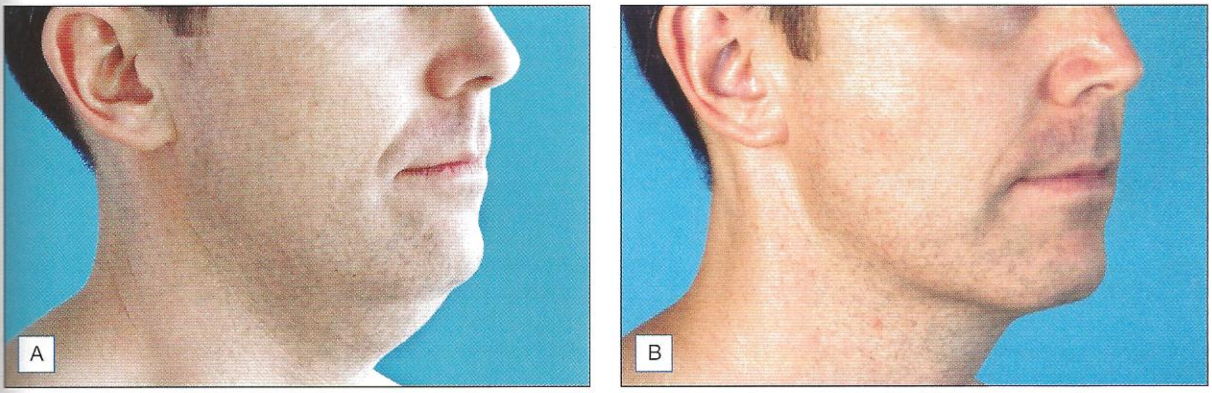

Figure 11.9 Preoperative **(A)** and postoperative **(B)** photos; VAL on the neck. (Courtesy of Tanya Atagi MD and Sound Surgical Technologies LLC)

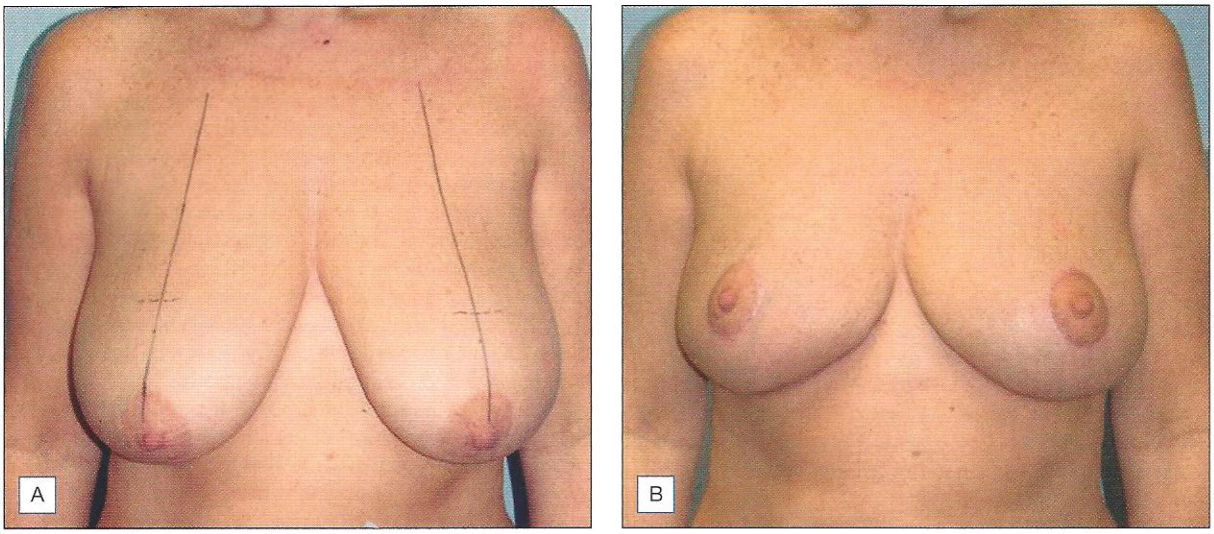

Figure 11.10 (A) Preoperative and **(B)** postoperative photos. 'Down-staging' breast reduction to periareolar

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