Body Sculpting Surgery: Technologies and Techniques

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'Lipoplasty' is the all-encompassing term that refers to body contouring by sculpting or removal of fatty tissue. The major groups of different technologies and techniques for lipoplasty are described below, along with a short assessment of their respective advantages and applicable volume considerations.

Suction-Based Technologies
- Liposuction or Suction-Assisted Lipoplasty (SAL)
- Power-Assisted Lipoplasty (PAL)

Ultrasound-Based Technologies
- Internal Ultrasound-Assisted Lipoplasty (IUAL)
- VASER-Assisted Lipoplasty (VAL)
- External Ultrasound-Assisted Lipoplasty (EUAL)
- Transdermal Ultrasound-Assisted Lipoplasty (TUAL)

Laser-Based Technologies
- External Laser-Assisted Lipoplasty (ELAL)
- Internal Laser-Assisted Lipoplasty (ILAL)

Chemical-Based Technologies
- Mesotherapy

Suction-Based Technologies

Liposuction/Suction-Assisted Lipoplasty (SAL)

Liposuction, with all of its many variations, is the predominant form of body contouring surgery today. These variations include liposculpture, tumescent liposuction, suction lipectomy, syringe lipoplasty, and micro-cannula technique. All of these suction-based techniques can be included in a general category commonly referred to as Suction-Assisted Lipoplasty, or 'SAL'.

SAL is a two-step process that requires the infusion of a wetting solution into the fatty tissues followed by the insertion of a suction cannula that is attached to a suction source. The cannula avulses (tears) and aspirates the fatty tissue fragments which are deposited into a waste canister.

This technology has been around in basic form for more than 30 years and has undergone improvement and refinement during that period. Major advances for the SAL technique include the introduction of the side-ported cannula, the introduction of wetting solutions with drugs for pain and control of bleeding, and overall reduction in cannula size.

Suction-based technologies are not tissue selective. Any tissues, such as nerves, vessels, or collagen structures in the fatty layer that get pulled into the ports on the suction cannula will be torn or avulsed. The technology is reliable, and has been used and studied extensively.

SAL has been used for small to very large volumes of fat removal in lipoplasty.

Power-Assisted Lipoplasty (PAL)

Power-Assisted Lipoplasty (PAL) is essentially a liposuction cannula (SAL) with the addition of a motor-driven reciprocating handle. The primary advantage of this technology is that it makes passage of the suction cannula through the tissues easier for the surgeon but represents no clinical improvement in outcomes or safety relative to SAL for the patient[1].

Surgeons may develop arthritis, ulnar palsy, or carpal tunnel syndrome as a result of the motor-induced vibration[2]. Like SAL, PAL is not tissue selective – any tissues, such as nerves, vessels, or collagen structures, in the fatty layer that get pulled into the ports on the suction cannula will be torn or avulsed.

PAL is generally used for medium to large volumes of fat removal in lipoplasty as it may be too aggressive for smaller, more delicate areas.

Ultrasound-Based Technologies

Internal Ultrasound-Assisted Lipoplasty (IUAL)

Internal Ultrasound-Assisted Lipoplasty (IUAL) uses an ultrasonically vibrating cannula to emulsify (liquefy) adipose tissue during the aspiration process. IUAL technology was introduced with the promise that the ultrasonic technology would provide a level of tissue selectivity due to the emulsification process and thereby improve outcomes relative to those obtained using SAL. However, clinical experience and outcomes with IUAL vary considerably. Some surgeons report no significant clinical change in outcomes[5,6]. Some surgeons report an improvement in outcomes[3,4]. Others report increased complications or tissue damage relative to SAL[7]. This wide variation in results is in large part explained by the design of the technology which aspirates protective fluids/ tissue while the ultrasonic energy is active, by application of excess power to the tissues, and by the initial insufficient clinical understanding of the technology, all of which prevented consistent and uniform effectiveness[9].

IUAL is called internal UAL to differentiate it from external UAL (EUAL, explained below). Most IUAL is a two-step process similar to SAL: infusion of a wetting solution into the fatty tissues followed by a combined emulsification and aspiration phase using a hollow ultrasonically powered cannula.

IUAL has been used generally for medium to very large volumes of fat removal in lipoplasty as it may be too aggressive for smaller, more delicate areas.

VASER®-Assisted Lipoplasty (VAL)

VASER-Assisted Lipoplasty (VAL) represents a third-generation internal ultrasound system that incorporates significant design improvements over the previous two generations of internal ultrasound devices.

VASER technology is the ultrasonic component of an integrated lipoplasty system. The VASER System uses small-diameter, solid, multi-ringed probes to deliver a minimal level of ultrasonic vibrating energy to specifically target and emulsify fatty tissues. Smaller diameter probes and pulsed delivery of the ultrasonic vibratory energy further reduce delivered energy by as much as 50% compared to continuous wave ultrasound used in first and second generations of internal ultrasound-assisted lipoplasty[8].

By emulsifying the fatty tissue prior to extraction, aspiration can be performed with less avulsion, and hence less tearing of the tissues. The VAL procedure does not utilize standard SAL to remove the emulsified tissues and fluids - rather, specially designed aspiration cannulae, call VentX® Cannulae, are used to remove the emulsified fluids and minimize avulsion and other tissue trauma associated with standard SAL aspiration devices.

This third-generation ultrasound technology was specifically designed to preserve and spare as much of the tissue matrix as possible, yet still remove the desired amount of fatty tissue. This approach helps minimize post-operative pain and bruising and also addresses the limitations inherent in earlier generation IUAL devices[10,11]. VAL was compared to IUAL in a clinical study and found to significantly reduce potential complications relative to the earlier generations of IUAL[9].

VAL has been used on volumes from the very smallest (face/neck) to very large volumes.

External Ultrasound-Assisted Lipoplasty (EUAL)

External Ultrasound-Assisted Lipoplasty (EUAL) is the application of non-focused ultrasonic energy in the 1-3 MHz range to the skin of the patient prior to the use of standard SAL techniques. The theory is that the externally applied ultrasonic waves disrupt or soften the fatty tissue so that subsequent suction aspiration is easier. However, there has been no scientific substantiation that this additional step, prior to SAL, improves outcomes or safety.

Because SAL is used to remove any fat targeted by the EUAL technique, the outcomes are generally consistent with SAL outcomes. EUAL surgery may involve significantly more time if larger volumes are to be pre-treated with the EUAL device. This technology is not in widespread use today, primarily because the combination of EUAL and SAL has not been shown to be clinically superior to SAL alone.

Because SAL must be used in conjunction with the EUAL device, addressable volumes are the same as SAL, from small to very large, strictly a function of the SAL step.

Transdermal Ultrasound-Assisted Lipoplasty (TUAL)

Transdermal Ultrasound-Assisted Lipoplasty (TUAL) is the application of focused ultrasonic energy directly to the skin of the patient to disrupt the fatty tissue below the skin and does not require removal of the ruptured cells with a suction cannula (SAL). This technology is not currently available for use in the United States, as it has not yet gained Food and Drug Administration (FDA) clearance.

Transdermal ultrasound is a single-step process which involves application of the ultrasonic energy directly to the skin without the prior infusion of wetting solution as required in all other techniques. The body's natural processes remove the damaged tissues over a period of time after the ultrasound application.

This technology is used to treat only small volumes in a single patient visit, on the order of 250–300 milliliters (cc's) per treatment. The treatable volume is limited because this approach requires that the patient's body remove or process the dead or damaged tissue. Because the treated fatty tissues are not removed at the time of surgery, results are not seen until several months after the procedure. Many treatments are required over an extended period of time if more significant volumes are to be addressed.

Laser-Based Technologies

External Laser-Assisted Lipoplasty (ELAL)

External Laser-Assisted Lipoplasty, also called Low-Level Laser-Assisted Lipoplasty, is the application of low-level laser energy to the skin of the patient prior to the use of standard SAL techniques. The theory is that the application of the low-level laser energy causes the fatty cells to produce a transitory pore in their cell membranes, which allows the fat inside the cells to pass to the outside of the cells[12]. This claim was subsequently studied for validation, and results showed that the ELAL therapy did not influence the fat cell structure as reported[13]. This technology is not in widespread use today, primarily because the combination of ELAL and SAL has not been shown to be clinically superior to SAL alone[13].

Because SAL is used to remove any fat targeted by the ELAL technique, the outcomes are generally consistent with SAL outcomes, as are addressable volumes, from small to large, strictly a function of the SAL step.

Internal Laser-Assisted Lipoplasty (ILAL)

Internal Laser-Assisted Lipoplasty (ILAL) uses a small-diameter laser fiber to deliver laser energy directly to the fatty tissues through an incision in the skin. The laser is reported to operate through photomechanical and photothermal effects[15]. In short, these processes cause destruction of cells via coagulation and vaporization due to localized heating and rapid thermal expansion. ILAL was first introduced in the mid to late 1990's[15] and did not gain wide adoption or use. It has been reintroduced and is marketed as SmartLipo™ and Cool Lipo™.

A contra-lateral study comparing SAL on one side of the patient to ILAL (SmartLipo) on the other side of the patient showed no significant difference in outcomes[14]. The American Society for Aesthetic Plastic Surgery issued a guidance statement for this technology stating "Although SmartLipo received FDA clearance in late 2006, alarm bells rang for many experts when discussing this procedure based on the recent publication of data showing that this procedure was no better than traditional liposuction, and that it may present some risks to the liver and kidneys due to the way it releases free fatty acids when destroying the fat cells"[16].

The surgical technique for ILAL is a three-step process: (1) infusion of wetting solution followed by (2) application of the laser energy to the fatty tissue then (3) aspiration of the emulsified tissues using SAL. It has been proposed that the suction phase is not required for ILAL but surgeons are generally not willing to risk leaving the laser-affected volumes of damaged or dead tissue in the body. ILAL is therefore applicable only to small volumes as a standalone technology if no SAL step is used. If ILAL is combined with SAL to remove larger volumes, then outcomes consistent with SAL can be expected[14]. In this case (ILAL with SAL) the laser is used to treat only a small percentage of the removed tissues.

Chemical-Based Technologies

Mesotherapy

Mesotherapy is the use of a large number of injections of non-FDA approved drug mixtures, most often including phosphatidylcholine. The drug mixture is injected directly through the skin and into the fatty layer using several hundred needle injections to distribute the drugs throughout the fatty layer.

The mesotherapy theory provides that the drug mixture causes the breakdown (cell rupture and cell death) of the fat cells, which are then absorbed by the body. The American Society of Aesthetic Plastic Surgery recently released a position statement on mesotherapy which warns patients, stating: "efficacy and safety are not known, the procedure and the drug mixtures are not approved by the FDA, and that the procedure is often offered by unqualified personnel"[17]. Mesotherapy is marketed as LipoDissolve®, LipoStabil®, and LipoShape®.

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