Principles of Ultrasound

BODY CONTOURING WITH THE VASER LIPO SYSTEM

By Mark E. Schafer, Ph.D., FAIUM FASA

Ultrasonic energy has been used for years in a wide array of medical applications – from dentistry to neurosurgery. The introduction of ultrasonic instrumentation for body contouring began in the late 1980s and early 1990s. Researchers began developing the VASER® (Vibration Amplification of Sound Energy at Resonance) System in the late 1990s in response to the limitations of traditional liposuction and other energy-based technologies.

More recently, VASER technology has been demonstrated to be ideal for autologous fat transfer and Adipose Derived Stem Cell applications

The VASER System by Sound Surgical (www.vaser.com) was designed to advance liposuction procedures by improving safety and efficiency, reducing complications and physician fatigue, and allowing for faster patient recovery. More recently, VASER technology has been demonstrated to be ideal for autologous fat transfer (AFT) and Adipose Derived Stem Cell (ADSC) applications.

The VASER Lipo System is a minimally invasive body contouring technology that employs mechanical and acoustic forces to create a suspension of fat cells within a targeted area, while preserving other important tissue structures and maintaining fat cell viability. Fat cells are then removed from the body using proprietary, atraumatic aspiration cannulas, called VentX®, that maximize procedure speed and efficiency while reducing trauma to the surrounding tissue. A new version of the VASER Lipo System specifically adapted for AFT was released in May of this year. This article discusses the basic principles of ultrasonic energy and how that energy is applied to efficiently create fat cell suspensions with minimal tissue damage and maximal fat cell viability.

BASIC ULTRASOUND TERMINOLOGY AND APPLICATION

Sound is a mechanical vibration or pressure wave that travels through media. Sound travels in waves of higher and lower pressure. The high pressure (compression) and low pressure (rarefraction) regions alternate as the wave travels. Compression causes particles to be pushed closer together, while rarefraction pulls the particles away from one

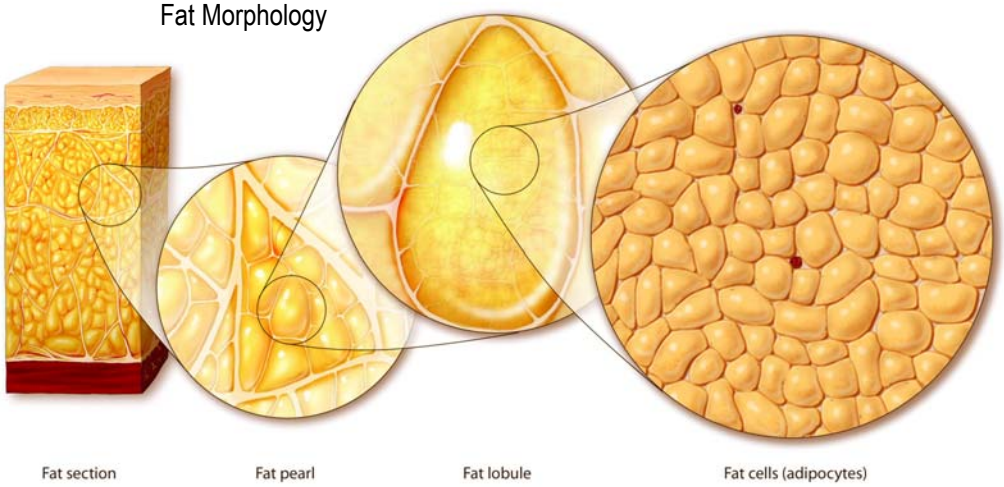
another. This causes the individual particles to vibrate back and forth in place. The amplitude of the vibration and acoustic energy can be controlled on the VASER Lipo System for specific body contouring applications.

Sound waves are characterized by their frequency, or the number of times the pressure wave oscillates back and forth per second. Ultrasound waves are sound waves that vibrate at frequencies greater than what can be detected by human hearing. The VASER System vibrates at a frequency of 36 kHz (36,000 cycles per second).

FAT MORPHOLOGY

Individual fat cells are contained within larger groups of cells that comprise fatty tissue. Fat cells are part of fat lobules, which are part of fat pearls, which are contained within fat sections, which are within fat compartments. Since fat cells have the ability to change dramatically in size (from 20 to over 200 microns in diameter as a person gains weight), they are bound together relatively loosely compared to muscle, fascia, nerves and blood vessel cells. During body contouring with VASER Lipo, a tumescent fluid is infiltrated throughout the targeted fatty tissue area. The tumescent fluid naturally contains small gas bubbles on the order of 5 to 10 microns. As the fluid is infiltrated, the microbubbles become dispersed throughout the tissue matrix. Due to the relatively loose packing of the fatty tissue, the tumescent fluid surrounds the fat cells, allowing the gas bubbles to infiltrate between individual cells. In contrast, the tight junctions between cells within blood vessel walls and connective tissues prevent gas bubbles from interspersing among and affecting these tissues.

Fat Morphology



Ultrasound Energy

- Sound is a vibration or pressure wave traveling through media
- Sound travels in waves of higher (compression) and lower (rarefaction) pressure
- Sound waves are characterized by their **Frequency**: the number of times the pressure wave oscillates back and forth per second
- Unit of measure is the **Hertz (Hz)**: the number of cycles per second
- **Ultrasound** waves are sound waves vibrating at frequencies greater than what can be detected by human hearing, which is about 18 kHz (18,000 Hertz) and higher
- The VASER System vibrates at a frequency of 36 kHz, or 36,000 cycles per second

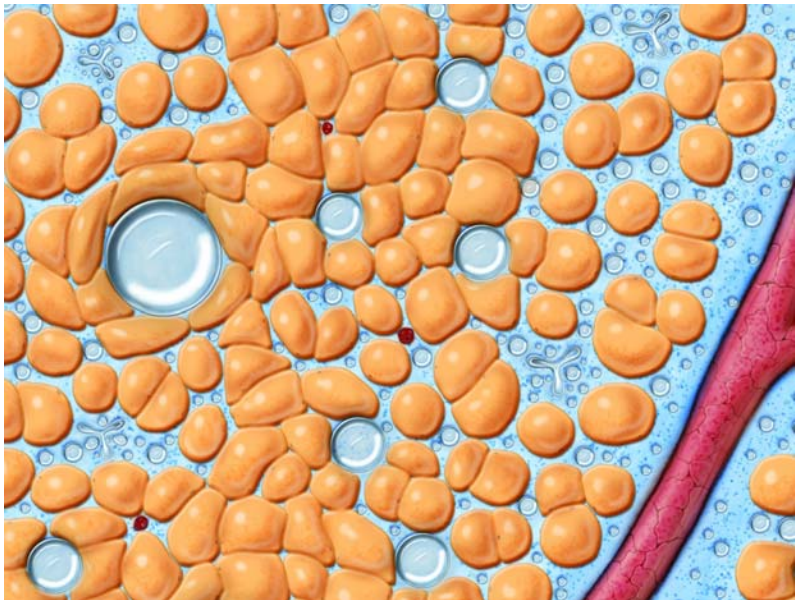
ULTRASOUND EFFECTS

As described earlier, the VASER Lipo System delivers ultrasound pressure waves at 36 kHz via a titanium probe. These waves produce a push/pull force on the dispersed gas microbubbles found in the tumescent fluid. As the pressure wave pulls on the microbubbles, they expand, increasing their surface area and allowing additional gas dissolved in the fluid to enter by diffusion.

The pressure wave next compresses the bubble, causing some of the gas to diffuse back out. Since the bubble is smaller when compressed, less gas diffuses out during compression than diffuses in when the bubble is under tension. Thus, with the passage of every ultrasound wave, there is an overall net increase in the volume of the gas bubble.

This diffusion action causes the microbubbles to rapidly expand to approximately 180 microns, allowing the bubbles to act as wedges between the fat cells, dislodging the cells from the adipose matrix. Once the bubbles reach their resonant size, they implode, pulling on and further loosening the fatty tissue matrix. The progression then starts over again.

This process of gas bubble action is called stable cavitation. Since adipose cells contain no gas, *ultrasound energy does not cavitate adipose cells.* Also, since the bubbles cannot intersperse between the cells of blood vessels, nerves, and other similar tissues, the bubble-mediated cavitation action only acts to dislodge the adipose cells, leaving the other tissues unaffected. This is the source of the natural tissue selectivity of VASER technology. As the fat cells are displaced, they are mixed with the tumescent fluid by a process called acoustic streaming, resulting in a complete suspension of small clusters of fat cells, which are subsequently aspirated. The atraumatic VentX cannulas minimize rapid changes in vacuum level during aspiration. The newly released system also allows precise vacuum control, since high vacuum levels can contribute to fat cell mortality.



Cavitation Effect on Fat Lobule

CLINICAL STUDIES

In a recent scientific comparative study, researchers set out to evaluate post-operative differences between VASER Lipo and traditional liposuction methods. Results showed that the VASER Lipo treatment demonstrated 53% improvement in skin retraction per cc of aspirate removed and an average reduction in blood loss of 26% compared to traditional liposuction. This is the first study to demonstrate statistically significant and clinically relevant improvements relative to traditional liposuction.

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This prospective study used a contra-lateral (side-by-side) study design to evaluate post-operative differences between the two techniques over a six-month time period. The study involved twenty female patients between the ages of 20 and 48 who received contra-lateral treatment with traditional liposuction and VASER Lipo in one or more anatomical regions that included the upper arms, upper back, flanks, outer thighs, and inner thighs for a total of 33 regions. Patients were blinded to the technology that was used on them and aspirate was kept separate and analyzed for blood content. Skin retraction was measured using changes in UV tattoos placed prior to surgery.

According to another recent study conducted at the University of Pittsburgh, human fat harvested by VASER Lipo was shown to be as viable as fat collected by conventional liposuction, with nearly 80% volume retention. The study, led by Dr. J. Peter Rubin, Associate Professor of Plastic Surgery at the University of Pittsburgh, is the first research to establish strong support for VASER Lipo as a collection method of choice for fat transfer procedures.

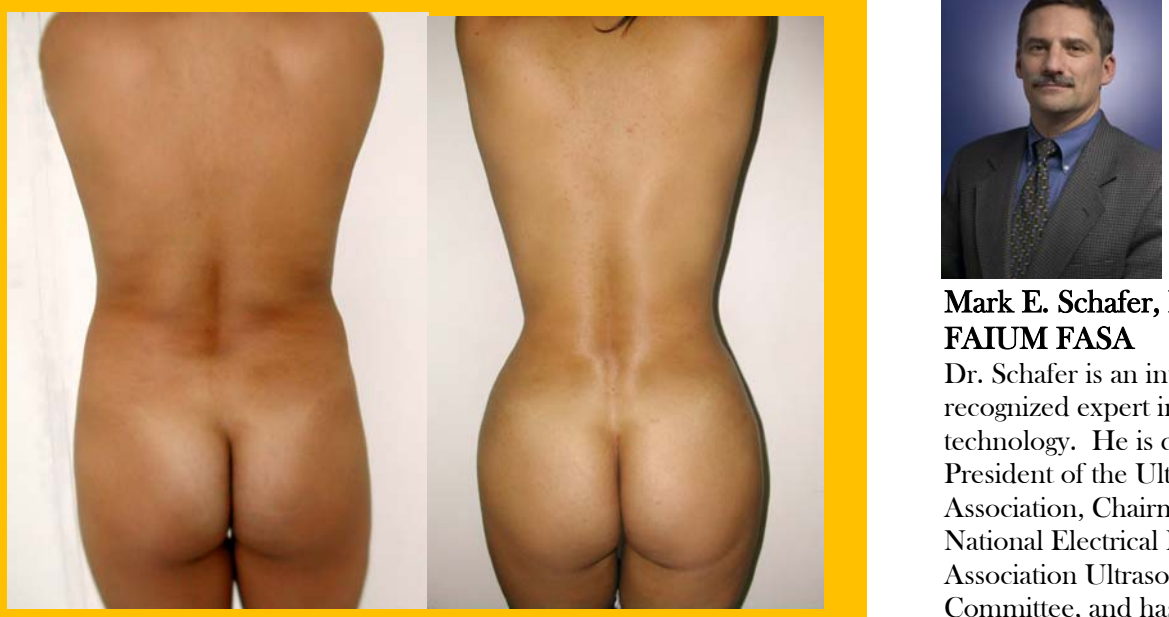
The study investigated tissue samples of a female subject who underwent liposuction of the thighs and flanks. Detailed cellular viability analysis was performed on tissues collected, each having undergone VASER Lipo and suction-assisted liposuction on the body area. The researchers found little or no difference at the cellular level between the treatments, concluding that VASER Lipo is just as effective in yielding viable fat cells as suction-assisted liposuction devices.

Results at six weeks showed ~80% of the filtered VASER fat survived by volume. Additionally, a study from Stanford University last year showed high viability of ADSCs harvested using VASER technology. As a point of comparison, other studies have shown less than 5% fat survival and a significantly reduced number of ADSCs available for harvest using the water-jet assisted liposuction (WAL) method.

SUMMARY

The use of VASER ultrasonic energy for body contouring has several benefits, including tissue specificity, limited blood loss and patient discomfort, smooth skin retraction, and preservation of fat cell and ADSC viability. Since individual fat cells remain intact, fat collected during the VASER Lipo procedure may be harvested for AFT procedures. The fat aspirated during VASER Lipo is refined down to small lipocyte packets, which support growth and vascularization upon reinjection. This is in contrast to the fat aspirated during other liposuction procedures, which may be harvested in large cell packets several millimeters in diameter.

These large cell clusters are associated with high rates of cell disruption from shear forces during reinjection, and necrosis at the core after reimplantation due to inadequate blood supply. VASER Lipo utilizes acoustic forces to safely dislodge fat cells while protecting surrounding tissues, ultimately producing a clean, smooth aspirate with excellent cell viability.



Before (left) and after (right) VASER Lipo procedure with fat grafting. Photos courtesy of Dr. Alfredo Hoyos.

VASER LIPO®

About the Author

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Dr. Schafer is an internationally recognized expert in ultrasonic technology. He is currently Vice President of the Ultrasonic Industry Association, Chairman of the National Electrical Manufacturers Association Ultrasound Technical Committee, and has been named a Fellow of the American Institute of Ultrasound in Medicine and the Acoustical Society of America.

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