Protecting Exposed Tissues With External Ultrasonic Super-Hydration

The author contends that a technique preventing dehydration of exposed tissues, such as external ultrasonic super-hydration, will result in a lower morbidity rate, decreasing deep tissue pain, susceptibility to infection, fat necrosis, wound dehiscence, and improving recovery times. He discusses how he uses this technique in his aesthetic surgery practice. (Aesthetic Surg J 2006;26:230-232.)

It has been 9 years since the first-generation external ultrasound was introduced for use in plastic surgery. External ultrasonic super-hydration represents the latest developments in this technique. Here, I discuss its significance, history, surgical applications, and relevance for aesthetic surgery.

In this technique, saline or wetting solution is infused under the skin, using a cannula. The infusion is followed by transcutaneous high-frequency, high intensity (1 MHz) ultrasound, which gently disperses the fluid into the adjacent and deep subcutaneous tissues by the process of microstreaming, using the Tissue Preparation System (TPS) Mettler Model ME 800 (Mettler Surgical, Anaheim, CA), a device specifically engineered and cleared by the FDA for this application.

Preventing Dehydration in Exposed Tissues

The rationale for this technique is based on the premise that the human body is a water vessel, consisting of up to 70% water in the healthy state. The very word “sick” comes from the Greek, meaning “dry.” In the surgical milieu and in the diseased state, the normal methods of fluid balance and regulation are disrupted and must be controlled by intravenous administration or local wound management.

After subcutaneous tissue becomes exposed, superficial dehydration occurs. Wounds that heal without primary closure discard this desiccated layer. Examples are open treatment of burns or open infected wounds that are allowed to heal by secondary intention. I believe that the incorporation of this superficial dehydrated layer into the closed wound contributes to postoperative wound problems such as increased pain, infection, dehiscence, and fat necrosis. I also contend that irrigation of these tissues at the end of the procedure, while perhaps mitigating the problem, does not completely prevent it.

Studies relating postoperative infection rate to various factors have concluded that length of surgery is the most significant factor. In one large study, the rate of postoperative infection doubled with each hour of tissue exposure. Length of surgery relates to exposure time of tissues; these tissues, at body temperature and under operating room lights, begin to dehydrate immediately—an effect that can be easily observed.

Figure 1 demonstrates fat on the surgical field exposed to the air for 10 minutes. There is already significant superficial dehydration. Figure 2 demonstrates an abdominoplasty specimen left on a back table for one hour. Beneath a thick dehydrated layer, the normal tissue is protected. Figure 3 demonstrates the same specimen irrigated with normal saline; the tissue looks healthier, as if it may have been brought back to normal viability. Figure 4 demonstrates an abdominoplasty specimen left on the table for one hour after preoperative treatment with the TPS device. Super-hydration has protected the tissues from dehydration.

It was Ambroise Paré who first started dressing battlefield wounds, thus preventing dehydration. Before that, wounds were cauterized and left open. Paré wrote, “I dress the wound and God heals it.” Fat desiccation is obvious in the operating field, and attention to this problem has been sorely lacking. Over the years, I have observed some surgeons meticulously maintaining the moisture of exposed tissue while others allow tissue to dehydrate, believing that terminal irrigation will prevent any problems.

It is my contention that a method preventing dehydration of exposed tissues will result in a lower morbidity rate. If this method can be used successfully, deep tissue pain,
susceptibility to infection, fat necrosis, wound dehiscence, and recovery times will all be improved or decreased.

All of these factors are important to the aesthetic surgeon. If deep tissue pain were significantly reduced, the pain pump would be unnecessary. If subcutaneous tissues could be sufficiently loosened by “microstreaming” of infused fluid, there would be no need for internal low-frequency ultrasound. If surgical planes could be “hydroloosened,” dissection would be faster and less traumatic.

Tumescent fluid usually consists of saline or Ringer’s solution, lidocaine, and epinephrine, but other agents, such as antibiotics, can be added. Many surgeons irrigate wounds with antibiotic solution in open procedures. By using TPS, antibiotics can be infused deeply into the tissues and into superficial, exposed tissues where there is a limited blood supply.

**First-Generation Device**

The first use of external ultrasound in surgery was with lipoplasty. Although the first-generation devices varied in effectiveness and were not ideal, they improved upon physical therapy devices. Greater ease of fat extraction with less blood content, less bruising in most patients, and a faster, less painful recovery have been described as results of using external ultrasound with lipoplasty procedures.
Seth Putterman, PhD, professor of physics and director of the sound laboratory at UCLA, studied this device and demonstrated a new phenomenon that he called “cavitation by nanobubbles at a distance.” Dr. Putterman demonstrated the mechanism of action whereby the solution is infused into the tissues. His paper is published in the physics literature.9

Second-Generation Device

A second-generation device, the Mettler Model ME800, was developed with specific engineering for ultrasonic super-hydration. The Mettler Model ME800 is the first device to be cleared by the FDA for ultrasonic dispersion of infused fluids.

In a study of more than 100 patients undergoing open saphenous vein harvesting prior to coronary bypass (112 patients received treatment, 40 patients were control), ultrasonic super-hydration was accomplished by infusing 150 mL of saline just under the skin anterior to the course of the saphenous vein. This was followed by 3 minutes of external ultrasound at 3 W/cm² using the Mettler Model ME800 over the infused area. The study compared consecutive study patients with consecutive control patients in a prospective and retrospective manner. Among the patients receiving ultrasonic super-hydration, there was a complication rate of less than 5% compared to a complication rate of 25% in patients not receiving the treatment. There were no further readmissions to the hospital for wound treatment, and postoperative pain was significantly reduced. Patients were able to ambulate sooner, and there was a significant cost savings resulting from decreased use of pain medications, shorter hospital stay, and less postoperative intervention.10

Safety

The safety of high-frequency external ultrasound has been demonstrated over many years on millions of patients. The device used for surgery is much more powerful on the highest settings than physical therapy devices and should be used only in the presence of infused wetting solution. Devices designed for physical therapy may not have the safety features and self-diagnostics present in devices specifically designed and approved for ultrasonic super-hydration.

External ultrasonic super-hydration uses high-frequency ultrasound. It is as different from low-frequency ultrasound (as is used with internal ultrasound-assisted liposuction [ie, Vaser or Lysomics]) as visible light is from radio waves. Tissue is not destroyed by this technique.

Use in Aesthetic Surgery

I use TPS routinely in face lift, abdominoplasty, lipoplasty, and fat harvesting procedures. The results are a faster, easier, and less traumatic dissection with less bleeding, bruising, swelling, and a faster recovery. Application times vary from 2 to 4 minutes in a given area.

With ultrasonic super-hydration used before lipoplasty, a less than usual amount of wetting solution is required, it is infused superficially, and the ultrasound disperses the fluid gently and evenly into the deeper tissues by microstreaming, in just 3 to 6 minutes. The viscosity of the tissue is greatly reduced. In using this technique with abdominoplasty, I have not found the need for a pain pump, and operating time has been decreased. Further studies should be done to evaluate this technique.

References


Note: References can be found at www.silberg.com/ultrasound.

The author receives patent royalties on the sale of the Silberg T.P.S. from Mettler Surgical.

Reprint requests: Barry N. Silberg, MD, 1111 Sonoma Ave., Suite 210, Santa Rosa, CA 95495.

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