Letter to the Editor

Potential Long-term Effects of Ultrasound-assisted Lipoplasty: A Clinical Analysis

To the Editor:

We read with interest the article, “Possible Long-term Complications in Ultrasound-assisted Lipoplasty Induced by Sonoluminescence, Sonochemistry, and Thermal Effect,” written by Moris Topaz, MD (Aesthetic Surg J 1998;18:19-24). This article is not an original scientific publication, but rather a review of prior work done by other authors. No institutional experience, original data, or scientific work is provided by the author.

Regarding the specific issues raised in the article, we agree that the use of ultrasound energy in liposuction carries potential risks, as do all operative procedures. The potential immediate hazardous effects of ultrasound-assisted lipoplasty (UAL) are well known; they include thermal injury, dysesthesia, and neuropraxia. Fortunately, these effects are largely preventable with proper surgical technique.

Dr. Topaz is appropriately concerned with the potential long-term effects of ultrasonography on tissues. His concerns focus on three areas: sonoluminescence, sonochemistry, and thermal effects. We agree that further research into these issues is warranted, especially sonoluminescence. However, a critical analysis of the same literature that Dr. Topaz cites does not support a basis for such concern at this time, because none of the sources use or mimic current UAL technology, and the reported effects are contrary to the massive clinical experience with ultrasound dissection in use since 1967.

The process of sonoluminescence is the conversion of sound energy to light energy through cavitation. This phenomenon has been sparsely described in the literature, but Dr. Topaz raises concern about the production of ultraviolet and possibly soft X-ray radiation from cavitation. His references include Puterman1 in Scientific American. Unfortunately, this reference is not clear in its conclusions regarding the implications of this process and its relation to clinical ultrasound use. Puterman1 does discuss the production of ultraviolet light in a wavelength of 0.2 μm and possibly higher, but he states that this is difficult to measure “because above those energies light cannot propagate through water.” Additionally, he speculates that soft X-rays might be produced, but “such photons do not propagate through water, so we do not know whether they are there.” These limited ultraviolet rays and possible X-rays are of little apparent clinical significance because UAL contouring must be performed in a wet environment. This high extracellular water content should rapidly absorb any such photons produced. Dr. Topaz’s reference to the work of Vona et al.2 includes such phrases as “near ultraviolet emissions” and “marginal support for the production of higher energy photons.” Neither of these studies uses ultrasound in the frequency range of clinical UAL equip-
ment. These data should have been presented as purely speculation on the work of other authors.

The second concern is the production of free radicals through the process of cavitation. Although this has been reported in vitro, an in vivo experiment performed at The University of Texas Southwestern failed to detect any evidence of free radical generation.

The concerns raised regarding the potential biologic effects of sonochemistry on DNA are also speculative and of questionable application to clinical ultrasound use. The DNA changes detected by Liebeskind et al. were generated in an experiment with a 2.0 MHz unfocused probe, quite dissimilar to all current UAL technology. Additionally, the study concluded, "our results with cells exposed to ultrasound in vitro cannot be directly extrapolated to the clinical situation where the ultrasound probe is in constant motion and no one region is continuously exposed to the beam." Furthermore, Barnett et al., in an article prepared by the World Federation for Ultrasound in Medicine and Biology Safety Committee, concluded in 1997 that "there is at present no indication that medical ultrasound is capable of inducing mutations in mammalian tissue in vivo."

There is no debate that ultrasound energy can be converted to thermal injury both in vitro and in vivo. It is clear that temperatures high enough to cause tissue necrosis can be achieved. To minimize this, skin protectors, wet towels, and wetting solutions are used clinically and are described as an essential part of UAL.

Perhaps the most relevant answer to the questions regarding the long-term use of ultrasound in soft tissue dissection is the extensive and safe use of substantially equivalent technology over the past 30 years. Ultrasound has been used medically to dissect and excise soft tissue since Kelman introduced it in phacoemulsification in 1969. Since that time, thousands of surgeons have used ultrasound in the eye and other organs, such as the cavitron ultrasonic surgical aspirator, with a large margin of safety and no clinically significant reports of resultant DNA changes, radiation effects, free radical generation or other serious complications. It is reasonable to extrapolate from this experience to that of using ultrasound in body contouring. In the interests of safety and the current medicolegal environment, we caution against the use of UAL in the female breast but believe that UAL technology (like its counterpart, the cavitron ultrasonic surgical aspirator, which has had extensive clinical use), is effective when used properly.

In conclusion, the use of ultrasound in soft tissue dissection has proven safe and effective since its introduction in 1969. Of course, the use of UAL is potentially injurious in inexperienced or untrained hands, as is a scalpel or electrocautery in the hands of an ill-prepared physician. As with most procedures, surgical complications with UAL are related more to what occurs proximal to the cannula, that is, the surgeon, rather than to the tool. UAL is a useful adjunct to extend the capabilities of the body contouring surgeon in lipoaspiration. When it is used in combination with good judgment and clinical sense, it is a very effective tool.

The concerns raised by Dr. Topaz regarding the safety of ultrasound in body contouring are best answered through further directed research of the type sponsored and encouraged over the past 3 years by the UAL Task Force (with representation from the Aesthetic Surgery Education and Research Foundation, the American Society for Aesthetic Plastic Surgery, the American Society of Plastic and Reconstructive Surgeons, the Lipoplasty Society of North America, and the Plastic Surgery Educational Foundation).

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References
Dr. Topaz’s reply:

My article was indeed merely a review of previously published literature. Its originality was in the extrapolation of previous basic work on low-intensity ultrasound energy relevant to possible adverse effects of high-intensity ultrasound energy (HIUE) as used in ultrasound-assisted lipoplasty (UAL), and in drawing attention to the issue of the possible long-term effects of HIUE, which had not been previously addressed.

HIUE operating in an aqueous environment generates sonoluminescence, which can affect the intercellular space when applied in UAL. Ultraviolet light and soft x-rays are absorbed in water, and their effect is limited to a very short range. Cavitation can nevertheless be formed in air bubbles within the sonication jet that projects from the tip of the cannula within the intercellular space. Its effects can certainly be harmful to cell membranes in the irradiated area.

The failed attempt by Rohrich et al., to detect free radicals in vivo does not confirm their absence. Primary free radicals have a short half-life of $10^{-6}$ to $10^{-9}$ seconds.$^{2,3}$ Their detection is more difficult because adjacent organic tissue reacts to the free radicals as scavengers, that is, it absorbs them. Dr. Rohrich’s findings should be evaluated in light of the high quantities of free radicals that were observed in the UAL-simulated environment in our laboratory, in as yet unpublished data.

I could not find any relevant reference that would suggest the use of HIUE ultrasound to be safe with respect to changes in DNA. I agree with Drs. Rohrich and DiSpaltro that, like the cavitrone ultrasonic surgical aspirator, UAL is effective when used properly, but it is misguided to compare the two. The use of the cavitrone ultrasonic surgical aspirator in clinical application is limited to the treatments of preexisting pathologic conditions and operates at lower intensities of energy and for shorter durations of time. The effect of the use of HIUE on healthy tissue has not been examined, as I had cautioned in my article. Drs. Rohrich and DiSpaltro’s reference to Barnett et al.$^4$ is irrelevant because the ultrasound energy used in diagnostic medical applications is set at much lower intensities of energy, with shorter duration of exposure and under conditions differing from those used in UAL.

The authors’ comparison of the risk involving the use of UAL to the use of a scalpel or electrocautery is incongruous, because UAL machines contain inherent risks mediated by free radicals and sonoluminescence that are not a function of the physician’s capabilities or training. The risks are intrinsic to the technology itself when applied in aesthetic surgery. I am unaware of any relevant basic scientific literature to support the long-term safety of the use of HIUE in UAL.

During the last 8 months I have been conducting thorough basic research at Tel Aviv and Bar Ilan Universities on the effect of HIUE in a UAL-simulated clinical environment. This and further research will be presented in due time.

References