A New Look at Wound Burn

Long ultrasound runs at full power are potentially dangerous.

BY RANDALL J. OLSON, MD

Ever since the availability of ultrasound as a means of cataract removal, it has been possible to attain a temperature of 60ºC due to the frictional load on the wound when ultrasound is actuated. Unfortunately, at a temperature of 60ºC, wound burn can occur in a matter of seconds and can result in complications ranging from mild postoperative astigmatism to difficulty closing the wound to burns so severe that a corneal transplant is necessary to provide a patch graft to seal the incision (Figure 1). Even with the incision finally closed, prolonged recovery and significant astigmatism make this a complication best avoided. A surgeon has no idea what the temperature in the wound is until a wound burn suddenly appears.

Little epidemiologic evidence has been published on phaco wound burn. We reported a survey showing an overall incidence of moderate-to-severe wound burn of approximately one in 1,000 cases[1] and showed that the incidence strongly correlated with the use of continuous ultrasound during either divide-and-conquer or nucleus-carousel surgical approaches and with the use of a stroke-length–protected phaco machine. When a stroke-length–protected phaco machine encounters a hard cataract, and no additional pressure is applied to the phaco pedal, more energy surges to the machine to protect the stroke length, creating a potential risk for wound burn. The latest generation of phaco machines is not stroke-length protected.

MULTIVARIATE ANALYSIS

In a multivariate analysis of our survey results, we found that ultrapulse ultrasound (micropluse or WhiteStar [Abbott Medical Optics Inc., Santa Ana, CA]), with on times of 5 to 6 milliseconds, was the most protective factor. This was followed by use of a vertical chop technique, followed by the machine used.

We also investigated the effect of ophthalmic viscosurgical devices (OVDs) on the heat generation of ultrasound during phacoemulsification.[2] We were interested in how wound temperature is affected when the anterior chamber is full of an OVD. This is a known risk factor that has always been considered problematic, due to the fact that the OVD blocks irrigation and aspiration, so there is no cooling effect from either when ultrasound is actuated. We found that ultrasound in the presence of an OVD can be exothermic, varying by amount depending on the OVD. All OVDs were exothermic in comparison to balanced saline solution. The most forgiving OVD increased heat production approximately 50% more than balanced saline solution; however, under some circumstances, heat production increased as much as 600% in comparison to balanced saline solution control.[2] This meant that it could be only a matter of seconds from initiation of ultrasound to wound burn. This has been documented

(Courtesy of Jorge L. Alió, MD, PhD.)

Figure 1. A wound burn that occurred after a matter of seconds in an anterior chamber full of an OVD.

in video segments. Interestingly, the worst offenders regarding exothermic reactions were on both ends of the viscosity spectrum (Table 1)—Healon5 (Abbott Medical Optics Inc.) and Viscoat (Alcon Laboratories, Inc., Fort Worth, Texas).

WOUND BURN STILL POSSIBLE WITH HORIZONTAL ULTRASOUND

Recently, alternatives to longitudinal ultrasound have been introduced, including torsional and transversal modes of delivery—technologies I will call *horizontal ultrasound*. Many surgeons using these new modalities seem to feel that, because little friction is created inside the wound, wound burns are unlikely or potentially impossible. There is no question that the frictional component of horizontal ultrasound is very low, much less than that in conventional ultrasound.[3] The problem is that, due to the great followability of horizontal ultrasound and the feeling that there is basically no risk of wound burn, it is not uncommon for surgeons to use 100% ultrasound energy for prolonged periods. Unfortunately, this combination can create wound burns. In a more recent survey (submitted for publication), we found that wound burns with horizontal ultrasound are not uncommon; they particularly seem common when horizontal ultrasound is used in an anterior chamber filled with an OVD.

How can horizontal ultrasound create too much frictional energy in a wound when the friction created is minuscule? Wagging a titanium needle from side to side produces metal stress in the proximal needle shaft. Propagation of this heat from the proximal needle to wherever the wound is located, combined with the minimal additive effect of wound friction, probably causes this wound burn problem. Indeed, we have been able to document that this additional generation of heat can be substantial when combined with long runs of 100% horizontal ultrasound and a tip largely blocked by nuclear material—a common clinical scenario. We found that the Ellips (Abbott Medical Optics Inc.) variation of horizontal ultrasound produced statistically significantly less heat than OZil (Alcon Laboratories, Inc.), probably due to the difference in needle action (submitted for publication).

CONCLUSION

The take-home lesson here is that we should never assume, with any variation of ultrasound, that a wound burn is impossible. An understanding of wound burn and a little prudence can, indeed, prove the old aphorism, "An ounce of prevention is worth a pound of cure." Wound burns are indeed preventable. ■

TABLE 1. RATIO OF HEAT PRODUCTION FOR DIFFERENT OVDs COMPARED WITH BALANCED SALINE SOLUTION UNDER DIFFERENT SCENARIOS

		Legacy	Sovereign
OVD	Power	Ratio	Ratio
Eye bank eye	60%	1.62	0.91
Viscoat (Alcon Laboratories, Inc.)	20%	1.9	7.14[d]
	40%	3.53	6.30[d]
Healon5 (Abbott Medical Optics Inc.)	20%	2.97	3.86[f]
	40%	3.25	5.20[¶]
ProVisc (Alcon Laboratories, Inc.)	20%	1.71	4.00[g]
	40%	2.25	3.87[e]
Vitrax (Abbott Medical Optics Inc.)	20%	2.31[c]	2.88
	40%	2.25	3.72[f]
Healon GV (Abbott Medical Optics Inc.)	20%	1.57[a]	2.26
	40%	2.11	2.38[f]
Healon (Abbott Medical Optics Inc.)	20%	1.52	1.98
	40%	1.64	3.56
Amvisc Plus (Bausch + Lomb)	20%	1.51	1.70[b]
	40%	1.95	2.77

Balanced salt solution heat production value = 1.0.
OVD = ophthalmic viscosurgical device

[a]*P* = .008
[b]*P* = .002
[c]*P* = .004
[d]20-second comparison
[e]30-second comparison
[f]40-second comparison
[g]50-second comparison

Except where specified, comparisons are with 60-second data and *P* values < .0001 when comparing Legacy (Alcon Laboratories, Inc.) and Sovereign (Abbott Medical Optics Inc.).

This article is reprinted with permission from the March 2010 edition of Cataract & Refractive Surgery Today Europe.

Randall J. Olson, MD, is professor and chair of the Department of Ophthalmology and Visual Sciences and CEO of the John A. Moran Eye Center, University of Utah School of Medicine, Salt Lake City. He is a consultant to Abbott Medical Optics Inc. Dr. Olson may be reached at randallj.olson@hsc.utah.edu.

1. Bradley MJ, Olson RJ. A survey about phacoemulsification incision thermal contraction incidence and causal relationships. *Am J Ophthalmol.* 2006;141:222-224.
2. Floyd M, Valentine J, Coombs, J Olson RJ. Effect of incisional friction and ophthalmic viscosurgical devices on heat generation of ultrasound during cataract surgery. *J Cataract Refract Surg.* 2006;32:1222-1226.
3. Han YK, Miller KM. Heat production: Longitudinal versus torsional ultrasound. *J Cataract Refract Surg.* 2009;35:1799-1805.