Simulation of eye rubbing

To estimate the clinical relevance of the study by Masket et al., we have to answer the question, Does the study methodology adequately mimic what takes place when a postoperative patient rubs his or her eye?

An ounce is a unit of weight or volume, not of force. A force is created solely by an accelerating mass. The authors noted the length of the gauge they used in the study but not the width, which was probably shorter than the length. However, to present the study in the most favorable way, I would assume the tip is square with a resulting area of 9 mm². Converting ounces/millimeters² to the more familiar lb/in², the study tested the integrity of the incision by applying the maximum pressure 10.08 lb/in² to the surface of the eye 0.5 mm posterior to the external incision.

Rubbing the eye by the patient is usually done by applying a flattened surface of an index finger (on my finger, an area 400 mm²) against the closed eyelid. Using the same maximum weight as the study weight would create a pressure of 0.23 lb/in². Therefore, the point pressure on the surface of the eye was more than 44 times greater than the pressure applied by a finger to the closed eyelid.

If the authors had done optical coherence tomography imaging, the difference between leaking and nonleaking incisions might have been seen even though incision construction and wound architecture were not standardized. Optical coherence tomography imaging of our single-plane clear corneal incisions revealed that they were parabolic in profile, perhaps giving greater resistance to slippage than linear incisions, and they were longer than the cord length we were measuring.

I do not believe that point pressure applied to the surface of the eye adequately simulates eye rubbing by a patient to give this study clinical relevance.

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REFERENCES

Reply: We would like to address the concerns expressed by Dr. Fine regarding whether our model of applying force using a calibrated gauge in proximity to a clear corneal incision (CCI) appropriately simulates the variable action of a patient touching or rubbing his or her eyes.

Dr. Fine suggests that the ounce is a measure of only volume and not force. According to the Dictionary of Units of Measurement, ounce force is a traditional unit of force. It is also used to describe torque. One-ounce force (ozf), as opposed to 1 ounce of mass, was used to challenge CCIs. The psi (lbf/in²) unit cited by Dr. Fine is indeed a unit of pressure. Moreover, the force gauge described in our investigation was derived from an orthodontic tool; we opted to use the original nomenclature of the manufacturer. Dr. Fine also expresses doubt that the force gauge can simulate the effect of a patient rubbing the eye. Obviously, each patient may vary where, with what, and how they rub their eye at any given moment. However, from the existing literature, we determined the induced elevation of intraocular pressure (IOP) from eye rubbing and used this as target to quantify the necessary force of the gauge, providing a reasonable and quantifiable estimation of globe deformation by which incision competence could be evaluated. Since a calibrated and quantifiable device was necessary for standardized testing, the goal of the study was to reproduce changes in IOP that might be caused by patient manipulation rather than directly simulate a digital footprint on the ocular surface, which is quite variable. McMonnies et al. reported similar changes in IOP using a Schiotz tonometer with a 7.35 mm² area of indentation (total weight of 16.5 g) and application of light digital force with a mean measured finger pad print area of 168 mm². The change in IOP caused by 1-ounce force, using the calibrated force gauge, was consistent with IOP fluctuations recorded during light and firm digital forces on the sclera. As the globe is indented and pressure rises in the anterior chamber, fluid may be displaced through the CCI as a result.

Dr. Fine also suggests that OCT is a better means of evaluating incision construction. While OCT imaging has been well used and is excellent for describing incision morphology, it has been a somewhat disappointing tool with regard to incision function. We note descriptions of internal and external wound gape, stromal misalignment, and Descemet detachment, but we are aware of few published studies that relate OCT imaging to incision competence (such as wound leakage associated with hypotony) in human patients. Calladine et al. reported that wound architectural features such as gaping and misalignment were affected by changes in IOP. Conversely, Torres et al. did not observe wound leakage via OCT in patients who had CCIs. However, IOP values in that study were in the normal range (no observed hypotony; 1 day postop IOP = 16.4 mm Hg ± 3.7 [SD]). Previous research studies have used OCT imaging with...