Re: Hooshmand et al.: Ultrastructural integrity of human capsulotomies created by a thermal device (Ophthalmology. 2018;125:340-344)

TO THE EDITOR: Having been involved with development of the precision pulse capsulotomy (PPC) device (Zepto; Mynosys Cellular Devices; Fremont, CA), we thank Hooshmand et al. for sharing their findings from what was the earliest commercial experience of the PPC device in the world. Subsequent to their early experience reported in this study, important improvements to the PPC device and technique have been made with excellent results in >1000 clinical cases.

We would like to correct a misunderstanding in the authors’ characterization of PPC, which is not a cautery or plasma-based instrument delivering sustained energy directly into tissue causing it to burn or coagulate. PPC instead uses a new, patented method of tissue cutting characterized as a microbubble phase effect (MPE) to create its unique capsulotomy edge. An MPE causes the thin layer of water molecules trapped between the bottom edge of the nitinol capsulotomy ring and the capsule to undergo phase transition within just 4 ms. The resulting volume expansion instantaneously creates its unique capsulotomy edge. An MPE causes the thin layer of tissue cutting characterized as a microbubble phase effect (MPE) to cause the tissue to burn or coagulate. PPC instead uses a new, patented method of characterization of PPC, which is not a cautery or plasma-based instrument delivering sustained energy directly into tissue causing it to burn or coagulate. PPC instead uses a new, patented method of tissue cutting characterized as a microbubble phase effect (MPE) to create its unique capsulotomy edge. An MPE causes the thin layer of water molecules trapped between the bottom edge of the nitinol capsulotomy ring and the capsule to undergo phase transition within just 4 ms. The resulting volume expansion instantaneously creates its unique capsulotomy edge.

In addition, although manual capsulorhexis and the femtosecond laser produce identical SEM edge morphology on both the button and the peripheral anterior capsular rim, the same is not true for the PPC capsulotomy. This is because of the asymmetric tensile effects of suction acting on the central anterior capsule. Although they are no substitute for clinical studies, cadaver eye studies have significantly improved our understanding of basic capsulotomy biomechanics and pathology. During the development and testing of the PPC in human cadaver eyes, SEM was used repeatedly to analyze edge morphologies of the button and peripheral capsular rim. SEM analysis of the latter is, of course, impossible in living subjects. In all cases, the button edge had a much more pronounced and upturned roll of capsule tissue that irregularly bunched together to create extra folds and creases, and curled away from the button plane. In contrast, the peripheral anterior capsular rim was uniformly smooth with only a slight upward curl and consistent morphology for the entire 360° circumference. Achieving this uniform and slightly upturned functional or “working” edge is the intent of the PPC design. It was clear that one could not infer PPC’s peripheral and functional anterior capsular edge morphology by analyzing the excised button’s edge. Therefore, although useful for manual or femtosecond laser capsulotomy, SEM analysis of capsular buttons would be unable to predict or correlate with the edge morphology of the excised capsule. Tensile stress caused by simultaneous suction curls the cut edge of the peripheral anterior capsule slightly up, so that it faces away from the capsulotomy plane. During surgery, it is the rolled undersurface of the capsule—like a microscopic fold—that bears the stretching forces of surgical manipulation. This MPE capsulotomy method and scanning electron microscopy (SEM) edge morphology have been described previously.1, 2

Finally, the very pronounced, rolled-up edge of the excised capsular button makes both tissue preservation and interpretation of SEM images very challenging. Owing to the fixation, dehydration, and critical point drying used in SEM sample preparation, there is substantial tissue shrinkage and brittleness, which the authors acknowledged. Such tissue shrinkage further compresses the rolled up button edge causing folding, creases, tears, and even partial unrolling to expose cut edges. These are essentially SEM artifacts that that did not exist in the original freshly harvested sample and underscore the inaccuracy of inferring PPC capsulotomy edge morphology from SEM evaluation of the button.

Early clinical experience, such as that of Hooshmand’s group, has led to recent improvements in both the PPC device and the technique. New steps and guidelines for ensuring full PPC suction prior to capsulotomy creation have been implemented and ophthalmic viscosurgical device recommendations have been updated. In addition, the manufacturing process for the nitinol capsulotomy ring has been improved. Physical vapor deposition, a process by which the nitinol ring is literally created one atom at a time, allows much higher level of dimensional tolerance to be achieved. This improvement should ensure more consistent nitinol edge morphology, more uniform MPE conduction, and a more consistent capsulotomy edge.

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References
