Vernier acuity below the diameter of photoreceptors can be achieved within a 150-msec presentation time, with reaction times increasing moderately with the number of distractors. Thus, a nonstraight feature in the hyperacuity range can be detected simultaneously (within a 150-msec presentation time) among straight distractors and seems to represent an elementary feature of visual perception. The actual cue used by the underlying neuronal mechanism is not necessarily lateral offset, but could be, eg, the orientation gradient that exists explicitly in a bent or implicitly in an offset target. Absolute orientation is an important parameter in vernier detection;\(^{10,11}\) the new results show that relative orientation or orientation gradient is equally important.

Neurones similar to the ones that are believed to code orientation\(^{12}\) should exist for detection of miniature lateral displacements, or orientation gradients. It seems promising to search for such neurones in the visual cortex.

**Key words:** hyperacuity, visual psychophysics, early visual processing, parallel processing, serial processing

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**References**

We could not cut the lens capsule in cadaver eyes with a unipolar diathermy loop. Even with the highest power of 18 W with 750 kHz, we only coagulated the cortex protein. The lens capsule in the cadaver eyes remained intact. Berger4 (with the use of a bipolar loop, immediately cut a round capsular hole, and measured the temperature in animal and human cadaver eyes) and Gassmann et al5 (with the use of a straight bipolar high-frequency capsulotome with continuous cutting ability, but without temperature measurement) published in vitro results. Because we intend to adapt a diathermic instrument for phacoemulsification with small-incision technique for the future, we tried for the first time in the initial stages to apply clinically the latter capsulotome invented by Kloti.6 The instrument was modified to meet our requirements. The probe has a platinum inner active electrode that is insulated from the coaxial return electrode. The conical tip is bent at 90°. Its largest diameter is 0.25 mm. A concentric cannula ending near the hot tip is used for irrigation (cooling) and maintainance of the anterior chamber. The external diameter of the instrument is 1.25 mm. High-frequency current flows at 500 kHz modulated by a frequency of 100 Hz that generates a temperature of 130°C at the point of the tip. A bipolar generator produces an electrical field only at the extremity of the tip. Thus, temperature spreading is ball-shaped around the tip. Because this temperature is above the boiling point of the irrigation fluid, small gas bubbles are released. Regarding the three main side effects of diathermy (thermic, faradic, and electrolytic), these questions arose: How high did the temperature rise in the anterior chamber? Could damages of the corneal endothelium be ruled out? What clinical qualities does the new kind of capsulotomy offer?

**Materials and Methods.** Patients: Twenty-five patients (72–79 yr old) already pseudophakicon one eye were chosen for cataract surgery of their second eye and for posterior chamber-intraocular lens (PC-IOL) implantation into the capsular bag. Their corneal endothelium had to show a minimum of 2250 cells per mm² preoperatively. Second eyes were chosen to get a standard of comparison with conventional ECCE that was performed on the first eye in the same individual. Ten patients had intumescent lenses and 15 had mature cataractous lenses without any red fundus reflex. Thus, they were unsuitable for capsulorhexis.3 Informed consent was obtained from all patients after the nature of the procedure had been fully explained. The operations were filmed by video equipment that was connected by a mixer unit.

**Technique:** A corneoscleral incision was made (105°), and two silk corneoscleral sutures were inserted and tied with a single bow over the surgeon’s loop. This procedure divided the wound into three segments.7 The bipolar diathermic capsulotome was inserted into the anterior chamber through the right segment (surgeon’s dominant hand), and the temperature probe was inserted through the left (nondominant hand, Fig. 3A). The probe not only measured the temperature but also kept the wound patent for outflow of irrigation fluid. Physiologic NaCl solution was kept at room temperature until it reached 21°C and was used as irrigation fluid. Inflow rate of 2.75 ml/min maintained the depth of the anterior chamber without iris prolapse in this large incision technique. The first half of capsulotomy was performed with a continuous movement from 6 o’clock passing 9 o’clock to 12 o’clock (clockwise), the second from 6 o’clock passing 3 o’clock to 12 o’clock (counterclockwise). The procedure did not last longer than 20 sec. After the procedure, the nucleus was expressed in bimanual technique; then, cortex aspiration and PC-IOL implantation into the capsular bag occurred.

**Temperature Measurement:** Temperature was measured by a resterilizable, glass-sealed PTC probe (positive temperature coefficient resistor) calibrated between 10°–90°C (fluid reaction speed, 0.15 sec) with indication on a calibrated digital voltmeter. Accuracy was ±0.25°C at room temperature. The temperature was measured at the limbus and within the anterior chamber before, during, and after capsulotomy. The voltometer was filmed by a second video camera and faded in at the upper-left corner of the picture taken by the main camera. Thus, the maneuver could have been stopped when the temperature increased excessively. Also, this method ensured post-operative study of the results.

**Search for Electrolysis:** Electrolysis would have caused oxyhydrogen to be released from the irrigation fluid, and the small gas bubbles mentioned above could have indicated this. Because electrolysis should not occur when high-frequency current is used,9 we experimented to confirm this. The capsulotome was electrically driven under a bell-like glass container for 1/2 hr. We used electrocautery to ignite oxyhydrogen possibly produced in the container.

**Examination of Corneal Endothelium:** With a special contact glass from Eisner,11 which provided 80 × magnification, comparative endothelial biomicroscopy10 was performed the day before and 5 days, 1 month, and 12 months after the operation.

**Results. Temperature (Highest Measured Values in 25 Cases, Figure 1): Before starting capsulotomy, the temperature of the limbal region measured 28.7°C and that of the anterior chamber measured 29.1°C (Figs. 2A, 2B). During capsulotomy, the temperature in the anterior chamber rose to a maximum of 33.4°C.
visualization. Small gas bubbles (Gassmann's problem) and loose cortex material tumbling in the anterior chamber when no irrigation is used (Berger's problem) are flushed out immediately by good irrigation.

The coagulated edge of the capsulotomy can be stressed mechanically in any direction, and it did not tear during nucleus expression (as often occurs with the can opener technique). PC-IOL could be reliably placed in the capsular bag in all 25 cases.

One drawback to the bipolar diathermic capsulotome is that it cannot be used in eyes with glaucoma and narrow pupils and/or shallow anterior chambers. These contraindications would also rule out capsulorrhexis, but the can opener technique could still be used.

In our opinion, this capsulotome could be modified to provide a second concentric tube for aspirating the irrigation fluid, replacing passive outflow. Thus, the large-incision technique, which is a prerequisite for Berger's bipolar loop, could be replaced by a small-incision technique for phacoemulsification, as we intended originally. We believe that our investigations on diathermy showed that with this instrument an exact anterior capsulotomy of any desired shape can be obtained. It is especially favorable for intumescent and mature cataractous lenses that are difficult to handle by other methods.

Neither we, nor any relatives have any commercial or proprietary or financial interest in this device. No employer, partner, or business associate of ours holds financial interests in this product.

Key words: anterior capsulotomy, bipolar diathermy, intraocular temperature, corneal endothelium

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References


Effect of Fibronectin on Corneal Epithelial Wound Healing in the Vitamin A-Deficient Rat

Kiyoshi Watanabe, George Frangieh, Chitraranjan V. Reddy, and Kenneth R. Kenyon

The authors investigated the in vitro and in vivo effects of fibronectin (Fn) on the migration of corneal epithelium of vitamin A-deficient (A−) and pair-fed control (A+) rats. Groups treated with 50 μg/ml Fn showed accelerated healing of epithelium in vitro (P < 0.05) compared with control groups of A− and A+ rats. However, when 100 μg/ml Fn eye drops were administered 14 times over 20 hr, they had no significant effect on A+ rats in vivo, but increased the healing in A− rats (P < 0.05). In this model, Fn promoted the healing of corneal epithelium under A− conditions.