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Histology of Anterior Capsule Edges Produced by CCC and DC

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Abstract: We compared the postoperative characteristics of the anterior capsule edges produced by two incision techniques: continuous curvilinear capsulorhexis (CCC) and diathermy capsulorhexis (DC). We examined the incised rims of human and animal capsules histologically and also compared the configuration and strength of the rims produced in animal experimentation. Histological examination of rabbit lenses revealed that 0.5 seconds was sufficient for coagulation of the anterior capsule: longer times caused deeper cortical tissue damage. Experimentally produced small capsulorhexis (3.5 mm diameter) with DC produced edges were less elastic than with CCC when tension was applied. **Jpn J Ophthalmol 1997;41:77–80**

Key Words: Continuous curvilinear capsulorhexis, diathermy capsulorhexis, histological study, radio frequency endodiathermy.

Introduction

Continuous curvilinear capsulorhexis (CCC) is generally used to assure safe phacoemulsification without tearing of the anterior capsule.[1,2] This technique, however, requires a high level of expertise and is difficult to accomplish in cases that have the poor red reflex of a mature cataract, or inadequate mydriasis. And in younger patients, there is a tendency for the rim to flow toward the surrounding area. Painstaking care is required in this procedure: If a tear should occur at the rim, there is a great risk of vitreous loss. In extreme cases, extracapsular cataract extraction (ECCE) is unavoidable.

Radio frequency endodiathermy capsulorhexis was proposed first by Kloti in 1984.[3] A platinum alloy chip, heated to approximately 160°C, is used to incise the anterior capsule. Diathermy capsulorhexis (DC) is technically easier than CCC for achieving the precise anterior capsulorhexis caliber in difficult cases.[3–9] Luck et al[8] reported, however, that the rim produced by the DC procedure tends to tear more easily.

We compared the histology, configuration, and strength of rims resulting from the two methods in human and animal capsules.

Materials and Methods

Experiment 1

Six male nonpigmented rabbits were used in this study; animals were cared for according to the ARVO resolution on the care and handling of animals in vision research.

Two rabbits were used to study the effects of DC on the lens epithelium and cortex, produced by several different coagulation times. After the rabbits were anesthetized with phenobarbital, a keratotomy was done at the limbus. Sodium hyaluronate (Healon, Pharmacia, Monrovia, CA, USA) was injected into the anterior chamber and electricity transmitted for specific times (0.5, 1.0, 2.0, and 5.0 seconds) as the tip of the DC chip was placed at different sites. An orbit capsulotome (Oertli Co.) was used for this procedure (Figure 1). The lens was immediately removed and fixed in 0.1 mol/L phosphate buffer solution (pH 7.4) with 4% paraformaldehyde, for 48 hours at 4°C. Fixed specimens were dehydrated in an ethanol series (10 minutes in each concentration: 50, 60, 70, 80, 90, and 95%), embedded in methacrylate

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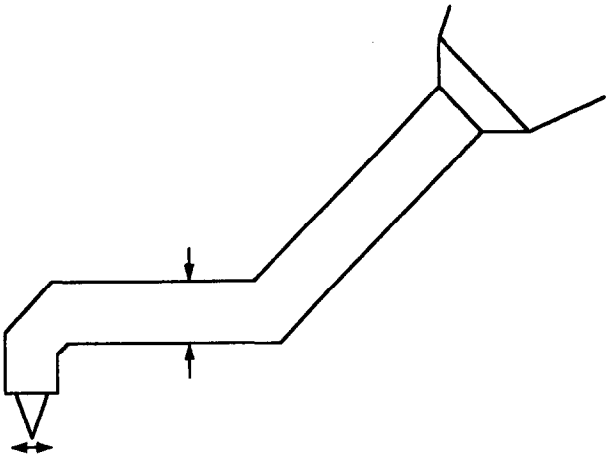

Figure 1. Capsulotomy tip (↔: 0.3 mm, → ←: 0.6 mm).

(JB-4, Polyscience Co., Ltd.), sliced into 1–2 μm sections, and stained with toluidine blue for examination by light microscope.

Four animals were used to compare the strength of the incised rim produced by the two methods. After anesthesia and keratotomy as in the first procedure, sodium hyualuronate was injected into the anterior chamber. Anterior capsulorhexis (6 mm and 3.5 mm) was done with CCC in the right eyes, and with DC in the left. Following aspiration of the nucleus and cortex, the rim of the incision was gently pulled parallel to the plane of the iris with iris retractors, and the length was measured to evaluate its strength.

Experiment 2

Rim configurations produced by CCC and DC in human lenses were compared using human anterior capsules obtained at surgery. These specimens were fixed, dehydrated, and examined as described in experiment 1. Capsules from patients who had ophthalmic complications, such as uveitis and pseudo–exfoliation syndrome, or systemic complications, such as diabetes mellitus, were excluded.

Table 1. Mean Diameter and Depth of Rabbit Lenses Coagulated for Various Times

	Coagulation Time (sec)			
	0.5	1.0	2.0	5.0
Mean caliber (μm)	50	80	80	75
Mean depth (μm)	5	145	190	240

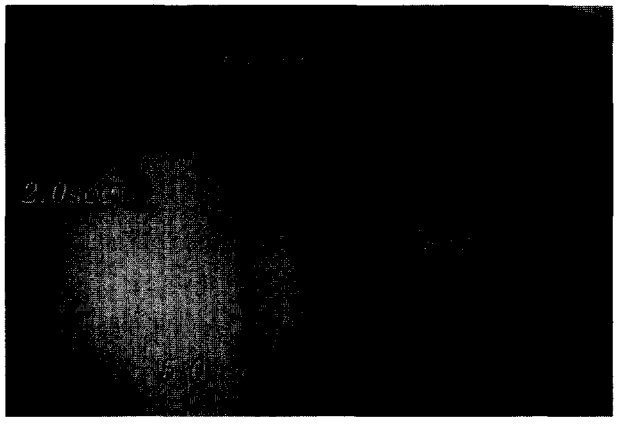

Figure 2. Stereoscopic photomicrograph of lens surface from rabbit in group 1.

Results

Experiment 1

Photomicrographs of the lens surface from rabbits in group 1 are shown in Figure 2. Numerous bubbles formed when the heat was applied, indicating successful capsulorhexis. With coagulation time of 0.5 second, the anterior capsule was cut, although the incision was smaller than areas coagulated at longer times. At more than 2.0 seconds, coagulation produced carbonization in areas well beyond the actual incision site, but the incision itself was not noticeably larger (Table 1). At 0.5 second, heat degeneration was limited chiefly to the anterior capsule and the incision size was small (Figure 3). At 1.0 second, the anterior capsule was completely cut and heat effects were seen in the cortex (Figure 4). At more than 2.0 seconds, the anterior capsule was largely destroyed,

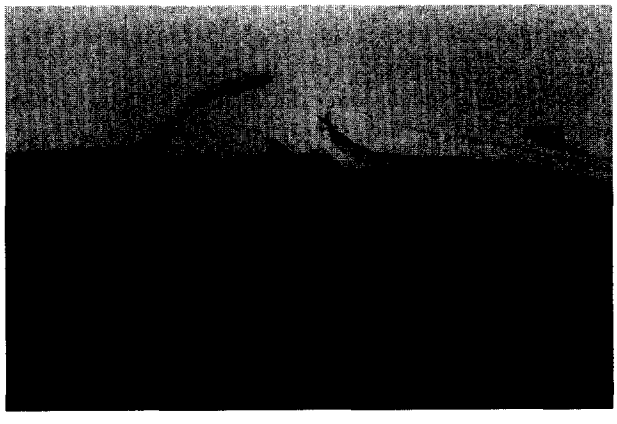

Figure 3. Light micrograph: Heat degeneration at 0.5 sec limited to anterior capsule; small incision. Toluidine blue stain (× 200).

Figure 4. At 1.0 sec, anterior capsule was cut; cortical heat damage. Toluidine blue stain (× 200).

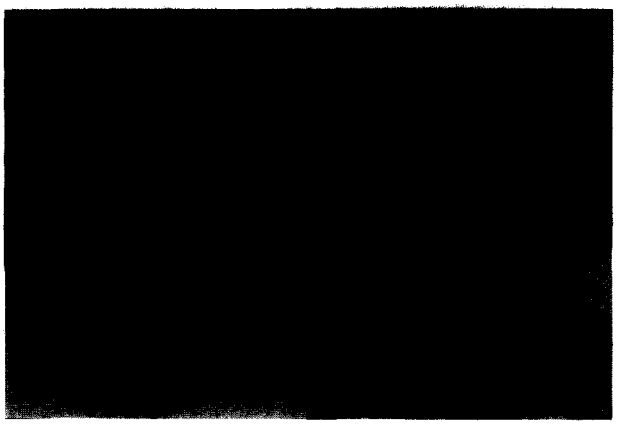

Figure 6. Anterior capsule incision of 6.0 mm diameter stretched well without tearing in both CCC and DC.

with only a few fragments remaining. Heat damage within the cortex extended further than that seen at 1.0 second (Figure 5).

Figures 6 and 7 illustrate the comparison of rim strength in group 2. It was possible to stretch the 6 mm incision of both CCC and DC specimens without tearing (Figure 6). The 3.5 mm incision produced by CCC stretched almost linearly without tearing, but the incision produced by DC tore radially in all specimens at maximum traction of 5 mm (Figure 7).

Experiment 2

Representative tissue specimens of human lens anterior capsules obtained after CCC and DC are shown in Figures 8 and 9. The incised surface resulting from CCC smooth and beveled, with a shorter epithelial side (Figure 8). The incised surface produced by DC has an irregular rim with obvious heat-caused degeneration and ectropion (Figure 9).

Discussion

In experiment 1, results with the first group of animals indicated that excessive coagulation did not produce a larger incision, but merely carbonized the surrounding anterior capsule and extended heat degeneration toward the lens cortex, or longitudinally. Longer coagulation times will not increase the cutting effect. When DC is used, the tip of the chip should be in steady contact with the anterior capsule surface and be manipulated more slowly than in CCC.

In the second group, anterior capsulorhexis rim strength resulting from the two methods was compared. Luck et al,[8] using specimens obtained from an eye bank, reported that tearing occurred easily when using DC. Our study found the rim produced by DC

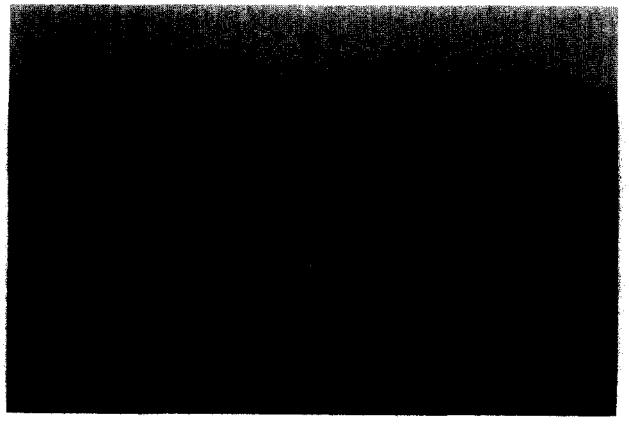

Figure 5. Over 2.0 sec, anterior capsule largely disappeared. Toluidine blue stain (× 200).

Figure 7. Anterior capsule incision of 3.5 mm stretched almost linearly without tearing in CCC; in DC, incision tore with 5 mm fraction.

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Figure 8. Incised surface of anterior capsule of CCC is smooth and beveled.

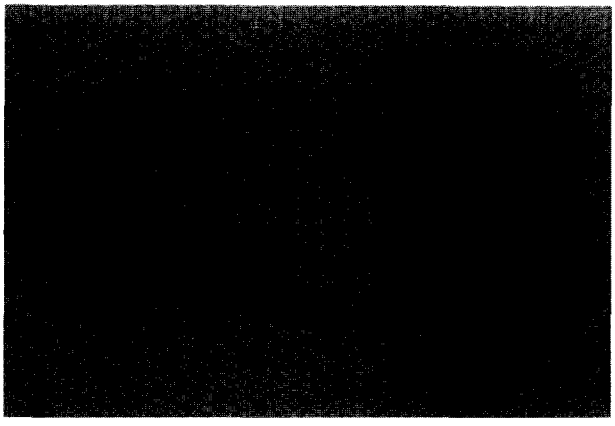

Figure 9. Incised surface of anterior capsule of DC had irregular rim, with degeneration and ectropion.

was less elastic than that with CCC. Although no tear occurred in 6 mm incisions with either method, the 3.5 mm incision of DC did tear, suggesting that this rim was weaker than the one resulting from CCC. Tearing may be minimized by creating an incision large enough to minimize stretching. In clinical application of DC, a 6 mm incision seems to prevent tearing.

Experiment 2 illustrated that the configuration of the rim in the human lens anterior capsule differed clearly with the two techniques. With CCC, the anterior capsule is inverted and pulled, with an incision made first at the lens epithelial side, then extending toward the peripheral portion and proceeding to the surface of the capsule. The incised surface is sloped and smooth. In contrast, the microstructure of the incised surface of the rim produced by DC was irregular and, apparently, facilitated tearing when excessive traction was concentrated at one area.[6,7,9]

Postoperative follow-up periods of the anterior capsulorhexis rim created by radio frequency endodiathermy are not yet sufficiently long enough to evaluate the long-term outcome. Postoperative complications, including contraction of the anterior capsule and late cataract, also need further study. Although DC may produce results that have some strength problems, it does permit precise capsulorhexis, when used with proper care, in cases for which CCC would present difficulty.

An abstract of this study was presented at the 99th General Conference of the Japanese Ophthalmological Society (April 1995, Nagoya).

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