CLINICAL SCIENCE

Diamond burr superficial keratectomy for recurrent corneal erosions

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Br J Ophthalmol 2002;**86**:296–298

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Accepted for publication 16 August 2001

Aims: To evaluate the efficacy and safety of diamond burr superficial keratectomy in the treatment of recurrent corneal erosions.
Methods: A retrospective review of 54 eyes (47 patients) with recurrent corneal erosions treated with diamond burr superficial keratectomy. Preoperative and postoperative visual acuities and refractions, slit lamp examination findings, and the incidence of recurrent erosion after keratectomy were studied. Specular microscopy was also performed in six patients before and after surgery.
Results: 30 eyes had underlying map dot fingerprint anterior basement membrane corneal dystrophy, while 24 eyes did not. Postoperative follow up time ranged from 3 to 53 months (mean 12.3 months). Corneal erosion recurred in three eyes (6%) after diamond burr superficial keratectomy. This procedure improved the best corrected visual acuity from 20/26 to 20/22 by logMAR statistical evaluation (p=0.002) and caused very little change in the refractive spherical equivalent. No endothelial cell loss or changes in morphology were noted on specular microscopy.
Conclusion: Diamond burr superficial keratectomy appears to be an effective and safe method of treating recurrent erosions and is a good alternative therapy to needle stromal micropuncture, Nd:YAG induced epithelial adhesion, and excimer laser surface ablation.

Recurrent corneal erosions can not only be frightening and frustrating for the patient, but also a disabling condition that occasionally may have a protracted clinical course. Abnormalities in epithelial adhesion, which form the basis of this disorder,[1] are frequently associated with previous traumatic abrasions or with corneal dystrophies. There is loss or damage to the ultrastructural adhesional complexes normally responsible for the attachment of the epithelial layer to its underlying substrate.[1–3] Although many cases of recurrent erosion respond satisfactorily to lubrication, patching, topical hypertonic agents, and bandage contact lenses, the more stubborn cases may require surgical intervention.

Surgical treatments include simple epithelial removal, needle or Nd:YAG laser induced anterior stromal micropuncture, excimer laser surface ablation, and superficial keratectomy with either lamellar dissection or with diamond burr polishing. Simple epithelial peeling or scraping[2–5] may not be effective in cleaning the substrate totally free of abnormal basement membrane, and consequently can be associated with higher rates of recurrence.[4] Needle anterior stromal micropuncture therapy,[6 7] although very effective with low recurrence rates, produces multiple focal, permanent scars in the cornea and has a small risk of corneal perforation. Although isolated, small focal corneal scars in the visual axis have never been documented to cause decreased vision or glare symptoms, we believe that it is, nevertheless, best to avoid inducing any opacities in the line of sight. Nd:YAG laser induced adhesion of the epithelium[8 9] similarly produces multiple focal breaks in basement membrane and Bowman's layer, and is associated with low rates of recurrence. Because this technique produces minimal scarring, it is safer than needle micropuncture for treatment of the visual axis. Excimer laser phototherapeutic keratectomy[10–12] is also very effective in treating recurrent erosions, but is associated with a postoperative refractive shift towards hyperopia. However, superficial treatment of less than 10 μm would not be expected to cause a significant hyperopic shift. Both Nd:YAG and excimer laser treatments require large, expensive, highly sophisticated equipment. In a poster presentation, Forstot and coworkers in 1994 reported good success with mechanical superficial keratectomy for recurrent erosions, especially when combined with diamond burr polishing of Bowman's layer.[13] This method requires inexpensive, commonly available instruments, produces no scars in the cornea, and does not tend to produce a refractive shift. We retrospectively studied the records of 54 consecutive eyes (47 patients) which underwent diamond burr superficial keratectomy (DBSK) for recurrent corneal erosion in the 5 year period between 1995 and 2000.

METHODS AND PATIENTS

The clinical records of 47 consecutive patients (54 eyes) who underwent DBSK at the WK Kellogg Eye Center (by surgeons HKS, RFM, and AS) were reviewed. Additional history and follow up data were collected from the referring ophthalmologists when indicated. The M:F sex distribution was essentially equal with 28 males and 26 females, and the mean patient age was 50 at the time of surgery (range 21–67 years). The mean duration of recurrent corneal erosions before diamond burr keratectomy was 48 (range 2–67) months and the mean postoperative follow up time was 12.3 months (range 3–53). All eyes had been treated with at least one other mode of therapy before undergoing DBSK. These methods included the use of lubricants, artificial tears, hyperosmotic agents, patching, bandage soft contact lenses, needle stromal micropuncture, simple epithelial peeling, and excimer laser phototherapeutic keratectomy. Thirty of 54 eyes had map dot fingerprint dystrophy, while the remaining 24 eyes had no evidence of underlying anterior dystrophies.

The DBSK surgeries were performed in the minor outpatient procedure room under an operating microscope and under topical anaesthesia consisting of oxybuprocaine (proparacaine) and/or amethocaine (tetracaine). After sterile preparation and draping, a wire eyelid speculum was inserted. Loose sheets of epithelium were debrided from the cornea, using a combination of peeling with forceps and gentle wiping with an iris spatula or cellulose sponge. In all cases in which the erosions were close to or within the visual axis (44 eyes), the

Table 1 Advantages and disadvantages of diamond burr superficial keratectomy

Advantages:
- Inexpensive
- Requires little surgical skill
- Requires no sophisticated equipment, such as lasers
- Causes no permanent corneal scarring and can be used to treat visual axis
- Possibly removes more abnormal basement membrane than debridement alone
- Low recurrence rate of erosion after treatment
- Re-treatments are simple
- No chance of corneal perforation
- Causes no significant refractive shift
- Removes superficial corneal opacities, if any present

Disadvantages:
- Eye is often painful while epithelial defect is present
- Chance of persistent epithelial defect (eg, in diabetic and neurotrophic corneas)

entire central corneal surface was gently polished with a fine diamond burr (Ugo-Fisch polishing drill), using multiple, even, circular movements, taking care not to induce irregular topography by pushing too hard or tarrying in one region too long. In the remaining 10 eyes with focal erosions well outside the centre, only the affected areas were treated. In order to assure uncomplicated re-epithelialisation, a narrow 1–2 mm rim of corneal epithelium was left intact in the circumferential periphery unless visible erosions were obvious in that area. Whenever possible, in order to reduce the chances of producing haze or refractive changes, treatment was limited to no deeper than anterior Bowman's layer. A bandage soft contact lens was then applied and the eye was started on a combination tobramycin-dexamethasone (Tobradex collyrium) four times daily, which was subsequently tapered over a period of 1–3 weeks. In roughly half the patients, a topical non-steroidal anti-inflammatory agent (diclofenac or ketorolac) was also used four times daily for about a week.

The patients were seen at least once during the first postoperative week, and then at 1 and 3 months thereafter. Some of the patients who were referred from a long distance were eventually returned to their local ophthalmologists for follow up. Patients who had less than 3 months of postoperative follow up were excluded from the study. Preoperative and postoperative clinical examination included visual acuity measurements, manifest refraction, keratometry, and slit lamp biomicroscopy. In six eyes, specular microscopic studies of the corneal endothelium were performed preoperatively and postoperatively to assess the cellular counts and morphology. The cell counts were compared preoperative and postoperatively with Student's *t* test.

Statistical evaluation for the preoperatively and postoperative visual acuities was performed with the logMAR (log of the minimum angle of resolution)[14] program.

Manifest refractions before and after DBSK were converted into spherical equivalents in order to evaluate refractive change after surgery.

RESULTS

Before DBSK, all 54 eyes had failed on medical treatment for recurrent erosion, which consisted of artificial tears, lubricating ointments, patching, hypertonic agents, and bandage contact lenses. Twenty nine eyes had also undergone sometimes multiple previous surgical interventions for their recurrent erosions. Twenty five of these eyes had undergone needle stromal micropuncture therapy or Nd:YAG surface adhesion therapy, three had undergone simple epithelial debridement, and one had undergone excimer laser surface ablation. In each case, corneal erosions recurred within 2 months after these antecedent surgeries.

DBSK improved the best corrected visual acuity from 20/26 (logMAR 0.107) to 20/22 (logMAR 0.043) by logMAR statistical evaluation ($p=0.002$).

The mean preoperative and postoperative dioptric spherical equivalents by manifest refraction were −1.38 (SD 2.95) and −1.41 (2.58), respectively. The change in spherical equivalent from before to after DBSK was −0.37 (0.15). Forty nine eyes (91%) had <0.50 dioptre change in the spherical equivalent after DBSK, while five eyes (9%) had >0.50, but <1.50 dioptre change.

Three eyes (6%) had a recurrent corneal erosion within 2 months after DBSK; however, following re-treatment with DBSK, none of these eyes had further recurrences in at least 2 years. Two of the three eyes with recurrence had underlying map dot fingerprint dystrophy. Although no eyes had anterior stromal scarring resulting from the procedure, 11 eyes did show faint anterior stromal haze lasting about a month before fading. Specular microscopy of the endothelium showed neither evidence of morphological change nor decreases in cell density ($p<0.05$)

DISCUSSION

It has been over 125 years since recurrent corneal erosion syndrome was first described by Hansen in the Danish literature.[15] In 1906, Franke treated recurrent corneal erosion by debriding the epithelium and applying chlorinated water.[16] Over a 3 year period, only two of his patients required re-treatment. Thygeson reported a 60% cure rate in 1959 with chemical cautery with iodine.[17] Buxton and Fox reported in 1983 an 85% success rate with total epithelial debridement, followed by use of bandage contact lens therapy.[18] In 1984, Wood described excellent results using superficial corneal puncture therapy with diathermy.[19] McLean and coworkers[6] described in 1986 superficial puncture therapy with a 20 gauge hypodermic needle with an 86% success rate after one therapeutic session. The eyes that had recurrence after initial therapy underwent a second session, which effectively prevented further recurrences. More recently, the use of Nd:YAG laser superficial corneal spots instead of needles showed good results with less scarring.[8 9] In 1987, Buxton and Constad[5] reported a 3% recurrence rate in patients treated with total epithelial debridement when they polished the limbus with a diamond burr; however, they did not polish the central cornea.

Our study strongly suggests that DBSK is a safe and effective treatment of recurrent corneal erosions. It appears to be a good alternative surgical therapy to simple epithelial debridement, needle stromal puncture, Nd:YAG laser induced epithelial adhesion, and excimer laser anterior corneal ablation. Table 1 enumerates the advantages and disadvantages of this technique in comparison with other current surgical modes of therapy.

To date, the exact anatomical and functional mechanisms of action for procedures that affect Bowman's layer, such as DBSK, needle stromal puncture, Nd:YAG laser treatment, and

excimer ablation, are unknown. It is generally accepted that these procedures may involve reactive fibrosis or production of extracellular matrix proteins responsible for proper adhesion of the epithelium to its substrate.[7 20] Brown and Bron noted that epithelial debridement alone was no more effective than medical therapy alone, and that scarring of Bowman's layer might be necessary for prevention of recurrent erosions.[4]

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