SCIENTIFIC REPORT

Choroidal detachment in perforated corneal ulcers: frequency and management

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Aims: To determine the frequency of choroidal detachment (CD) in eyes with non-traumatic corneal ulcer perforation and, also, to assess the efficacy and safety of cyanoacrylate glue in sealing corneal perforations.

Methods: 18 eyes of 17 patients were studied. Inclusion criterion was any patient with a non-traumatic perforated corneal ulcer. All patients had a thorough history taken and complete ophthalmic examination including B-scan ultrasonography. Patient demographics, presence of CD, and efficacy of corneal gluing were assessed.

Results: Eight of the 18 eyes (44%) were documented to have a CD. Among perforations of $>2\text{ mm}^2$, six eyes (75%) were documented to have CD compared with two eyes (20%) with perforations of $\leq 2\text{ mm}^2$ ($p=0.054$). No correlation could be determined between perforation duration and incidence of CD. Of the 15 eyes that underwent gluing, there were 13 successes (87%) and two failures (13%). Within the successes four patients (27%) required re-gluing because of infection (one patient) or progression of melt and glue loosening (three patients). Failure was the result of severe progression of melting (one patient) and a very large perforation (one patient).

Conclusion: Choroidal detachment following corneal ulcer perforation is common and is more likely in larger corneal perforations. Preoperative B-scan should be considered in cases of large corneal perforations requiring therapeutic keratoplasty to document choroidal detachment, which if large may require drainage. Cyanoacrylate glue is an effective and safe method for sealing small corneal perforations. A vigil must be maintained for infection while the glue and bandage contact lens are in situ.

Corneal perforation is a sight threatening condition, which if untreated can lead to complications including glaucoma, cataract, and endophthalmitis.¹ It can be caused by trauma or ulceration from infectious, inflammatory, or neurotrophic conditions and exposure keratopathy.^{1,2} Initial management is by sealing the perforation and controlling inflammation. Perforations can be sealed with cyanoacrylate or fibrin glue, conjunctival flap, scleral or amniotic membrane graft. Emergency (therapeutic) penetrating keratoplasty (EPK) may be required for large perforations.^{1–7}

EPK can be quite challenging and has a poor prognosis when performed in an inflamed eye.^{5,8,9} Maharajan *et al* noted that choroidal detachment (CD) in perforated corneal ulcers frequently required drainage during EPK to re-form the anterior chamber.³ A shallow anterior chamber (AC) can cause synechiae, glaucoma, and endothelial trauma compounding the risk of graft failure. They recommended routine

preoperative B-scan ultrasound on all patients with corneal perforation to anticipate this surgical difficulty.

The frequency of CD in eyes with perforated corneal ulcers is not known. Our aim was to determine this frequency and to assess the efficacy and safety of cyanoacrylate for sealing ulcerative corneal perforations.

PATIENTS AND METHODS

This was a prospective consecutive case series from a single tertiary referral centre from March 2004 to September 2005. Patients with non-traumatic perforated corneal ulcers were included but excluded if they had another perforation within 3 months of their initial episode. All patients had a complete history taken and examination including B-scan ultrasonography. CD presence, size of perforation, and where possible its duration were recorded.

Eighteen eyes of 17 patients were included (table 1). Cases 5 and 6 were the same eye of the same patient with two rheumatoid related corneal perforation episodes 1 year apart. Fifteen of the perforations could be glued. The average age was 69 years (range 53–85 years). Nine were male (50%). Eight corneal perforations were from rheumatoid related melts that were also treated with aggressive systemic immunosuppression (methotrexate, azathioprine) and topical lubrication. Seven were perforated ulcers from bacterial keratitis and were treated with intensive fortified topical antibiotics (cefuroxime 10% and gentamicin 1.5%). *Pseudomonas aeruginosa* was the micro-organism in five patients, *Staphylococcus aureus* in patient 18, and no organism was found in patient 3. Two patients had perforation from herpes simplex keratitis and one had a melting cornea from a non-healing neurotrophic ulcer secondary to molten metal injury 7 years earlier.

The duration of the perforation, defined as the time from the occurrence of perforation to the detection of CD by B scan ultrasound, when not directly observed was estimated from the history by asking when the patient noticed a sudden decrease in their vision and/or when they noticed a sudden gush of fluid from their eye or experienced pain of sudden onset. In some cases accurate assessment of the time of perforation was not possible.

B-scan ultrasound (Ophthalmic Technologies Inc, Ontario, Canada) was performed gently through closed eyelids with enough pressure to achieve an image and not compress the eye as previously described.³ Patients were asked to look in different directions of gaze during the examination.

Corneal gluing using N-butyl-2-cyanoacrylate, Histoacryl (B Braun, Melsungen, Germany) was performed under topical anaesthesia. A 3 mm disc of non-adhesive sterile drape (3M Minnesota, USA) was cut with a skin punch biopsy trephine and mounted on a swab stick (K-Sponge-Katena Products, NJ, USA) with chloramphenicol ointment.

Abbreviations: AC, anterior chamber; CD, choroidal detachment; EPK, emergency penetrating keratoplasty

Table 1 Summary of patient details

Case	Age	Sex	Diagnosis	Eye	Perforation area*	Perforation duration†	Choroidal detachment	Initial treatment	Glue duration¶	Vision	
										Preop	Postop
1	77	M	PUK	R	2	1	yes	glue	13	2/60	6/60
2	79	M	PUK	L	4	3	yes	glue	4	6/60	6/36
3	60	M	MK	R	4	1–15‡	no	glue	6	CF	6/24
4	76	M	PUK	R	1.5	1	no	glue	8	6/12	6/12
5	73	F	PUK	L	1	1	no	glue	4	HM	HM
6	73	F	PUK	L	1	2	no	glue	6	PL	HM
7	68	F	MK	L	8	7	yes	evisceration	NA	PL	NPL
8	85	M	PUK	R	4	1	yes	glue	3	HM	HM
9	72	F	PUK	L	1	1	no	glue	12	2/60	6/36
10	53	M	HSV	L	1	3	no	glue	11	1/60	6/9
11	84	M	HSV	R	9	4	yes	glue	NS	CF	6/60
12	66	M	NU	L	4	1	no	glue	8	HM	HM
13	78	F	PUK	R	1	2	no	glue	4	6/36	6/18
14	83	F	MK	R	2	NA	no	glue	6	6/60	6/18, HMs
15	75	F	MK	R	15	2	yes	PK	NA	PL	6/5
16	63	F	MK	R	9	1	yes	PK	NA	HM	6/24
17	40	M	MK	R	1	1	yes	glue	5	CF	6/24
18	45	M	MK	L	1	4	no	glue	4	CF	6/24

PUK, peripheral ulcerative keratitis (all rheumatoid related); MK, microbial keratitis; HSV, herpes simplex keratitis; NU, neurotrophic ulcer, PK, therapeutic penetrating keratoplasty; NS, not successful; NA, not applicable; CF, counting fingers. HM, hand movements, PL= perception of light. NPL, no perception of light. *Area in mm²; †duration in days; ‡range given for possible duration of perforation; ¶duration of glue in weeks; §graft eventually failed.

A thin meniscus of glue was placed on the plastic disc, the area surrounding the perforation dried, and the disc applied to the perforation so that the glue spread as a thin layer between the cornea and the disc before it polymerised (fig 1). The eye was examined for AC reformation and leaks after 30 minutes and maintained on topical antibiotics.

B-scan examination and corneal gluing were carried out by the consultant or the trained fellow, under supervision.

RESULTS

Eight eyes (44%) were documented to have CD. Approximate perforation area was calculated by multiplying its length and height and patients divided into two groups: one with perforation size >2 mm² (eight patients), of which six (75%) had CD compared to the other of perforation size ≤ 2 mm² (10 patients), of which two (20%) had CD ($p = 0.054$, Fisher's exact test).

The approximate duration of CD was determined in 15 patients (mean 2.5 days, range 1–7 days). No correlation could be found between duration of perforation and the occurrence of CD.

Of the three eyes not initially glued one was in a 68 year old mentally handicapped patient (patient 7) who had a large unresponsive perforated *Pseudomonas* ulcer and required evisceration. The other two eyes (patients 15 and 16) underwent EPK because of large perforations. B-scan documented CD in both and suprachoroidal drainage was needed intraoperatively in one (patient 16).

Outcomes of gluing were divided into success and failure. Success was defined as complete and permanent sealing of the perforation with a single or repeated (four patients) application of glue, which remained healed when the glue was removed or came off. Failure occurred when initial gluing was not successful and subsequent gluing was inappropriate. Of 15 eyes that underwent gluing, 13 were

Figure 1 Patient 3. Corneal perforation (A), followed by successful gluing (B) and eventual removal of glue with healed corneal perforation (C and D).

Figure 2 Patient 11. Large central corneal perforation which could not be successfully glued (crystalline lens seen centrally (A)). Fluorescein picture demonstrating brisk leakage from perforation (B). B-scan showing inferior choroidal detachment (C). One month following successful penetrating keratoplasty (D).

successes (87%) and two failures (13%). The mean duration for glue in situ was 6.8 weeks (range 3–13 weeks).

Two eyes developed shallow AC from loosening of the glue and were re-glued successfully (patients 1 and 9, 14 days and 17 days after initial gluing respectively). Patient 6 had further melting and perforated 1 month after initial gluing and required EPK. No CD was present. Twelve months later corneal melting and perforation recurred (patient 5). The cornea was glued but 16 days later he re-presented with a shallow AC with glue loosening and was successfully re-glued.

Patient 10 developed microbial keratitis at the edge of the glue and perforated but was successfully re-glued and the infection treated. Patient 11 had a very large perforation that required EPK (fig 2). CD though present, did not require drainage.

DISCUSSION

The mechanism for CD in corneal perforation is complex.¹⁰ The pressure in the suprachoroidal space is lower than intraocular pressure by 2–3 mm Hg, which assists apposition of choroid and sclera. The elasticity of the choroid, constant loss of fluid across the sclera and emissarial channels, and fluid absorption from the choroidal vessels secondary to colloid osmotic pressure differences also contribute. Hypotony retards fluid loss below the rate of entry resulting in CD. A thick sclera with increased proteoglycans also resists flow of fluid with resultant accumulation and CD.¹¹ Inflammation, through increased vascular permeability, increases suprachoroidal colloid osmotic pressure encouraging fluid accumulation. CD increases uveoscleral outflow resulting in further hypotony and a vicious cycle thus occurs. CD resolves after hypotony settles or when the cycle is broken by surgical drainage.

CD can push the lens-iris diaphragm anteriorly and make AC reformation difficult during EPK unless drained.^{3 12} Lens-cornea touch causes loss of endothelium, which can lead to graft failure.

CD was present in 44% of eyes with perforated corneal ulcers and tended to be more frequent in larger perforations. Although no correlation was found between duration of perforation and presence of CD we were unable to accurately determine the actual time of occurrence of perforation in some patients and B-scan ultrasound examination to detect

CD was performed on the day of presentation, not necessarily the day the CD occurred.

Maharajan *et al* found CD drainage was required in all patients with documented CD.³ Three patients in our series required EPK, two with CD of which one required drainage. Maharajan *et al*'s patients may have had larger CDs because of larger perforations (all >4 mm²) and more inflammation (ulcers all 8–9 mm).

We found a tendency for CD to occur in larger perforations. We recommend preoperative B-scan in all patients with perforations, especially large perforations (>2 mm²) requiring EPK to help anticipate the need for CD drainage. The timing of drainage is best after the graft has been sutured. If attempts to reform the AC fail then drainage should be attempted. If the AC forms and the eye pressure is restored, the CD often resolves spontaneously.

Cyanoacrylate glue can effectively seal small corneal perforations (<3 mm diameter) and may inhibit collagen breakdown and have Gram positive bacteriostatic effects.^{13–18} Glue may however fail if there is recurrence of melting, complicating microbial keratitis or when the perforation is large. Since EPK has poor survival glue should be used to delay surgery until the eye is quiet.^{8 19} This study illustrates that sealing the perforation with cyanoacrylate glue results in resolution of the majority of choroidal effusions with restoration of ocular pressure. Human fibrin is an effective alternative that encourages less vascularisation but carries the risk of transmitting infections.^{7 14 20}

The protocol used in the examination and management of patients with non-traumatic corneal perforations reflects the surgeon preference of our centre. As a tertiary referral centre, the case mix of patients with non-traumatic corneal perforations may be biased towards the more complex cases.

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