Original Article

To Assess the Efficacy of Chemical Corneal Tattooing for Unsightly Corneal Scars

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Purpose: To study the efficacy and safety of chemical corneal tattooing for unsightly corneal scars.

Material And Methods: A prospective clinical study of 44 consecutive cases in the age range from 5 - 60 years was conducted at the oculoplastic department o Mughal Eye Trust Hospital, Lahore from June 2012 - Dec 2013. All patients desired a cosmetic treatment for their disfigured, white blind eye. After a complete ophthalmic examination and B scan ultrasound, and photographs of the patients eyes were taken. Chemical corneal tattooing was performed using 2% Gold Chloride and 2% Hydrazine Hydrate. Patients were followed up at the first, third and fifth post-operative day; then weekly for a month, at 3rd month, 6th month and 1st year post-operatively.

Results: All patients had a mild red eye and discomfort in first few days but not afterwards. No corneal erosion or corneal melting was not noted in any case. Procedure had to be repeated in 5 cases (11.5%) after 3-6 months of the initial therapy. One year postoperatively, 42 cases (95.5%) were satisfied and asymptomatic; 2 cases (4.5%) were lost to follow-up.

Conclusion: Chemical corneal tattooing is a simple, safe and an efficient technique yielding acceptable cosmetic results.

Key words: Corneal tattoo, Corneal scar, Ocular trauma.

Corneal tattooing has been used not only as a cosmetic treatment for corneal opacities but for optical reasons as well for centuries. A whitish corneal scar following keratitis or trauma is cosmetically disfiguring as well as causes scattering of light and glare. Tattooing such a cornea not only blends the opacity to the normal eye color which is cosmetically acceptable in a blind eye but removes the glare in a sighted eye. It has been recommended to improve the sight of an eye in cases of albinism, aniridia, coloboma, iridodialysis, keratoconus or diffused nebulae of the cornea.[1,2] In these situations, it reduces the symptomatic glare associated with a dysfunctional pupil or scattering of light produced by corneal opacities.

Various methods have been introduced and modified over the years. Galen (131-210 A.D.)[3] is considered to be the first who dyed human cornea to mask a corneal opacity using reduced copper sulphate. Then Louis Von Wecker[4], an oculoplastic surgeon in 1869, used black India ink to tattoo a leucoma of the eye. He anesthetized the eye with cocaine and covered the cornea with a thick solution of ink. The pigment was then inserted into the corneal tissue with a grooved needle obliquely. In 1901, Nieden[5] used an electric tattooing needle based upon the idea of a fountain pen. Another physician, Armaignac[5], used a small funnel fixed to the cornea by three small points. China ink was filled into the instrument and injected into the stroma with a needle. Nowadays, two methods are used predominantly for tattooing the cornea.

(1) **Chemical Method**: this involves using metallic salts which react with each other chemically to produce a brown-black precipitate that is taken up by the keratocytes and stain the cornea. The chemicals

used are Gold chloride, platinum chloride, silver nitrate reduced by hydrazine hydrate to a black pigment. The reacting chemicals are applied over the stroma directly after peeling the corneal epithelium. This technique was first introduced by Arif O Khan and David Meyer[6].

(2) **Coloring Method**: this technique involves the direct introduction/impregnation of colored pigments into the corneal stroma. To obtain a uniform color, the dyeing agent is injected through multiple micro-punctures[7] by a needle inserted into the corneal stroma. Various colored dyes and inks such as Indian ink, organic colors, animal uveal pigment, Chinese ink, soot have been used. To obtain different shades, surgeons experiment with different combinations of such chemical products.

The new advances in technology include using excimer laser to prepare the corneal bed for tattooing[8]; lamellar keratectomy offers excellent results in terms of a homogeneous application of colour[9] but for many scars, this is not possible because of irregularity, thinning, staphyloma or calcification of cornea. Penetrating keratoplasty (PK) has the risks of infection and graft rejection and its use for cosmetic purposes is ethically unacceptable in many parts of the world due to the worldwide shortage of corneal donors. Mechanized keratopigmentation[10] is another costly option. Alternative methods to improve the aesthetic appearance of disfigured eyes are cosmetic contact lenses, keratoplasty, wearing ocular prosthesis with or without an enucleation or evisceration[11]. With contact lenses, intolerance frequently develops after prolonged use[12] while wearing an ocular prosthesis over a scarred cornea often causes inflammation, infection and corneal erosion. Hence tattooing of corneal opacities still has a role for the cosmetic improvement of unsightly corneal scars. Our study aimed to investigate the potential of corneal tattooing to improve the ocular cosmetic appearance, to demonstrate its safety, efficacy and to investigate its potential as an alternative to invasive reconstructive surgery for the cosmetic correction of disfigured corneas.

MATERIAL AND METHODS

This prospective, interventional, non-comparative clinical case study was conducted at the oculoplastic department of Mughal Eye Trust Hospital, Lahore, a tertiary care referral centre, from June 2012-Dec 2013. 44 consecutive, non randomized patients were included in the study between the age range of 5 – 60 years (median 21 years). There were 19 females (43.18%) and 25 males (56.82%). All of them were blind in one eye due to past trauma and desired a cosmetic treatment for their disfigured, white eye. Ophthalmic examination was performed thoroughly including B scan ultrasound to exclude intraocular tumor. The depth of corneal opacity, corneal thickness, the presence and extent of band keratopathy and corneal vascularization was carefully assessed by biomicroscopy. Study inclusion criteria was superficial or deep corneal opacities, band keratopathy, leukokoria (due to a dense cataract with no visual potential or a pupillary membrane). Patients with phthisical eyes, thin corneas, corneal edema (bullous keratopathy), anterior staphyloma and glaucoma were excluded from the study.

After fully explaining to the patients and their parents that this procedure was not meant to restore sight but only their cosmetic appearance and they may need a repeat procedure, an informed consent was obtained and preoperative photographs of the patients' eyes were taken. Corneal tattooing was performed under general anesthesia in children and local anesthesia (retrobulbar) in adults. Accurate measurement of corneal area to be tattooed compared to the second eye was done intra-operatively with a caliper. Corneal epithelium was debrided using a No.15 Bard Parker-knife. In eyes with band keratopathy (12 cases), first chelation was performed with EDTA solution applied with a cotton wick on the debrided cornea for 10 minutes. It was then washed off with normal saline. Any bleeding corneal vessels were cauterized at the limbus. After drying the cornea with a sponge, 2% Gold Chloride solution was applied over the corneal stroma and left for two minutes; then 2% Hydrazine Hydrate solution was applied over the stroma painted with gold chloride. A black precipitate immediately formed (due to a chemical reaction between the two solutions) which deeply stained the stroma. It was left in place for 25 seconds and then washed off with normal saline. Atropine eye drops (1%) and tobramycin eye ointment were instilled and a pressure dressing was done with a double eye-pad for 24 hour. Postoperatively, all cases were given NSAIDS orally for two days. The dressing was removed the next morning and Diclofenac Sodium eye drops were prescribed four times / day, atropine 1% eye drops twice / day and antibiotic eye drops four times /day for a week. Patients were followed up at the first, third and fifth post-operative day; then weekly for a period

of 1 month and then at 3rd month, 6th month and 1st year post-operatively.

RESULTS

Forty four eyes of 44 patients, 19 females (43.18%) and 25 males (56.82%), (Table 1), with an age range of 5 to 60 years (Table 2) underwent corneal tattooing for disfiguring corneal scars (Table 3). 24 cases (54.53%) had superficial corneal opacities, 12 cases (27.27%) had deep corneal opacities with associated band keratopathy. A dense pupillary membrane with clear cornea was present in 4 cases (9.1%) while a cataract with no visual potential and an associated corneal opacity was present in 4 cases (9.1%).

Table 1: Gender distribution

Sex	No. of Patients n (%)
Male	25 (54.53)
Female	19 (27.27)

Table 2: Age distribution

Age	No. of Patients n (%)
5 - 10 years	2 (4.7)
11 - 20 years	14 (31.81)
21 - 30 years	12 (27.27)
31 - 40 years	8 (18.18)
41 - 50 years	5 (11.32)
51 - 60 years	3 (6.81)

Table 3: Preoperative observations

	No. of Patients n (%)
Superficial corneal opacity	24 (53.53)
Deep corneal opacity and associated Band keratopathy	12 (27.27)
Dense Pupillary membrane	4 (9.1)
Cataract with no light projection	4 (9.1)

On the first postoperative day (Table 4), 96% of the patients complained of a moderate foreign body sensation and exhibited a conjunctival injection which corresponded to the surgically induced corneal epithelial defect and chemical reaction. Once the cornea was completely epitheliazed in 48 hours in 37 cases (84%) and after 5 days in 7 cases (16%), the discomfort and conjunctival injection resolved. Corneal infection was not observed in any case. Minimal pigment loss was observed in 5 cases (11.5%) from 3 month onwards and they underwent a repeat procedure. Corneal melting and corneal erosions were not seen in any case. One year postoperatively, 42 cases (95.5%) were satisfied with the cosmetic appearance and were asymptomatic; 2 cases (4.5%) were lost to follow-up.

DISCUSSION

Several methods for corneal tattooing are in practice today with varying opinions regarding their safety and success. Chemical tattooing as described in this study involves a chemical reaction where gold chloride is reduced by hydrazine hydrate to a black precipitate[7]. This metallic precipitate is deposited in the keratocytes and between the stromal lamellae from which it slowly migrates into the regenerated epithelium and stays there for a variable time period. It is important that the bowman's membrane is not damaged during the procedure as its integrity is very essential for maintaining a strong and healthy epithelial lining of the cornea. Injury to this membrane either mechanically while performing epithelial debridement or chemically results in recurrent corneal erosions which is an intractable and painful condition[14]. In our technique, the epithelium was carefully removed under the microscope without damaging the Bowman's membrane. This gave 95% satisfactory results to our patients with no corneal erosion seen in any case during follow up.

On the other hand, the method of direct impregnation of colored dyes either by a needle or a blade is not 100% safe[12]. It is very difficult to determine the exact depth the needle or the blade has traversed through an opaque cornea and accidental damage to the Bowman's membrane can easily occur particularly when multiple needle punctures are made. The corneal epithelium fails to adhere and stabilize at the site where Bowman's membrane is damaged. Hence the problem of recurrent corneal erosions is frequently seen because of this technique. Moreover, there is always a risk of accidently puncturing the cornea at the area of stromal thinning when corneal punctures are made blindly at multiple

Table 4: Postoperative complications

Complications	Day 1 No. of Cases	Day 3 No. of Cases	Day 5 No. of Cases	1 Month No. of Cases	3 Month No. of Cases	6 Month No. of Cases	1 Year No. of Cases
Total Corneal epithelization	–	9 (16%)	–	–	–	–	–
Pain	+44 (100%)	+9 (16%)	–	–	–	–	–
Congestion	+44 (100%)	+9 (16%)	–	–	–	–	–
Stromal thinning	–	–	–	–	–	–	–
Corneal erosions	–	–	–	–	–	–	–
Corneal melting	–	–	–	–	–	–	–
Repeat Tattooing	–	–	–	–	5 (11.5%)	–	–

sites by a needle. This complication was easily avoided by our technique.

According to Walter Sekundo et al.[14], in the British Journal of Ophthalmology, chemical dyeing is easier and quicker than carbon impregnation, but it fades more rapidly than non-metallic tattooing. However, in our study, fading of the dye occurred only in 5 cases (16.67%) and they needed repeating of the corneal tattooing. In the remaining 25 cases (83.33%), corneal staining remained stable over the one year follow-up.

Commercially available sterilized drawing ink in different shades had been used over decades being first introduced by Holth[13] in 1926. Sekundo[14] and co-workers recently supported this assessment of ink as a well tolerated staining agent in their histological evaluation of specimens up to 61 years after corneal tattooing. These inks obviously are superior to the ancient china ink, which is well known to cause substantial inflammation[14]. Nevertheless, the composition of the ink used is a crucial point and without a chemical analysis, the possibility of corneal or conjunctival toxicity cannot be excluded. Generally, these inks contain 85% water and 10% pigments which are water insoluble. Therefore, absorption and systemic toxicity may be excluded but there have been reports of keratitis and iridocyclitis seen as a result of toxicity caused by commercially prepared dyes and inks. A chemical reaction can potentially cause corneal toxicity; it was seen in two of our initial cases when we started this procedure (these cases are excluded from our study). In these, the Hydrazine Hydrate was not washed away for a minute and corneal epithelial healing was found to be delayed with a persistent red eye for a week. This was caused by epithelial toxicity and stromal melting by the chemicals. It was treated by applying a bandage contact lens and 1% Cyclosporin eye drops twice a day. Since then, we have revised the procedure and recommend washing away the black precipitate with plenty of distilled water after 25 seconds of application of Hydrazine Hydrate over Gold Chloride. Once we adopted this method, no epithelial defects were seen in any case; the cornea was fully epitheliazed in 37 cases (84%) within 48 hours and in 9 cases (16%), in five days, conjunctival injection disappeared similarly in all cases. It was observed in our study that the normal cornea as well as superficial corneal scars stained well permanently than deep stromal fibrotic scars; the 5 cases (11.5%) in which fading of the color was noted was on areas of dense stromal fibrosis and they needed a repeat procedure.

The 12 cases (27.27%) with calcified corneal plaques were easily managed by dissolving the calcium deposits in EDTA paste applied over the abraded corneal epithelium for 10 minutes. EDTA dissolves the calcium in the epithelium as well as the corneal stroma. However, it is a painful procedure and retrobulbar anesthesia in adults and general anesthesia in children is recommended. Simple corneal tattooing can be done under topical anesthesia alone.

CONCLUSION

Chemical tattooing of unsightly corneal scars has proved to be an efficient and a simple technique. It is a safe surgical procedure that does not require

expensive materials and offers a viable option to avoid more extensive and invasive reconstructive ocular surgery. Chemical corneal tattooing by this technique gives a stable, satisfactory cosmetic result with high patient satisfaction in all cases and an improved quality of life.

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