The Egyptian Journal of Hospital Medicine (April 2025) Vol. 99, Page 2509-2518

Assessment of Corneal Epithelial Healing Rate after Pterygium Excision When Using 2% Hyaluronic Acid

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ABSTRACT

Background: Hyaluronic acid (HA) ampule hastens corneal epithelialization in many clinical situations. Its anti-inflammatory effect helps to reduce pain and discomfort after eye surgery and accelerate healing.

Aim of the study: To assess the effect of 2% hyaluronic acid on corneal epithelial defect healing rate and on controlling pain after pterygium excision.

Patients and Methods: This case-control randomized interventional study involved 30 patients (30 eyes), aged 18–60 years, of both sexes, diagnosed with unilateral primary pterygium and treated with pterygium excision. Participants were divided equally into two groups: Group A (HA Group) received a thin layer of 2% hyaluronic acid (HA) along with standard treatment—tobramycin 0.3%, dexamethasone 0.1%, and a tear substitute—administered four times daily, plus a combination ointment of dexamethasone 0.1% and tobramycin 0.3% at bedtime. Group B (Control Group) received the same standard ophthalmic regimen without the 2% HA.

Results: Acuity, sphere, and cylinder values demonstrated negligible differences between groups. No significant differences were observed in intraocular pressure or pterygium grading ($p > 0.05$). Extraocular muscle assessment also revealed no significant difference ($p > 0.05$). On days 0, 1, 2, and 3, the width and height of corneal epithelial defects and visual analog scale scores were significantly lower in Group A compared to Group B ($p < 0.05$).

Conclusions: The effectiveness of 2% hyaluronic acid has been demonstrated, as it improves the size and healing of corneal epithelial defects and reduces pain following pterygium excision.

Keywords: Corneal Epithelial Healing Rate, Pterygium Excision, Hyaluronic Acid, Tobramycin.

INTRODUCTION

Pterygium is an ocular surface disorder characterized by a triangular, fibrovascular subepithelial encroachment of degenerated bulbar conjunctival tissue that extends over the limbus and onto the cornea [1].

The global prevalence of this condition varies significantly, with reported rates ranging from 1.2% to approximately 40% across different geographical regions. While its development is multifactorial, involving elements such as viral infection, hereditary predispositions, immune responses, aseptic inflammation, and general environmental irritation, the primary pathogenic driver of pterygium is exposure to ultraviolet (UV) radiation [2]. Specifically, prolonged exposure to sunlight is a key risk factor, as it is understood to damage the limbal stem cell barrier, thereby facilitating the conjunctivalization of the cornea and promoting pterygium advancement [3].

Beyond aesthetic concerns, pterygium can lead to various clinical problems, including ocular irritation, disruption of corneal transparency, particularly when encroaching upon the pupillary area, and visual impairment resulting from induced corneal astigmatic refraction [4].

Histopathologically, pterygium tissue is complex, involving proliferative clusters of limbal stem cells, epithelial metaplasia, active fibrovascular tissue formation, chronic inflammation, and a notable disruption of Bowman's layer along the invading apex of the lesion [5].

Surgical excision remains the primary treatment modality for pterygium. A range of surgical procedures are employed to address the condition, including bare sclera excision, rotational conjunctival flap techniques, limbal conjunctival autografting, application of amniotic membrane grafts, and free conjunctival autograft procedures [6]. Postoperative pain and discomfort are common sequelae, often managed with non-steroidal anti-inflammatory drugs (NSAIDs), topical anesthetics, and opioids. It has been observed that delayed epithelial healing is frequently associated with increased postoperative pain and discomfort [7].

Furthermore, the anti-inflammatory effects of certain agents are recognized for their ability to alleviate pain and discomfort across various clinical conditions, ranging from joint diseases like osteoarthritis to soft tissue injuries and skin wounds. In the ophthalmic context, such anti-inflammatory properties are particularly beneficial after eye surgery, where they contribute to pain reduction and accelerate the healing process [8].

The ophthalmic applications of hyaluronic acid (HA) are well-established and diverse, integrated into various pharmaceutical preparations such as artificial tears, eye drops, in situ forming hydrogels, modified nanoparticles, and intravitreal injections. Notably, HA-containing eye drops are recognized for their capacity to hasten corneal epithelialization in numerous clinical scenarios. A previous study specifically demonstrated that the rate of corneal wound healing exhibited a direct correlation with the concentration of HA applied [9].

Received: 20/01/2025
Accepted: 20/03/2025

AIM OF THE WORK

The present study was meticulously designed to investigate the therapeutic efficacy of topically administered 2% hyaluronic acid. Specifically, its primary objective was to ascertain the influence of this intervention on the rate of corneal epithelial defect healing and its capacity for controlling postoperative pain following surgical pterygium excision. This investigation sought to determine whether hyaluronic acid could accelerate corneal re-epithelialization and mitigate discomfort, thereby potentially improving patient recovery outcomes.

PATIENTS AND METHODS

Study Design and Participants

A prospective, randomized interventional study was meticulously conducted involving 30 patients (30 eyes) diagnosed with unilateral primary pterygium. These individuals were recruited from the Ophthalmology Department at Al-Zahraa University Hospital, with patient enrollment and procedures occurring between January 2024 and May 2024. All participants underwent standard pterygium excision surgery.

Randomization and Interventions

Participants were randomly assigned, in a parallel manner, into two distinct treatment groups:

- **Group A (HA Group):** Comprising 15 eyes, patients in this group received a thin topical application of **2% hyaluronic acid (HA)** in addition to a standardized regimen of ordinary ophthalmic medications. This regimen included antibiotic drops (tobramycin 0.3%), corticosteroid drops (dexamethasone 0.1%), and a tear substitute, all administered four times daily. A combined antibiotic (tobramycin 0.3%) and dexamethasone 0.1% ointment was also applied at bedtime.
- **Group B (Control Group):** Consisting of 15 eyes, patients in this group received the same ordinary ophthalmic medication regimen as Group A but without the addition of the 2% hyaluronic acid.

Eligibility Criteria

Stringent inclusion and exclusion criteria were applied to ensure study homogeneity and to minimize confounding variables:

Inclusion Criteria

- The age range was from 18 to 60 years.
- Both sexes were included.
- Patients had a confirmed diagnosis of unilateral primary pterygium.

Exclusion Criteria

Patients were excluded if they presented with any of the following conditions:

- Recurrent pterygium or pre-existing corneal abnormalities that could influence healing or assessment.
- Diagnosed limbal stem cell deficiency or corneal decompensation, as these conditions inherently affect corneal health and wound healing.
- Dementia or any form of mental instability that could impede their ability to provide accurate feedback or adhere to the study protocol.
- Deafness or any communication barrier that would prevent reliable assessment using tools like the Visual Analogue Scale (VAS).
- Regular use of preoperative or postoperative analgesics, which could confound pain assessment.
- Presence of ocular malignancy.
- Active ocular infections, which could impact surgical outcomes and healing.
- Diagnosed glaucoma.
- Concurrent use of other ophthalmic drugs that might interact with the study medications or influence healing.
- Systemic diseases known to interfere with corneal wound healing, such as diabetes mellitus and various collagen diseases, ensuring that the study's focus remained on the local effect of the intervention.

All enrolled patients underwent a comprehensive series of assessments, encompassing detailed history taking, essential laboratory investigations, and thorough ophthalmological examinations.

Full History Taking

- A comprehensive personal history was meticulously collected for each participant, including their name, age, sex, and occupation. The present history focused on the onset, course, and duration of their symptoms related to pterygium. Additionally, information regarding any history of ocular trauma or previous eye surgeries was documented, alongside a family history to identify any similar conditions that might indicate a genetic predisposition.
- **Laboratory Investigations**

  Routine preoperative laboratory investigations were performed for all patients. These included a complete blood count (CBC) to assess overall hematological status and a coagulation profile to evaluate blood clotting function, ensuring patient safety during the surgical procedure.

Ophthalmological Examination

- Each patient underwent a complete ophthalmic examination. This involved assessing **uncorrected visual acuity (UCVA)** and **best corrected visual acuity (BCVA)** using the Snellen Landolt's broken C ring chart, with results subsequently converted to decimal values for statistical analysis. Examination of the extra-ocular muscles was performed to detect

any limitations in eye movement. The anterior chamber was carefully examined using a slit-lamp to diagnose and grade the pterygium. **Intraocular pressure (IOP)** was measured using non-contact tonometry.

- Before the surgical procedure, each patient received detailed instructions on how to use the **Visual Analog Scale (VAS)** for postoperative pain assessment. The VAS, ranging from 0 to 10, was explained as follows: 0 representing "no pain" and 10 representing "the most severe pain imaginable."

Surgical Procedure

- Here's a rephrased and expanded description of the surgical procedure:
- All patients underwent pterygium excision with superior conjunctival autografting**,** a meticulous procedure designed to remove the abnormal growth and reconstruct the ocular surface. This involved precisely transferring a free graft of healthy superior bulbar conjunctiva to cover the scleral bed that became exposed after the pterygium was removed. The entire operation was performed under local anesthesia and meticulously guided by an operating microscope to ensure optimal precision and outcomes.
- For the surgical preparation, a 2% lidocaine jelly was carefully applied topically to both the conjunctiva and cornea approximately 10 minutes prior to the start of the operation, ensuring effective surface anesthesia. A lid speculum was then gently positioned to provide maximum surgical exposure of the operative field. The pterygium itself received an infiltration of a mixture containing 1% lidocaine and 1:100,000 adrenaline. This local injection served a dual purpose: to enhance local anesthesia directly at the surgical site and to achieve localized vasoconstriction, which helps minimize bleeding during the procedure. A disposable surgical blade was then cautiously used to superficially excise the involved corneal tissue, extending the incision precisely up to the limbus at the very head of the pterygium. Subsequently, **Westcott scissors** were employed to meticulously dissect and excise the main body of the pterygium from the surrounding conjunctival tissue. All fibrovascular pterygium tissue was thoroughly and meticulously removed from both the scleral bed and the limbus. Following this, any remaining sub-Tenon's tissue was also completely excised to reduce the risk of recurrence. Minimal cautery was applied judiciously throughout the procedure to ensure precise control of any bleeding points.
- Following the initial excision phase, the patient was gently asked to direct their gaze downwards. This maneuver effectively exposed the superior conjunctiva, which was designated as the donor site for the graft. One percent lidocaine, specifically formulated without adrenaline, was then injected subconjunctivally. This injection aimed to gently separate the conjunctiva and Tenon's capsule adjacent to the limbus, typically around the 6 o'clock position, facilitating easier graft harvest.
- Next, **Westcott scissors** were once again precisely utilized to carefully excise a free conjunctival graft from this prepared donor site. This graft was meticulously sized and shaped to ensure it would precisely match the dimensions and contour of the prepared scleral bed, ensuring optimal coverage. Once harvested, this delicate free graft was then meticulously positioned with the correct anatomical orientation onto the recipient scleral bed. It was then securely fastened using **interrupted sutures** of 8–0 polyglactin, a fine absorbable material, thereby ensuring optimal placement, stability, and proper apposition of the graft. At the conclusion of the entire surgical procedure, all epithelial defects that resulted from the pterygium excision were carefully stained with a fluorescein paper strip. This vital step allowed for clear visualization and accurate assessment of their exact extent and configuration, providing an immediate postoperative baseline for healing.
- Following the surgical intervention, the operated eyes were carefully patched for a period of 24 hours. Subsequently, patients in both study groups began receiving their designated postoperative medications according to the established protocol.

Postoperative Evaluation of Corneal Epithelial Healing and Pain

- To evaluate corneal epithelial healing, a slit-lamp adaptor combined with a smartphone equipped with a 32-megapixel camera was fitted to an SL-D701 slit-lamp (Topcon Corporation, Tokyo, Japan). This setup was used to capture images of the fluorescein-stained epithelial defect immediately after the operation on Day 0, and subsequently on postoperative Days 1, 2, and 3. Each captured image was then converted into an uncompressed Red, Green, and Blue Joint Photographic Experts Group (JPEG) file with dimensions of 2576 x 1934 pixels using ImageJ freeware for detailed analysis.
- Postoperative pain assessment was conducted using the Visual Analog Scale (VAS), with patients instructed on its 0-10 numerical range. A score of 0 indicated "no pain," 1-2 represented “mild pain”, 3-4 signified “moderate discomfort”, 5-6 indicated “severe pain”, 7-8 denoted “very severe pain”, and 10 represented “the most pain imaginable”. This assessment was performed by observing the patient's facial expression during the ocular examination.
- Throughout the study, four thorough ocular examinations and pain score evaluations were concurrently arranged for each patient on successive postoperative days. The investigator systematically documented the subjective pain score (VAS) derived

from the patients' markings on a standard printout of the same VAS file during each scheduled patient visit.

Ethical Conduct and Consent

The study protocol received full approval from the Local Ethics Committee of Al-Azhar University, ensuring all investigative procedures were in strict accordance with the tenets of the Declaration of Helsinki, which guides ethical research involving human subjects. Prior to participation, each individual provided written informed consent, granted only after a comprehensive explanation of the study's nature, its procedures,
and potential implications was thoroughly provided.

Statistical Analysis

All statistical analyses were performed leveraging the Statistical Package for the Social Sciences (SPSS), version 26 (IBM Inc., Chicago, IL, USA). Prior to primary analyses, the normality of data distribution for all continuous variables was rigorously assessed through the application of the Shapiro-Wilk test complemented by visual inspection of histograms.

For quantitative parametric variables, data were expressed as the mean ± standard deviation (SD) and range, and comparative analyses among the two study groups were conducted utilizing the Mann-Whitney U test, quantitative non-parametric data were presented as the median [interquartile range] and analyzed using the Mann-Whitney U test to evaluate for significant differences. Qualitative variables were summarized as frequencies and percentages (%), with comparisons between groups performed using the Chi-square test. $P<0.05$ was designated as statistically significant and $P < 0.01$ was indicative of a highly significant statistical finding.

RESULTS

This prospective, randomized, and rigorously controlled interventional study was diligently conducted on 30 eyes, each belonging to a distinct patient (n=30), encompassing individuals of both sexes.

The study cohort presented with a mean age of 47.8±10.26 years. For robust comparison, these patients were precisely divided into two equally sized groups:

- **Group A (HA group)**, where participants received a thin topical coat of 2% hyaluronic acid in addition to their standard postoperative medication regimen; and
- **Group B (control group)**, where patients received only the conventional postoperative medication regimen.

Table (1) showed that age, sex, and affected side were insignificantly different between both groups (p-value>0.05).

Table (1): Demographic data, medical history and affected side of the studied groups

		Group A (n=15)	Group B (n=15)	P value
Age (years)	Mean ± SD	47.8± 10.26	51.87 ± 7.91	0.234
	Range	30 – 60	35 - 60	
Sex	Male	8 (53.33%)	7 (46.67%)	0.715
	Female	7 (46.67%)	8 (53.33%)	

Table (2) showed that width and height of corneal epithelial defect and visual analog were statistically significantly improved in group A. the width and height of corneal epithelial defect and visual analog scales were significantly lower at (day 1, day 2 and day 3) than day 0 (p-value <0.001).

Table (2): Width and height of corneal epithelial defect and visual analog scales in group A

	Day 0	Day 1	Day 2	Day 3
Width	204.6±86.89	92.45±32.54	65.67±30.2	30±0
P value		**0.001***	**0.021**	**<0.001***
Height	187.53±88.03	146.27±54.7	92.33±51.8	55±0
P value		**0.004***	**0.011**	**<0.001***
Visual analog scales	8 (7 – 8)	5 (4 – 6)	5 (4 – 6)	4 (1–1)
P value		**<0.001***	**<0.001***	**<0.001***

Data presented as mean ± SD or median (Interquartile range), *: Significant. P value: compared between day 0 and (day 1, day 2 and day 3).

Table (3) showed that width and height of corneal epithelial defect and visual analog were statistically significantly improved in group B. the width and height of corneal epithelial defect and visual analog scales were significantly lower at (day 1, day 2 and day 3) than day 0 (P vale <0.001).

Table (3): Width and height of corneal epithelial defect and visual analog scales in group B

	Day 0	**Day 1**	**Day 2**	**Day 3**
Width	272.27±128.85	216.53±141.08	222.46±130.1	271.67±92.8
P value		**0.003***	**<0.001***	**<0.001***
Height	268.33±140.34	239.13±124.79	230.46±113.99	260±75.66
P value		**<0.001***	**<0.001***	**<0.001***
Visual analog Scales	8 (7 – 8.5)	7 (5 – 7)	5 (4 – 5)	4 (3 – 4)
P value		**<0.001***	**<0.001***	**<0.001***

Data presented as mean ± SD or median (Interquartile range), *: Significant. P value: compared between day 0 and (day 1, day 2 and day 3).

Table (4) showed that width and height of corneal epithelial defect and visual analog scales were significantly lower in group A than group B at day 1 (P-value<0.05).

Table (4): Width and height of corneal epithelial defect and visual analog scales of the studied groups at day 1, day 2 and day 3

	Group A (n=15)	**Group B (n=15)**	**P value**
Day 1			
Width	92.45 ± 32.54	216.53 ± 141.08	**0.009***
Height	146.27 ± 54.71	239.13 ± 124.79	**0.030***
Visual analog scales	6 (4.5 – 6.5)	7 (5 – 7)	**0.033***
Day 2			
Width	65.67 ± 30.2	222.46 ± 130.1	**0.011***
Height	92.33 ± 51.83	230.46 ± 113.99	**0.012***
Visual analog scales	3 (2.5 – 5)	5 (4 – 5)	**0.05***
Day 3			
Width	30 ± 0	271.67 ± 92.8	**0.039***
Height	55 ± 0	260 ± 75.66	**0.033***
Visual analog scales	1 (1 – 2.5)	4 (3 – 4)	**<0.001***

Data presented as mean ± SD or median (Interquartile range), *: Significant.

Baseline ophthalmological assessments, conducted prior to the intervention, revealed no statistically significant differences between the two groups. Specifically, measurements of **visual acuity (VA)**, encompassing both spherical and cylindrical refractive errors, **best-corrected visual acuity (BCVA)**, **intraocular pressure (IOP)**, and the initial **grading of pterygium** were found to be insignificantly different. Furthermore, comprehensive examination of **extraocular muscle (EOM)** function also yielded no statistically discernible disparities between the groups. These findings underscore the successful randomization and comparability of the two cohorts at study commencement.

CASE 1 (Figures 1-3)

A 32-year-old female patient presented with a left primary pterygium, graded as 3. She underwent a pterygium excision with conjunctival autograft. Immediately following the procedure, a thin layer of 2% hyaluronic acid was topically applied to the affected eye as part of the hyaluronic acid (HA) group's protocol. Postoperatively, her treatment regimen included a combination of eye drops containing 0.1% dexamethasone and 0.3% tobramycin, along with tear substitutes, administered four times daily with a plan for gradual withdrawal. Additionally, a combined 0.1% dexamethasone and 0.3% tobramycin ointment was applied at bedtime.

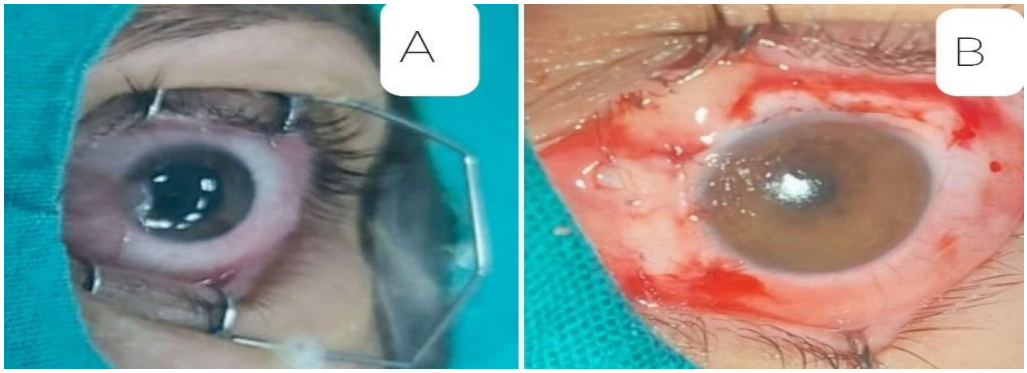

Fig. (1): (A) Pterygium (B) Pterygium excision with conjunctival autograft.

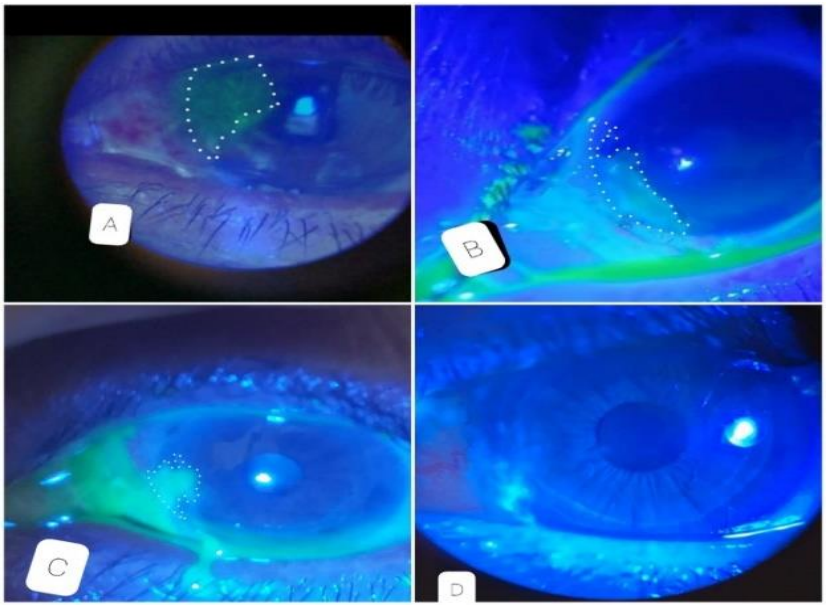

Fig. (2): Corneal epithelial defect (HA group) at (A) Day 0, (B) Day 1, (C) Day 2, (D) Day 3.

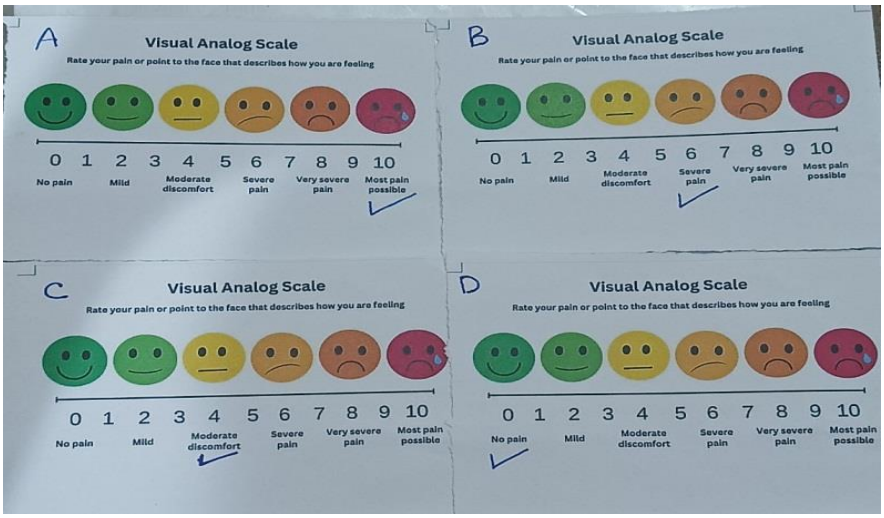

Fig. (3): VAS of HA group (A) Day 0, (B) Day 1, (C) Day 2, (D) Day 3.

CASE 2 (Figures 4-6)

A 34-year-old male presented with a right primary pterygium, classified as grade 3. He underwent **pterygium excision with conjunctival autograft**. Postoperatively, his treatment regimen included a combination of eye drops containing **0.1% dexamethasone** and **0.3% tobramycin**, along with tear substitutes, administered four times daily with a plan for gradual withdrawal. Additionally, a combined **0.1% dexamethasone and 0.3% tobramycin ointment** was applied at bedtime. This patient was part of the control group, not receiving the hyaluronic acid intervention.

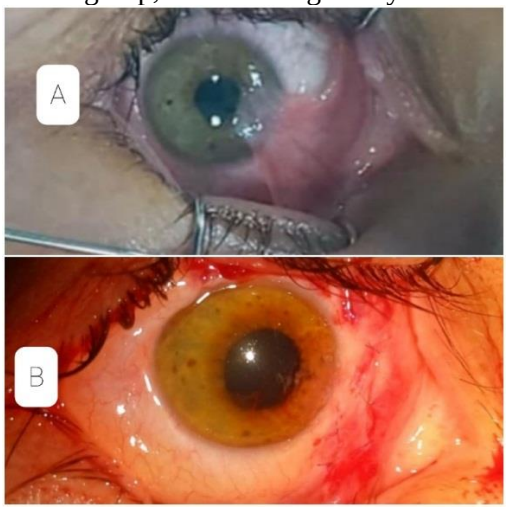

Fig. (4): (A) pterygium (B) pterygium excision with conjunctival autograft.

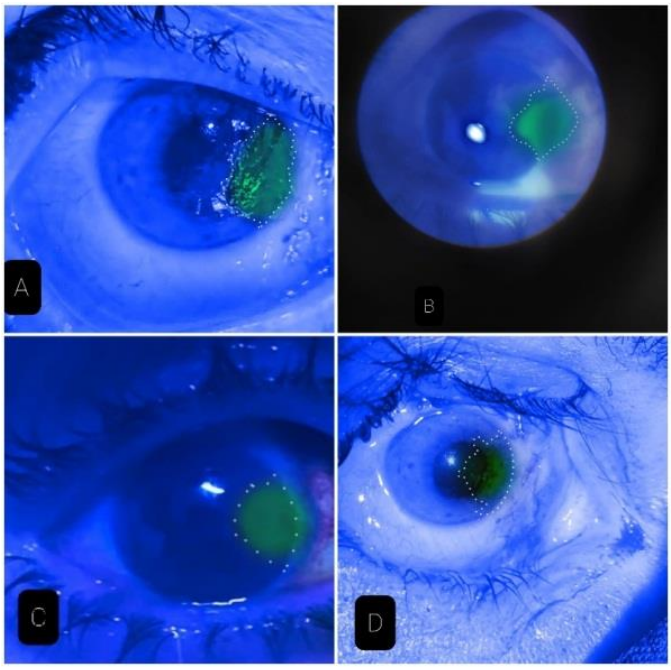

Fig. (5): Corneal epithelial defect (Control group) at (A) Day 0, (B) Day 1, (C) Day 2, (D) Day 3.

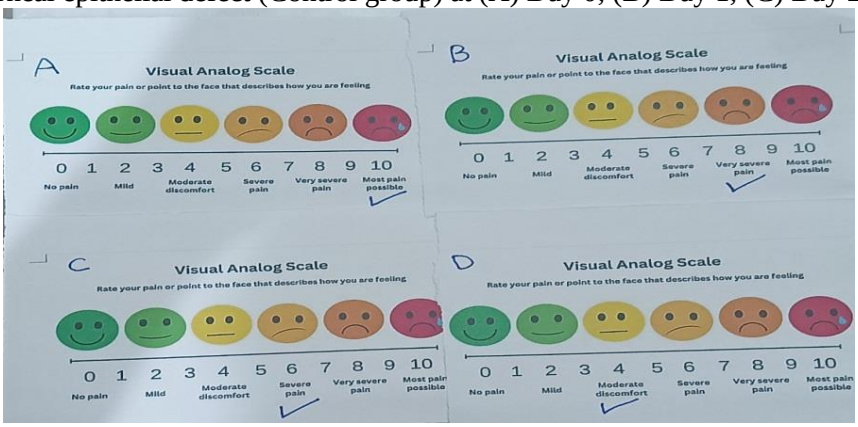

Fig (6): VAS of control group (A) Day 0, (B) Day 1, (C) Day 2, (D) Day 3.

DISCUSSION

Pterygium is a distinctive and often progressive ocular surface disorder, fundamentally characterized by the abnormal growth of a triangular-shaped fibrovascular tissue that originates from the bulbar conjunctiva and gradually extends across the limbus onto the cornea [10]. For the management of this condition, pterygium excision with superior conjunctival autografting has become a universally acknowledged and widely accepted surgical procedure, firmly established as the gold standard treatment due to its demonstrated efficacy in reducing recurrence rates [11].

At a molecular level, hyaluronic acid (HA), a high molecular weight extracellular glycosaminoglycan, exerts a profound and multifaceted impact on corneal epithelial healing. Its biological roles include modulating critical cellular processes such as proliferation and differentiation, but most importantly, HA actively promotes the directed migration of epithelial cells. This migratory capacity is, in essence, the fundamental basis of the corneal wound healing cascade, facilitating rapid re-epithelialization [12].

In congruence with our observed baseline characteristics, **Chaidaroon *et al.*** [9] similarly conducted a prospective, randomized, double-blind clinical study involving 50 patients who underwent pterygium excision with conjunctival autograft transplantation. Their investigation, which stratified patients into two groups receiving either 0.18% sodium hyaluronate (SH) or 0.3% SH, also reported that the baseline grading of pterygium was insignificantly different between their respective groups (P=0.654), reinforcing the consistency of patient characteristics across similar clinical trials.

Corneal Epithelial Healing Outcomes

In the concurrent study, a highly statistically significant improvement was unequivocally observed in both the width and height of the corneal epithelial defect in Group A (HA group) when directly compared to Group B (control group) (P<0.001). This compelling result indicates a substantial accelerative effect of topical HA on epithelial closure. Furthermore, within each group, the width and height of the corneal epithelial defect were significantly lower on postoperative Days 1, 2, and 3 when compared to Day 0 (immediately post-operation) in both groups (P<0.05), demonstrating the natural progression of wound healing. Critically, while the baseline width and height of the corneal epithelial defect were insignificantly different between the two groups on Day 0, the defect dimensions were significantly lower in Group A than in Group B on Day 1, Day 2, and Day 3, unequivocally establishing the superior healing efficacy in the HA-treated cohort.

These current results are notably in strong agreement with the results previously reported by **Chaidaroon *et al.*** [9]. Their research observed that the area of corneal epithelial defect was consistently and significantly lower on postoperative Day 1 and Day 2 when compared to baseline Day 0 measurements, a positive trend evident in both their 0.18% hyaluronic acid (HA) group and their 0.3% HA group. Furthermore, their study compellingly demonstrated that the area of the epithelial defect in the 0.3% HA group was statistically significantly smaller than that recorded in the 0.18% HA group on both Day 1 and Day 2. This latter finding strongly suggests a potential concentration-dependent therapeutic effect of HA, indicating that higher concentrations may offer enhanced efficacy in actively promoting epithelial closure and accelerating overall corneal healing.

The superior efficacy of hyaluronic acid (HA) in facilitating the healing of corneal epithelial defects is attributable to its complex and beneficial properties. Beyond merely providing hydration, HA exerts potent anti-inflammatory effects and fundamentally supports the intricate processes of wound healing. HA actively promotes crucial cellular behaviors such as epithelial cell migration and proliferation, thereby fostering a highly conducive and regenerative microenvironment essential for effective tissue repair and regeneration [13]. Moreover, its significant contribution to ameliorating inflammation, substantially enhancing ocular surface lubrication, and effectively preventing postoperative ocular dryness—a very common and often discomforting sequela following such intricate surgeries—collectively synergize to robustly accelerate the overall healing process and optimize the recovery of complete epithelial integrity.

Further reinforcing the consistency of our findings, **Chaidaroon *et al.*** [9] conducted another double-blind randomized clinical study on a cohort of 50 patients with primary pterygium. This study strategically divided patients into two equally sized groups: a control group and a group treated with a single topical application of 2% HA. Their results indicated that the area of the corneal epithelial defect demonstrated a statistically significant improvement in the HA group on Day 1 and Day 2 when compared to Day 0. Crucially, the initial areas of epithelial defect were comparable between the HA and control groups on Day 0, but the area of the defect in the HA group was significantly smaller on both Day 1 and Day 2, validating the benefit of HA at an early stage.

Similar supporting findings were independently reported by **Zhong *et al.*** [14], whose research was specifically designed to rigorously evaluate the effects and underlying mechanisms through which exogenous hyaluronate (HA) contributes to promoting corneal wound healing. Their robust investigation demonstrated conclusively that HA actively enhanced corneal epithelial cell wound healing by facilitating critical cellular processes such as cell migration, concurrently upregulating vital cellular repair responses, and concurrently suppressing undesirable inflammatory responses that can significantly impede the natural healing trajectory.

Consistently supporting our present findings, **Kocatürk *et al.*** [15] conducted a study involving 80 patients who had undergone pterygium surgery. In this particular study, patients were systematically divided into two equally sized groups. The first group received a combination eye gel containing sodium hyaluronate, xanthan gum, and netilmicin. The second group, in contrast, was given a single drop of an eye gel containing fusidic acid. The results of this study were clear: the combined eye gel, which included hyaluronate, xanthan gum, and netilmicin, significantly sped up the recovery of corneal epithelial defects. It also effectively reduced the patients' reported levels of postoperative pain when directly compared to the fusidic acid gel alone. This highlights the multimodal benefits of hyaluronic acid (HA) in ophthalmic recovery.

Furthermore, consistent with our conclusions, **Lin and Gong** [4] conducted a randomized clinical study involving 30 patients who presented with corneal epithelial abrasions specifically caused by mechanical damage. These patients were strategically allocated to either an HA treatment group or a recombinant bovine basic fibroblast factor (rb-bFGF) group. Their investigation conclusively found that HA provided a highly promising and therapeutically effective treatment for superficial corneal abrasion resulting from mechanical trauma, exhibiting efficacy comparable to that of rb-bFGF, which is a known potent healing agent.

Additionally, **Li *et al.*** [16] conducted a relevant study on 68 cases (76 eyes) that had undergone pterygium transposition surgery. These patients were systematically allocated to either a sodium hyaluronate (SH) group or a control group. Their comprehensive findings compellingly indicated that SH can be remarkably effective not only in promoting the overall healing process of the surgical site but also in facilitating the crucial restoration and stabilization of the tear film integrity following pterygium transposition, underscoring its broader beneficial impact on ocular surface health.

Postoperative Pain Control

In accordance with the observations of our study, **Visual Analog Scale (VAS)** scores were not statistically different among both groups on Day 0, immediately following surgery, where the reported pain level was consistently very high (typically ranging from 9-10, signifying "most possible pain imaginable"). However, a highly statistically significant and clinically meaningful improvement in VAS scores was subsequently observed in Group A (HA group) when directly compared to Group B (control group) across the subsequent postoperative days. Specifically, in Group A, the majority of patients reported pain as severe (VAS 5-6) on Day 1, which then progressively and notably reduced to moderate discomfort (VAS 3-4) by Day 2, and further decreased to mild pain (VAS 1-2) by Day 3, indicating a rapid and significant amelioration of pain. In stark contrast, patients in Group B experienced very severe pain (VAS 7-8) on Day 1, which only marginally lessened to severe pain (VAS 5-6) on Day 2, and merely reached moderate discomfort (VAS 3-4) by Day 3. Importantly, for both groups, VAS scores were significantly lower on Day 1, Day 2, and Day 3 compared to the baseline Day 0 measurement, universally indicating a general, albeit differentially paced, reduction in pain over time in all patients.

Further corroborating our findings regarding the efficacy of HA in pain reduction, **Chávez-Mondragón *et al.*** [17] carried out a randomized clinical study involving 99 patients with pterygium grades 1-3. These patients received a combination therapy consisting of bromfenac 0.09% ophthalmic solution and sodium hyaluronate (SH) 0.4% administered over a three-week period. Their results clearly demonstrated that the incorporation of HA into the treatment regimen effectively reduced several key clinical signs associated with pterygium, including conjunctival hyperemia, a burning sensation, photophobia, and foreign body sensation, all of which are significant contributors to overall patient discomfort and quality of life.

However, it is pertinent to acknowledge a contrasting finding reported by **Chaidaroon *et al.*** [9] in a separate double-blind randomized clinical study specifically designed to investigate the effect of 2% HA on corneal epithelial defects after pterygium surgery. In their study, VAS scores for pain were found to be statistically insignificantly different among the HA group and the control group (P=0.953). This observed lack of a significant difference in pain scores in their investigation, despite employing a similar HA concentration, may potentially be attributed to variations in the concomitant medications utilized. Specifically, they employed topical 0.5% levofloxacin and 1% prednisolone acetate as adjunctive therapies, whereas our study utilized a different combination of dexamethasone 0.1% and tobramycin 0.3%. These differences in adjunctive pharmacological agents could plausibly influence overall patient comfort and modulate pain perception outcomes, highlighting the intricate interplay of therapeutic components in postoperative management.

CONCLUSION

Topical application of **2% hyaluronic acid** has demonstrably shown significant effectiveness and facilitated considerable improvement in both the size and the rate of healing of corneal epithelial defects following pterygium excision. Furthermore, this intervention concurrently provides a substantial reduction in the intensity of postoperative pain experienced by patients after this surgical procedure, underscoring its dual therapeutic benefits for ocular surface recovery and patient comfort.

Conflict of Interest: No conflict of interest to declare.
Funding: None.

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