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Original Article

VISUAL OUTCOME OF SIMULTANEOUS PHOTOREFRACTIVE KERATECTOMY AND CORNEAL COLLAGEN CROSS LINKING (PRK CXL) IN KERATOCONUS SUSPECTS

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Abstract

Background: *Keratoconus is a progressive ectatic condition that is non-inflammatory, bilateral, and characterized by apical bulging and central corneal thinning.* ***Aim:*** *To evaluate simultaneous photorefractive keratectomy (PRK) and the visual outcomes of corneal collagen cross-linking (CXL) in eyes with suspected keratoconus.* ***Patients and methods:*** *This was a prospective, interventional, nonrandomized research of 30 eyes performed in the ophthalmology department of Al Azhar University (Assiut) and El Nahar Eye Centre in Assiut.* ***Results:*** *The mean values of UCVA, BCVA, manifest spherical, and cylinder significantly decreased after three and six months, respectively, with a p-value of less than 0.001. After 3 months, dry eye was documented in 16.67% of eyes, decreasing to 6.67% after 6 months. Mild corneal haze was reported in 13.333% of eyes after three months, with no cases after 6 months. Throughout the follow-up duration, a significant decrease was observed in keratometric astigmatism, keratometric "Steep", keratometric "Flat", Steepest Keratometric "Kmax", spherical equivalent refraction, CT at the thinnest location, and back elevation, with a p-value of 0.001.* ***Conclusion:*** *The combination of a customized CXL (accelerated protocol) and a photorefractive procedure (PRK) led to a persistent flattening impact and a significant regularization of keratoconic corneas, as well as an enhancement in BCVA over a six-month follow-up.*

Keywords: *Visual outcome, CXL, Simultaneous PRK.*

1. Introduction

Keratoconus is defined as a progressive ectatic disorder that primarily affects adolescents and is distinguished by distortion of the cornea, thinning of the central cornea, and apical bulging. It is bilateral and non-inflammatory [1]. keratoconus suspects" (preclinical or subclinical ker-atoconus, usually described as a cornea with no identifiable abnormalities depending on slit lamp investigation, however inferior corneal steepening/asymmetry with unaffected visual acuity) from non-keratoconic

eyes) or "form fruste keratoconus" (slit lamp abnormalities or no corneal topography, nevertheless keratoconus in the fellow eye) [2]. Interventions performed for refractive, optical, or tectonic purposes comprise the majority of available treatments for keratoconus. The therapy for keratoconus is dependent upon the illness severity and the degree of disease progression [3]. Eyeglasses and rigid gas permeability contact lenses are traditional techniques for treating mild to moderate keratoconus. However, there are certain cases where people are unable to deal with contact lenses, and in some situations, spectacle correction is inadequate. Additionally, conventional therapy methods aren't as efficient in the advanced stages of keratoconus, which are characterized by corneal scarring and excessive corneal thinning/steepening. Additionally, none of these treatment options can deal with the main reasons for ectasia and cannot ensure the complete cessation of keratoconus progression [4]. The corneal collagen cross-linking is a promising therapy approach which has gained popularity in the late 20th century. Its objective is to address the underlying pathology of keratoconic eyes by efficiently strengthening the cornea by restoring its tensile strength, thereby slowing or arresting the development of keratoconus [5,6]. Furthermore, it is suggested that the treatment of keratoconus will be more effective when CXL is combined with PRK, a standard laser-assisted refractive procedure. The primary objective of the combined therapy of keratoconus with PRK/CXL is to enhance the quality of vision through PRK and to fortify the cornea and prevent the development of the illness through corneal collagen cross-linking [4]. This research objected to evaluate the visual consequences of corneal collagen crosslinking and simultaneously photorefractive keratectomy in eyes within suspected keratoconus.

2. Patients and Methods

This was an interventional, nonrandomized, prospective research of 30 eyes performed in the ophthalmology department of Al Azhar University (Assiut) and El Nahar Eye Centre in Assiut. *Inclusion criteria:* age more than eighteen years, myopia lower than −4.0 D of sphere, and myopic astigmatism lower than −3.0 D of cylinder. *Suspicious tomographic criteria:* Corneal thickness at the thinnest location is not less than 470 μm. keratometry reading (K2 reading) up to 49 D, mean posterior corneal elevation up to 20, mean anterior corneal elevation up to 17.7 and central corneal ablation less than 50 μm. *Exclusion criteria:* Frank keratoconus, corneal thickness at the thinnest location not less than 470 mm, central keratometry value more than 49 D, mean posterior corneal elevation more than 20, dry eye, history of herpetic eye illness, previous refractive surgery, collagen vascular disease, corneal scarring, amblyopia, lactation, and pregnancy, as well as topographic evidence of corneal ectasia.

2.1. *Methods*

Clinical evaluation: Examinations were performed preoperatively, and patients were followed after 1 week and 1 month for a complete ophthalmological assessment, involving slit lamp investigation, manifest refraction, and visual acuity. Furthermore, Pentacam was administered three to six months after surgery. Both the BCVA (log MAR) and the UCVA were measured prior to surgery. *Investigation:* We performed Pentacam preoperatively, three and six months after surgery, using Snellen's chart for BCVA. We positioned the patient in a well-lit area, ensuring they were at a

standard distance from the chart. Typically, the testing distance was set at 6 meters, although this may change depending on the circumstances. Additionally, a near Snellen chart has been utilized at fourteen inches in some patients, which required reading glasses if appropriate**.** *Operative method:* With immediate preoperative counseling before starting the treatment, the patient was counseled about what to expect during the procedure. *Preoperative medication:* We used topical anesthesia (benoxinate hydro-chloride 0.4%) for the surgical procedure and placed a sterile drape over the skin and eyelashes**.** *Operative details:* The subsequent 2-step technique has been carried out in all cases: *Step 1 (topography-guided PRK):* The epithelium has been carefully removed within a nine mm diameter utilizing a hockey knife following topical anesthesia. The objective of topography-guided photorefractive keratectomy was to reduction a portion of the refractive error and additionally irregular astigmatism. The transition zone was 2 mm. in diameter, and the optical zone diameter has been restricted to 6 mm. The maximum depth of ablation was 50 µm. In this situation, a correction has been attempted for up to forty percent of the spherical component and up to seventy percent of the cylinder. Following photoablation, a solution containing 0.02% MMC has been applied for a duration of 30 sec., and then copious irrigation with a balanced salt solution. *Step 2 (standard CXL):* riboflavin (0.1% in twenty percent dextran solution; Ricrolin, SOOFT, Italy) has been applied topically every two minutes for thirty minute and has been maintained at every two minutes during UVA exposure. The cornea has been subjected to UVA 370 nm light (UV-X System; Peschke Meditrade GmbH, Hünenberg, Switzerland) at an irradiance of 3.0 mW/cm for thirty minutes.

2.2. *Postoperative measurement*

For a period of one week and six weeks, all patients received corticosteroid (fluorometholone) drops and a topical antibiotic (moxifloxacin), with the steroid tapered over six weeks and the antibiotic given six hours per day. A therapeutic soft contact lens was implanted. The contact lens has been removed following the healing of the epithelium. Following the operation, all cases had sig-nificant enhancements in their refraction and visual acuity (log MAR).

2.3. *Ethical consideration*

Prior to the beginning of this investigation, the ethical committee of the Al Azhar Faculty of Medicine in Assuit gave its approval. Prior to data being collected, each participant was informed of the study's objective. Written consent has been collected from individuals who are welcomed for involvement in the research. Privacy of the data is ensured.

3. Results

The research group composed of 30 eyes, with an average age of 26.36 years, and (46.67%) female vs. (53.33%) male, tab. (1). The mean value of UCVA decreased by 54.08% after three months. and a decrease (61.22%) after 6 months with a moderately significant variance (P-value less than 0.001). According to BCVA, there was a reduction in the mean value after a period of three months, equal to 26.67%. and a decrease (40.0%) after six months, with a moderately significant variance (P-value less than 0.001), tab. (2). In manifest spherical, there was a decrease in mean value (16.98%) after 3 months and a decrease (19.72%) after 6 months with a highly significant difference (P<0. 001). Regarding the manifest cylinder,

there was a decrease in mean value (41.09%) after 3 months and a decrease (46.02%) after 6 months, with a highly significant variance (P-value less than 0.000), tab. (3). Keratometric astigmatism showed a significant reduction during the follow-up period, keratometric "Steep", Keratometric "Flat" Steepest Kerato-metric "Kmax", Spherical equivalent refraction, CT at the location"µm" and back elevation p on p <0.001, tab. (4). After 3 months, 16.67% of eyes had dry eyes, and that number decreased to 6.67% after 6 months. As regard, 13.33% of eyes have developed mild corneal haze after 3 months, with no cases after 6 months, tab. (5).

Table 1: Presents the demographic data of the study group.

Item	Descriptive "n=30"
Age "yrs."	25.37±5.73
Sex: • ***Male*** • ***Female***	 16(53.33%) 14(46.67%)

Table 2: Visual outcome (log MAR) in study group.

Item	Preoperative "number=thirty"	After 3months "number=thirty"	After 6months "number=thirty"	P-value
• **UCVA** Change %	0.98±0.19	0.45±0.29 -54.08%	0.38±0.26 -61.22%	**P<0.001****
• **BCVA** Change %	0.15±0.11	0.11±0.12 -26.67%	0.09±0.07 -40.0%	**P<0.001****

Table 3: Refractive outcome in study group.

Item	Preoperative "n=30"	After 3 months "n=30"	After 6 months "n=30"	P-value
• **Manifest Spherical** Change %	-1.65±1.21	-0.76±0. 3 -53.93%	-0.23±0.23 -86.06%	**P<0.000*****
• **Manifest cylinder** Change %	-1.63±1.67	-0.25±1.54 -93.11%	-0.17±0.22 -89.57%	**P<0.000*****

Table 4: Topographic outcome in study group.

Item	Preoperative "n=30"	After 3 months "n=30"	After 6 months "n=30"	P-value
• **Keratometric astigmatism** Change %	3.28±1.89	-1.73±0.58 -47.25%	1.1±0.24 -66.46%	**P<0.000*****
• **Keratometric "Steep"** Change %	45.72±3.24	44.47±3.17 -2.73%	44.25±3.16 -5.06%	**P<0.02***
• **Keratometric "Flat"** Change %	43.55±2.17	41.66±2.21 -1.15%	40.40±2.21 -1.72%	**P<0.04***
• **Steepest Keratometric "Kmax"** Change %	46.38±2.62	45.42±2.65 -3.32%	45.32±2.61 -3.53%	**P<0.03***
• **Spherical equivalent refraction** Change %	1.95±1.23	-0.79±1.04 19.07%	-0.59±0.28 74.01%	**P<0.001****
• **CT at thinesst location "µm"** Change %	498.61±12.97	457.25±15.67 -8.29%	457.23±15.53 -8.29%	**P<0.000*****
• **Back Elevation** Change %	15.89±3.57	14.31±2.14 -9.94%	13.07±2.26 -17.74%	**P<0.001****

Table 5: Complications in study group.

Item	After 3months "n=30"	After 6months "n=30"	P-value
• **Dry eyes**	5(16.67%)	6.67%)	
• **Developed mild corneal haze**	4(13.33%)	0	P<0.001**

4. Discussion

The corneal collagen cross-linking (CXL) technique received widespread international recognition in recent years as a method for delaying or preventing the progression of keratoconus [7]. For approximately a decade, topography-guided photorefractive keratectomy (PRK) was utilized to address abnormal astigmatism and ametropia caused by keratoconus, with favorable outcomes. This method is predicated on the removal of corneal tissue in a perfect corneal shape, typically a sphere, with the assistance of a topography map [8]. The simultaneous application of PRK and CXL techniques has been documented in numerous subsequent studies, demonstrating favorable outcomes in the areas of keratometry decrease, haze progress, UCVA, and BCVA [8]. A statistically significant enhancement of average keratometry, refraction, and visual acuity results was observed over a two-year follow-up period, which is in agreement with previous research [9]. Although Sherif et al. [10] conducted topography-guided photorefractive keratectomy in post-corneal collagen cross-linking keratoconus eyes, our research assessed the results of combined photorefractive keratectomy with corneal collagen cross-linking in keratoconus suspected eyes. They recorded statistically significant enhancements in visual acuity, mean cylinder, and keratometry in keratoconus eyes that underwent topography-guided photorefractive keratectomy at six months postoperatively, in agreement with our findings. This confirmed the photorefractive keratectomy's capacity to improve vision. In the current research, there was a reduction in the mean value of UCVA after 3 months (54.08%) and a decrease (61.22%) after 6 months with a moderately significant difference (P-value less than 0.001). About BCVA, the mean decreased by 26.67% after three months and a decrease (40.0%) after six months with a moderately significant variance (P-value less than 0.001). Over the initial six months following the procedure, our findings indicated a significant enhancement in the mean UCVA. These findings agreed with the previous investigation conducted by Alessio et al. [11]. Over the follow-up period, the enhancement persisted. Additionally, the reported gradual enhancement in BCVA was statistically significant over the period of twenty-four months under consideration. This agreed with prior research by Kontadakis et al. [12], who reported that it was determined that all parameters had stabilized or improved after two years, with gradual improvements in BCVA and uncorrected distance visual acuity, means Ks, Km, and Kf, SE, and mean cylinder in the 1st year. Subsequently, the variables kept stable over time, thereby demonstrating the long-term safety and effectiveness of the technique. In reality, there was no progressive deterioration in the case. In particular, 73.34% of eyes had a one-line increase (Snellen chart lines) in best corrected distance visual acuity, while 26.66% had a two-line increase. The outcomes of this study are comparable to those of other past researches [13,14]. Furthermore, reports of BCVA line loss have not been documented, which is consistent with another research [11,15]. Additionally, the mean Ks, Kf, and Km of our cases were reduced by 2.64 D, 0.83 D, and 1.72 D, respectively. In the recent research, only 4 eyes exhibited a grade one haze at the 3rd-

month examination that was resolved with sufficient local steroid treatment. Upon the conclusion of the 6th month follow-up, every eye was free of haze [13]. A hyperopic shift may result from the flattening of the cornea related to CXL, which is a possible disadvantage of simultaneous procedures. By adjusting the therapy to the individual, this disadvantage may be reduced. In reality, in our research, no patient exhibited a hyperopic shift. The simultaneous topography guided photorefractive keratectomy and corneal collagen cross-linking in keratoconus management of keratoconus have been positively assessed in additional research [16]. Corneal collagen cross-linking might decrease the risk of progression in cases with early, progressive keratoconus and a clear central cornea [17]. Nevertheless, CXL might not be sufficient to resolve the issue if the case is contact-lens intolerant. An additional corneal collagen cross- linking Cross-li-guidede collagen in the cornea might lower the risk of progress ion in people with early, progressive keratoconus and a clear central cornea [17]. PRK with customized topography may be considered in these situations. In a retrospective study, Iqbal et al. [18] examined the safety and efficacy of combined photorefractive keratectomy with corneal collagen cross-linking ("CXL plus") in 79 keratoconus eyes. They determined that the refractive status of keratoconus cases was enhanced throughout the 18th-month follow-up duration with the "CXL Plus" technique. Nevertheless, they detailed early complications following surgery, including corneal haze and delayed epithelial healing. The efficacy and safety of this method of therapy were shown in this research, as evidenced by the 6th-month refractive stability. The results of simultaneous customized topography-guided PRK with CXL keratoconus suspect eyes are promising and offer surgeons an additional tool in their armament to enhance vision with an elevated level of refractive prediction.

Conclusion

The combination of a customized a photorefractive procedure and corneal collagen cross-linking resulted in a persistent flattening impact, significant regularization of keratoconic corneas, and an improvement in BCVA over a six-month follow-up.

References

1. Al-Mohaimeed, M. Combined corneal CXL and photorefractive keratectomy for treat-ment of keratoconus: A review. ***Int J Ophthalmo****l*. 2019; 12 (12): 1929-1938.

2. Gomes, J., Tan, D., Rapuano, et al. Global consensus on keratoconus and ectatic dise-ases. ***Cornea***. 2015; 34 (4): 359-69.

3. Arnalich-Montiel, F., Alió Del Barrio, J., et al. Corneal surgery in keratoconus: Which type, which technique, which outc-omes? ***Eye Vis (Lond)*** 2016; 3, doi: 10.1186/s40662-016-0033-y.

4. O'Brart, D. Corneal collagen cross-linking: A review. ***J Optom***. 2014; 7 (3): 113-124.

5. Dahl, B., Spotts, E. & Truong, J. Corneal collagen cross-linking: an introduction and literature review. ***Optometry***. 2012; 83 (1): 33-42.

6. Mohammadpour, M., Masoumi, A., Mirghorbani, M., et al. Updates on corneal collagen cross-linking: Indications, techniques and clinical outcomes. ***J. of Current Ophthalmology.*** 2017; 29 (4): 235-47.

7. Mas Tur, V., MacGregor, C., Jayaswal, R., et al. A review of keratoconus: diagnosis, pathophysiology, and genetics. ***Surv Ophthalmol*** 2017; 62: 770-783.

8. Shetty, R., D'Souza, S., Srivastava, S., et al. Topography-guided custom ablation

trea-tment for treatment of keratoconus. ***Indian J Ophthalmol***. 2013; 61: 445-450.

9. Zhu, W., Han, Y., Cui, C., et al. Corneal collagen crosslinking combined with phototherapeutic keratectomy and photo-refractive keratectomy for corneal ectasia after laser in situ keratomileusis. ***Ophthalmic Res***. 2018; 59: 135-141.

10. Sherif, A., Ammar, M., Mostafa, Y., et al. One-year results of simultaneous topography guided photorefractive keratectomy and corneal collagen cross-linking in keratoconus utilizing a modern ablation software. ***J Ophthalmol***. 2015; 2015. doi: 10.1155/2015/321953.

11. Alessio, G., L'abbate, M., Sborgia, C., et al. Photorefractive keratectomy followed by cross- linking versus cross-linking alone for management of progressive keratoconus: two-year follow-up. ***Am J Ophthalmol***. 2013; 155: 54-65.

12. Kontadakis, G., Kankariya, V., Tsoulnaras, K., et al. Long-term comparison of simultaneous topography-guided photorefractive keratectomy followed by corneal cross-linking versus corneal cross-linking alone. ***Ophthalmology***. 2016; 123: 974-983.

13. Kymionis, G., Portaliou, D., Diakonis, V., et al., Management of post laser *in situ* keratomileusis ectasia with simultaneous topography guided photorefractive kerat-ectomy and collagen cross-linking. ***Open Ophthalmol J***. 2011; 5: 11-13.

14. Stojanovic, A., Zhang, J., Chen, X., et al. Topography-guided transepithelial sur-face ablation followed by corneal collagen cross-linking performed in a single combined procedure for the treatment of keratoconus and pellucid marginal degeneration. ***J Refract Surg***. 2010; 26: 145-152.

15. Mukherjee, A., Selimis, V. & Aslanides, I. Transepithelial photorefractive keratectomy with crosslinking for keratoconus. ***Open Ophthalmol J***. 2013; 7: 63-68.

16. Awwad, S., Chacra, L., Helwe, C., et al. Mitomycin C application after corneal cross-linking for keratoconus increases stromal haze. ***J Refract Surg***. 2021; 37: 83-90.

17. Rossi, S., Santamaria, C., Boccia, R., et al. Standard, transepithelial and iontophoresis corneal cross-linking: clinical analysis of three surgical techniques. ***IntOphthalmol*** 2018; 38: 2585-2592.

18. Iqbal, M., Elmassry, A., Tawfik, A., et al. Standard cross-linking versus photorefractive keratectomy combined with accelerated cross-linking for keratoconus management: A comparative study. ***Acta Ophthalmol***. 2019; 97: e623-e631.