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Change of ectropion surgery on astigmatic vector and ocular biometry

Ektropion cerrahisinin astigmatik vektör ve oküler biyometrideki etkisi

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Abstract
Aim: To evaluate corneal astigmatism change and intraocular lens (IOL) power values following ectropion surgery.
Materials and Methods: This comparative prospective research included patients with involutional ectropion who were divided using the snap-back test. The severity of ectropion increased progressively to reach the highest levels in Group 4. Patients underwent lateral tarsal strip procedures, and preoperative and 3-month postoperative biometry measurements were performed.
Results: While the mean flattest keratometry (K1), steepest keratometry (K2), and mean keratometry (Km) values exhibited nonsignificant increases at 3 months after surgery in Groups 1 and 2 ($p>0.05$ for all), the mean values of K1, K2, and Km were increased with statistical significance in Groups 3 and 4 at 3 months postoperatively ($p<0.05$ for all).
Conclusion: According to the snap-back test, ectropion in advanced stages will affect topographic values and IOL power calculations. If surgeons are going to perform cataract or refractive surgery after ectropion repair, they may consider changing the lens power selection accordingly.
Keywords: Ectropion; Keratometry; Intraocular lens measurement.

Öz
Amaç: Ektropiyon cerrahisi sonrası korneal astigmatizma değişimi ve göz içi lens (GİL) güç değerlerini değerlendirmek.
Gereç ve Yöntem: Bu karşılaştırmalı prospektif çalışmada involüsyonel ektropiyon hastaları snap-back testi kullanılarak şiddetlerine göre derecelendirildi. Ektropion şiddeti Grup 1'de en hafif Grup 4'te en ağır seviyedeydi. Hastalara lateral tarsal şerit işlemleri uygulandı ve ameliyat öncesi ve ameliyat sonrası 3. ayda biyometri ölçümleri yapıldı.
Bulgular: Ortalama en düz keratometri (K1), en dik keratometri (K2) ve ortalama keratometri (Km)) değerleri Grup 1 ve 2'de ameliyattan sonraki 3 ayda anlamlı olmayan artışlar gösterirken (hepsi için $p>0,05$), K1, K2 ve Km ortalama değerleri ameliyat sonrası 3. ayda Grup 3 ve 4'te istatistiksel anlamlı artış gösterdi (hepsi için $p<0,05$).
Sonuç: Snap-back testine göre ileri evredeki ektropiyonda topografik değerleri ve GİL gücü hesaplamalarını etkileyecektir. Cerrahlar ektropiyon onarımı sonrası katarakt veya refraktif cerrahi ameliyatı yapacaklarsa lens gücü seçimini buna göre değiştirmeyi düşünebilirler.
Anahtar Kelimeler: Ektropion; Keratometri; İntraoküler lens ölçümü.

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Introduction

Ectropion is the outward turning of the ciliated edge of the eyelid. The most common form, involutional ectropion, is an age-related eyelid malposition that primarily affects the elderly population.[1] The underlying cause is either increased lateral laxity or horizontal laxity.[2] A number of different procedures have been devised to correct this valve laxity, including the lateral tarsal strip (LTS) surgical technique. In some of these cases, the scope of the surgical procedure can be expanded. A well-known procedure used in the treatment of horizontal eyelid laxity, which significantly influences the occurrence of involutional ectropion, is tarsus fixation to the lateral orbital edge's periosteum.[3]

According to clinical studies, the effects of LTS surgery may include more benefits than merely the provision of a more cosmetically pleasing appearance of the eyelid. In addition, changes in corneal topography, the evaluation of corneal aberrations, and increases in intraocular pressure (IOP) after LTS surgery have been presented in the literature.[4-6] Attention is increasingly being devoted to the possible impact that LTS surgery may have on both the functional and structural properties of the eye. The present study was undertaken with the aim of exploring the effects of LTS surgery on astigmatism vector analysis and ocular biometry in patients with lower eyelid ectropion of varying severity.

Materials and Methods

This research had a prospective comparative design and was conducted in the setting of a tertiary hospital. The research protocol was granted approval by the Local Research Ethics Committee (2021-3-6). The patients provided informed consent prior to their examinations and all procedures were carefully undertaken in accordance with the ethical standards presented in the Declaration of Helsinki.

A total of 44 Caucasian patients (44 eyelids) who underwent LTS procedures for lower eyelid ectropion and satisfied the specified inclusion criteria were enrolled as participants. The inclusion criteria were as follows: 1) lower eyelid involution ectropion; 2) IOP of ≤21 mmHg; 3) third- or fourth-degree anterior chamber angle based on the Van Herick technique; 4) spherical equivalent of apparent refraction within ±3 D; and 5) normal anterior segment (except mild nuclear sclerotic cataract) and fundus examination results.

Patients meeting any of the following criteria were excluded from enrollment: 1) a history of any ocular surgery; 2) eyebrow ptosis or sagging adipose tissues; 3) a history of contact lens use; 4) media opacity; 5) any chronic ocular disease or a history of relevant drug use; and 6) histories of any conditions that could have an effect on wound healing.

The patients' systemic and ocular diseases were evaluated. All patients were subjected to basic ophthalmologic evaluations comprising best corrected visual acuity with a Snellen chart, IOP measurement by Goldmann applanation tonometry, slit lamp biomicroscopy, and posterior segment evaluation with a 90 D lens.

The patients included in the study had horizontal lower lid laxity without medial tendon laxity, involutional lower lid ectropion, and no scars on the lower lid. All patients had positive snap-back test results and pinch tests and negative medial canthal tendon laxity test results.[7]

According to the results of the snap-back test, representing different severity levels of ectropion, the patients were categorized within 4 groups. Among the patients of Group 1, the lid position improved in a short time after the snap-back test. In Group 2, the lid position was restored within 4–5 s without blinking; in Group 3, blinking was required to fulfill the lid position; and in Group 4, the lid position could not be achieved with a blink of the eye.[8] The patients were evaluated by 2 ophthalmologists and divided into groups. (EA, GAA)

The patients' initial central corneal thickness (CCT), flattest keratometry value (K1), steepest keratometry value (K2), mean keratometry value (Km), anterior chamber depth (ACD), axial length (AL), corneal astigmatism (CA), and intraocular ocular biometric variables such as intraocular lens (IOL) power (obtained with a constant value of 118.7 mm using an Acrysof IQ device (Alcon

Laboratories, Inc., Fort Worth, TX, USA), aiming for the emmetropia and using the Holladay 2, Haigis, Hoffer Q, SRK/T, and Barrett equations) were obtained via optic biometric methods (LenStar LS 900, Haag Streit Diagnostics, Köniz, Switzerland). These ophthalmological evaluations and measurements were conducted again 3 months after the patients' LTS surgeries. Comparisons of these postsurgical corneal topography indices with the initial measurements were conducted and any changes were recorded. Relevant changes in astigmatism were diagnosed upon identification of a change in the axis of greater than 10° and a change in power of greater than 0.2 D, because smaller changes in the axis and the power may not have significant impacts on visual acuity. Breaks were analyzed in the negative cylinder form for the sake of consistency. With-the-rule (WTR) astigmatism was accepted as a steep axis determined within a range of 90° ± 30°, while against-the-rule (ATR) astigmatism was diagnosed in the event of a steep axis determined within a range of 0° ± 30°. Any axis determined to be beyond these ranges was taken as oblique astigmatism.

All of the LTS surgeries were performed by one experienced surgeon (E.A.) under local anesthesia. A solution comprising povidone and iodine was used to sterilize the surgical site. A sterile surgical pen was used to mark the surgical incision line on the lateral canthal region while patients were in upright positions. For infiltration anesthesia, 4 mL of 2% lidocaine and 1:100,000 epinephrine were administered simultaneously by subcutaneous route. A lateral canthotomy incision was made following the drawn line and then the anterior lamella and posterior lamella were separated in the eyelid. The tarsal plate were released from the retractors and conjunctiva along the posterior surface and inferior border, and the marginal epithelium was cut in a strip. Hand cautery was used in cases when hemostasis was deemed necessary. The free tarsal strip was sutured to the lateral orbital margin's periosteum with 5.0 polypropylene sutures. The lateral canthal angle was corrected and the skin was sutured with a 6.0 Vicryl suture. Ophthalmic Terramycin (Pfizer Inc., New York, NY, USA), a topical oxytetracycline ointment, was prescribed for patients as postoperative care. One week after the surgeries, the sutures were removed in follow-up appointments.[9,10]

Statistical analysis

IBM SPSS Statistics 22.0 for Windows (IBM Corp., Armonk, NY, USA) was utilized in the analysis of the study data. For descriptive statistics, the calculated values were given as mean ± standard deviation (SD) and minimum to maximum (max–min) ranges. The Kolmogorov–Smirnov test was applied in determinations of whether variables reflected normal distribution, while the Mann–Whitney U test was utilized for comparing variables that were independent and the Wilcoxon test for those that were dependent. The threshold of statistical significance was taken to be $p<0.05$.

Ethics committee approval

Permission was received from Adiyaman University Clinical Research Ethics Committee to conduct the research (decision no: 2021-3-6 and decision date: 11 February 2021). The study was in compliance with the Helsinki Declaration.

Results

The mean ages and gender of patients in Groups 1–4 did not differ with statistical significance ($p=0.362$ and $p=0.489$, respectively). Thirteen patients were included in Group 1, 11 patients in Group 2, 12 patients in Group 3, and 8 patients in Group 4. The mean ages of the patients in Groups 1–4 were respectively 63.62±8.76 (51–75), 61.79±8.16 (50–75), 67.54±7.29 (58–77), and 64.87±6.61 (54–74) years. The male-to-female ratios in Groups 1–4 were respectively 6/7, 7/4, 5/7, and 3/5.

The IOL measurement parameters of the patients (keratometry, ACD, and AL) and the IOL power values according to different calculations are provided in Table 1. Similar mean values of CCT and IOP were determined preoperatively in Groups 1–4 and at 3 months postoperatively, without statistical significance (for all, $p>0.05$). For K1, K2, and Km, it was similarly found that the mean values had increased without statistical significance at 3 months after the surgeries in Groups 1 and 2 (for all, $p>0.05$), while the mean values obtained for K1 ($p=0.006$), K2 ($p=0.005$), and Km ($p=0.006$) in Group 3 and for K1 ($p=0.025$), K2 ($p<0.001$), and Km ($p<0.001$) in Group 4 were seen to have increased significantly at 3 months postoperatively. The mean CA size was also increased in Group 1 ($p=0.810$), Group 2 ($p=0.186$), Group 3 ($p=0.268$), and Group 4 ($p=0.013$) at 3 months postoperatively.

Table 1. Clinical characteristics of groups of patients with ectropion ranging from least severe (Group 1) to most severe (Group 4)

	Group 1			**Group 2**			**Group 3**			**Group 4**			***p*-value†**
	Preoperative	**Postoperative**	***p*-value***	**Preoperative**	**Postoperative**	***p*-value***	**Preoperative**	**Postoperative**	**P-value***	**Preoperative**	**Postoperative**	***p*-value***	
IOP (mmHg)	15.78 ± 1.72	16.02 ± 2.13	0.785	15.33 ± 2.10	16.00 ± 2.86	0.246	17.72 ± 2.83	17.36 ± 3.26	0.341	16.15 ± 3.05	15.69 ± 3.32	0.323	0.864
CCT (μm)	542.87 ± 35.94	543.25 ± 36.10	0.197	542.91 ± 36.10	543.16 ± 36.02	0.186	539.63 ± 22.83	539.54 ± 22.85	0.341	540.38 ± 34.67	540.15 ± 34.72	0.190	0.975
K_1 (D)	43.96 ± 0.90	43.99 ± 0.90	0.147	44.18 ± 0.56	44.20 ± 0.58	0.276	43.83 ± 0.62	44.00 ± 0.61	**0.006**	43.74 ± 0.29	43.86 ± 0.19	**0.025**	0.671
K_2 (D)	44.87 ± 0.81	44.88 ± 0.81	0.535	45.19 ± 0.42	45.27 ± 0.44	0.073	44.72 ± 0.66	44.92 ± 0.66	**0.005**	44.43 ± 0.50	44.74 ± 0.56	**<0.001**	0.611
K_m (D)	44.41 ± 0.82	44.43 ± 0.82	0.198	44.68 ± 0.44	44.70 ± 0.41	0.245	44.28 ± 0.63	44.46 ± 0.63	**0.006**	44.08 ± 0.33	44.29 ± 0.31	**<0.001**	0.596
CA (D)	0.90 ± 0.49	0.88 ± 0.49	0.810	0.93 ± 0.37	0.86 ± 0.48	0.186	0.89 ± 0.23	0.91 ± 0.21	0.268	0.69 ± 0.49	0.88 ± 0.53	**0.013**	0.968
ACD (mm)	3.27 ± 0.48	3.28 ± 0.45	0.527	3.07 ± 0.28	3.10 ± 0.24	0.407	3.50 ± 0.36	3.51 ± 0.35	0.160	3.36 ± 0.36	3.36 ± 0.33	0.497	0.380
AL (mm)	23.24 ± 0.52	23.31 ± 0.55	0.252	22.93 ± 0.59	22.94 ± 0.61	0.097	22.78 ± 0.61	22.78 ± 0.63	1	23.04 ± 0.77	23.04 ± 0.78	0.421	0.749
IOL power (SRK/T) (D)	21.25 ± 1.10	21.18 ± 1.03	0.104	22.12 ± 1.46	22.16 ± 1.41	1	22.54 ± 1.90	22.22 ± 1.91	**0.011**	23.11 ± 1.83	22.80 ± 1.98	**0.040**	0.191
IOL power (Haigis) (D)	21.12 ± 1.02	20.87 ± 1.12	0.164	21.87 ± 1.50	21.91 ± 1.48	0.186	22.63 ± 1.93	22.18 ± 1.94	**0.010**	23.30 ± 2.05	22.88 ± 2.11	**0.009**	0.085
IOL power (Holladay 2) (D)	20.75 ± 1.10	20.93 ± 1.08	0.164	21.41 ± 1.54	21.50 ± 1.53	0.166	22.13 ± 1.81	21.72 ± 1.91	**0.020**	22.76 ± 1.95	22.30 ± 2.02	**0.011**	0.136
IOL power (Hoffer Q) (D)	20.62 ± 1.12	20.68 ± 1.03	0.351	21.18 ± 1.50	21.20 ± 1.47	0.329	22.09 ± 1.84	21.68 ± 1.94	**0.020**	22.80 ± 2.05	22.38 ± 2.11	**0.009**	0.097
IOL power (Barrett Universal II) (D)	21.18 ± 1.13	21.06 ± 1.01	0.351	21.63 ± 1.41	21.61 ± 1.36	0.665	22.45 ± 1.82	22.04 ± 1.94	**0.005**	23.26 ± 2.02	22.84 ± 2.08	**0.009**	0.095

IOP: Intraocular pressure; CCT: central corneal thickness; K_1: flattest keratometry; K_2: steepest keratometry; K_m: mean keratometry; CA: corneal astigmatism; ACD: anterior chamber depth; AL: axial length; IOL: intraocular lens. Bold font indicates statistical significance. *: Comparisons of preoperative and postoperative values. †: Comparisons of preoperative values

Preoperatively, 4 patients (50%) were found to have WTR astigmatism, with a steep meridian at 90° ± 30°, while oblique astigmatism was present in 2 patients (25%) and ATR astigmatism in 2 patients (25%). At 3 months postoperatively, 6 (87.5%) of 8 patients had WTR astigmatism, which included the same 4 patients diagnosed with this astigmatism before surgery and 2 additional patients previously diagnosed with oblique astigmatism. The 2 patients (25%) with preoperative ATR astigmatism retained that type of astigmatism in the postoperative period. Table 2 provides K and axis values of the 8 patients in Group 4, the group with the most severe ectropion.

Table 2. Keratometry values of Group 4, comprising patients with the most severe ectropion

Patient	Preop K1	Preop K2	Preop Axis	Postop K1	Postop K2	Postop Axis
1	42.90	43.85	**24**	42.95	43.90	12
2	45.01	45.74	35	45.10	45.80	10
3	43.02	43.89	**165**	43.10	43.92	176
4	44.90	45.95	**173**	44.94	45.96	182
5	43.75	44.15	**20**	43.70	44.10	9
6	44.02	45.13	133	44.00	45.10	152
7	44.98	45.25	80	44.99	45.24	102
8	43.14	45.02	110	43.16	45.03	97

K1: Flat meridian, K2: steep meridian

At 3 months after the surgeries, the mean values obtained for ACD and AL were found to be statistically similar to the preoperative values obtained for all groups of patients (p>0.05 for all).

Mean IOL powers were evaluated with the application of 5 different equations, and they were found to be similar in Groups 1 and 2 when the preoperative and postoperative values were compared (for all, p>0.05). In Groups 3 and 4, however, these comparisons revealed significant postoperative decreases (for all, p<0.05). For each of the equations used in calculating the power values, the mean decreases in Groups 3 and 4 were approximately 0.40 D. The mean changes in Group 4 following LTS surgery were obtained as 0.30 D ± 0.48 with the SRK/T equation, 0.42 D ± 0.49 with the Hoffer Q equation, 0.42 D ± 0.49 with the Haigis equation, 0.42 D ± 0.49 with the Barrett Universal II equation, and 0.46 D ± 0.55 with the Holladay 2 equation.

Discussion

Involutional ectropion may cause some refractive errors and astigmatism by irregularizing the corneal surface.[11,12] In adult patients diagnosed with age-related involutional ectropion, we see poor distribution of tears on the ocular surface because of the outward turning of the eyelids. Blurred vision and watery eyes are expected to exert a negative impact on the quality of life for these patients. In patients experiencing eyelid ectropion, the cornea possesses the normal curvature but symmetry is lost between the eyes.[12] In addition, the calculation of the IOL power in patients with cataract is important because of the keratometric changes that may occur due to ectropion. No studies could be found in the literature investigating the effects of surgery for the treatment of involutional ectropion on IOL power, making the current research important because it is the first to explore that relationship.

In the literature, different results were reported for corneal keratometry parameters in different series of eyelid surgeries such as those for ptosis and blepharoplasty.[13,14] Detorakis et al. evaluated 18 eyelids of 18 patients newly diagnosed with ectropion following LTS surgery and they reported significantly increased residual astigmatism using corneal topography at 6 months postoperatively.[7] In another relevant study, Eshraghi et al. evaluated 19 eyes (10 with ectropion; 9 with entropion) of 15 patients.[4] They performed LTS surgery and evaluated the patients at 3 months postoperatively. At that point, they were unable to detect any changes of statistical significance in postoperative keratometry values (i.e., mean keratometry and vertical and flat meridian values).

In the current study, the final keratometry and CA values of Group 4 were found to be significantly decreased compared to baseline.

Additionally, a significant decrease was observed for all of the calculated IOL measurements. While keratometry and astigmatism values were similarly examined in some studies, there is not yet consensus in the literature regarding these outcomes. The reasons for these variable results include the small sizes of sample populations, evaluations being conducted for one eye or both eyes, differences in surgical methods, the failure of some studies to appraise the degree of ectropion in patients, and different durations of follow-up times. In comparison to the previous works available in this body of literature, the present research has a relatively adequate number of patients and those patients were grouped according to their degrees of ectropion. These characteristics of our research can be listed as strengths of the study.

Our hypothesis was that corneal deformation may differ depending on the degree of ectropion. The differences observed in the keratometry values and CA sizes between Group 1 and Group 4 pre- and postoperatively supported this hypothesis.

According to our findings, decreases in RA associated with ectropion levels occurred in patients with involutional ectropion. After ectropion surgery, the corneal shape has been affected and astigmatism may change. Although the axis of astigmatism does not change systematically in these cases, it is more common for the operated eyes to experience a change of the axis towards WTR depending on the level of ectropion. In ectropion surgery, corneal keratometry and astigmatism changes may be seen in consequence of the eyelid's contact with the anterior surface of the cornea as a result of the tightening of loose eyelids. The horizontally tightened lower eyelid exerts pressure on the lower limbus and eyeball, causing local flattening in the lower limbus running parallel to the horizontal meridian. The steep meridian becomes steeper and WTR astigmatism is further increased by the merging effect.

In Group 4, which included patients with the most severe ectropion, the extent of astigmatism increased with surgical correction. More than 10° of astigmatism axis change was observed in 7 patients (87.5%). Even if these changes do not affect vision, it is important to consider them in procedures such as planning for astigmatic correction in the course of cataract surgeries, refractive surgeries, or toric IOL implantation.

Eshraghi et al. conducted a study that included 19 eyes of 15 patients (10 with ectropion; 9 with entropion) and found relevant changes of more than 0.2 D in astigmatism strength in 14 of those eyes (73.6%).[4] Among these patients, 6 of the 10 patients diagnosed with ectropion and 4 of the 9 patients diagnosed with entropion were found to have experienced axis changes of more than 10°. The value obtained for surgically induced astigmatism was 0.47 ± 1.34 D. These authors concluded that the applied treatment had induced WTR astigmatism, with axis values of 91 ± 23.[4] Detorakis et al. included 18 patients in their research and found that the 6-month postoperative RA values were increased significantly compared to preoperative values. When the pre- and postoperative astigmatic axis distributions were evaluated, they found that the percentage of eyes with WTR had increased after surgery, although this finding did not reach a level of statistical significance.[7]

These changes in the curvature of the cornea can be either increases or decreases depending on the size and axis of the astigmatism before surgery and the vertical pressure vector applied during surgery. However, further testing of our hypothesis should be done by conducting other studies that investigate alterations of the values of astigmatic vectors with longer follow-up periods to clearly assess the implications for patients. Although the decrease in the IOL power following LTS surgery was limited to patients with severe ectropion, the mean reduction was calculated with 5 different equations and found to be about 0.40 D. It was observed that as the severity of ectropion increased, the decrease in IOL power could be affected by as much as 1 D. It is surprising that, under these circumstances, the difference in severity was not significant from a clinical perspective. Clinicians need to consider these points so that they can prevent refractive deviation from developing after cataract surgery. These astigmatic errors can become problematic if special lens implantation (toric-multifocal) is planned. It may be more ideal to perform the LTS procedure in advance and follow the outcome for a while prior to cataract surgery. If the severity of ectropion is mild, cataract surgery is recommended at any time since the IOL measurement will not change.

The AL and ACD values used in the IOL calculations did not change after surgery. In order to interpret the changes in keratometry more accurately, the IOL was calculated with 5 different equations. To apply the Haigis equation, the value of anterior chamber depth (ACD) is required.[15] Variations between the different IOL equations should be considered here. LenStar OLCR measurements do not convey the full emmetropia data since the IOL is obtained in 0.50 D steps. This process returns the closest possible IOL value. In this study, the predicted target emmetropization value was used in calculations of IOL power. Only patients who had been diagnosed with involutional ectropion were accepted as participants in this study. Those who had undergone previous surgical procedures applied in cases of recurrent ectropion were not included in the study because those procedures impact the corneal topography and aberrations.[5] In future studies, it would be beneficial to evaluate the impacts exerted by recurrence on IOL calculations.

Limitations

The homogeneity of the patient group (including only involutional ectropion patients), the evaluation of a single surgical method (only LTS was applied), and the grading of ectropion levels are the strengths of this study· Not including cicatricial ectropion patients and not evaluating different surgical methods (not including wedge resection or medial spindle) are limitations. The small number of patients included in the study is another limitation.

The amount of outward rotation of the eyelid and the amount to be corrected according to the patient's eyelid anatomy are evaluated intraoperatively by surgeons. A second surgery may be required because of the over- or undercorrection that may occur as a result of these evaluations. Another strength of the present work was that patients requiring such revisions were not included in the analysis.

Conclusion

This research has explored postoperative corneal topographic changes and their effects on IOL in patients with involutional ectropion. Increases of statistical significance were observed in the corneal keratometry values of patients with severe ectropion, and a particularly significant increase of 0.20 D in CA was observed in Group 4. The resulting reduction in IOL power was found to be approximately 0.40 D. Surgeons should be aware of the corneal topographic changes of patients who will undergo treatment by LTS. This should also be taken into account when planning cataract or refractive surgeries.

Ethics Committee Approval

Permission was received from Adiyaman University Clinical Research Ethics Committee to conduct the research (decision no: 2021-3-6 and decision date: 11 February 2021). The study was in compliance with the Helsinki Declaration.

Informed Consent

Verbal permission and written informed consent forms were obtained from volunteers to participate in the study.

Author Contributions

Study concept/design: EA., GAA. Data collecting: EA., GAA., MK. Data analysis and interpretation: MK Literature review, writers: EA., GAA. The final version of this article was read and approved by all authors.

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Conflict of Interest

There is no conflict of interest regarding the research.

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Peer-review

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