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Keratoconus false-positive screening rates in eyes with pterygium: tomographic and biomechanical artifacts

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ABSTRACT

Purpose: To investigate tomographic and biomechanical screening artifacts associated with primary pterygium that may mimic keratoconus-like patterns before and after surgical excision. **Methods:** Twenty-five eyes with primary pterygium underwent Scheimpflug corneal tomography and dynamic corneal response analysis before surgery and 3 months after excision. Tomographic and biomechanical (parameters were compared using paired analyses. The proportions of eyes exceeding established screening thresholds (Tomographic Biomechanical Index ≥0.29; Corvis Biomechanical Index ≥0.5) were compared using McNemar's test. **Results:** BAD-D decreased significantly after surgery (1.69±1.22 vs. 1.36±0.90; Wilcoxon, p=0.027). Pentacam irregularity indices also improved significantly, including ISV (51.16±44.21 vs. 36.88±42.94; p<0.001) and IVA (0.39±0.29 vs. 0.30±0.32; p=0.006). No significant changes were observed in maximum keratometry, corneal astigmatism. The mean CBI decreased significantly (0.494±0.353 vs. 0.384±0.298; p=0.048), and the proportion of CBI-positive eyes (≥0.5) declined from 48% (12/25) to 28% (7/25). In contrast, the mean tomographic Biomechanical Index did not change remained unchanged (0.519±0.313 vs. 0.534±0.323; p=0.909), and the proportion of Tomographic Biomechanical Index-positive eyes (≥0.29) remained 76% (19/25). The number of topographic keratoconus classification positive eyes decreased from 8 (32%) to 3 (12%). Integrated Radius showed no significant postoperative change (p=0.131). **Conclusions:** Primary pterygium was associated with tomographic and biomechanical screening abnormalities that mimicked keratoconus-like patterns. Following surgical excision, anterior tomographic parameters improved, and the proportion of Corvis biomechanical index-positive eyes decreased. In contrast, Tomographic Biomechanical Index remained elevated in most eyes, and stiffness-related biomechanical parameters showed no significant change. These findings demonstrate a differential postoperative response among screening indices and suggest that pterygium-induced anterior corneal surface distortion may increase false-positive keratoconus screening rates, particularly for Tomographic Biomechanical Index, which may remain elevated even after lesion removal.

KEYWORDS: Pterygium; Cornea; Corneal topography; Biomechanical phenomena; Tomography; Keratoconus; Refractive surgical procedures

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INTRODUCTION

Pterygium is a fibrovascular growth of the conjunctiva that spreads to the cornea, usually from the nasal limbus. Pathogenesis is characterized by complex interactions between genetic, inflammatory, and environmental factors, with chronic ultraviolet (UV) exposure playing a prominent role[1,2]. Although pterygium is typically asymptomatic in its early stages, it can cause a variety of visual disturbances, particularly as it progresses into the central cornea. These include irregular astigmatism, decreased visual acuity, and ocular surface instability, which frequently necessitate surgical excision[3-5].

Topographic changes caused by pterygium, such as flattening of the horizontal meridian and increased corneal asymmetry, have been well documented and tend to resolve after surgery[6,7]. However, its influence on corneal biomechanics has received relatively little attention. Corneal biomechanics refers to the tissue's intrinsic viscoelastic properties, which contribute to overall ocular structural integrity and are required to maintain corneal shape and optical quality. With the introduction of non-invasive biomechanical devices like the Corvis ST (Oculus GmbH, Wetzlar, Germany), it is now possible to assess the cornea's biomechanical behavior in vivo using a variety of dynamic deformation parameters. This is especially important because integrated tomographic biomechanical indices are increasingly being used for ectasia screening and may be prone to surface-driven artifacts from ocular surface lesions[8].

Among the indices measured by this technology, the Corvis Biomechanical Index (CBI) and the Tomographic Biomechanical Index (TBI) are widely used for early detection of ectatic disease, particularly keratoconus. TBI combines tomographic data from Scheimpflug imaging with biomechanical response metrics to produce a sensitive indicator for detecting subclinical keratoconus[9-11]. However, both indices may be influenced by factors other than true biomechanical instability, such as anterior surface irregularities caused by ocular surface lesions[12,13].

Previous research has shown that pterygium can resemble ectatic patterns on corneal topography and tomography, potentially leading to false-positive screening results and misinterpretation of preoperative measurements[14-16]. More recent evidence shows that pterygium excision improves optical quality metrics, such as higher-order aberrations on both the anterior and posterior corneal surfaces, after pterygium excision[17-24]. Furthermore, prospective data show that pterygium excision can affect keratometry and other measurements over time, emphasizing the importance of postoperative reassessment[16]. However, it is unclear whether such imaging artifacts also apply to biomechanical screening indices and to what extent these changes revert after lesion excision[17-23].

The purpose of this study was to determine whether tomographic and biomechanical screening abnormalities associated with primary pterygium decrease after surgical excision as well as and whether different categories of indices (anterior surface tomography, composite AI-based screening indices, and stiffness-related parameters) exhibit distinct postoperative response patterns. We hypothesized that pterygium-related abnormalities in keratoconus screening indices are primarily caused by anterior surface distortion rather than by intrinsic stromal biomechanical weakness. A better understanding of this dynamic is critical for increasing diagnostic accuracy and avoiding misinterpretations of keratoconus screening tools in eyes with anterior segment pathology.

METHODS

Study design and ethical considerations

This was a prospective, single-center, observational study carried out at a tertiary ophthalmology hospital. The study followed the Declaration of Helsinki. This study was approved by the Research Ethics Committee (Approval No. 7.791.010; CAAE: 87411125.7.0000.5479). All participants provided written informed consent before enrollment.

Patient selection

Patients with primary nasal pterygium were enrolled sequentially. The inclusion criteria were age 18 or older, unilateral pterygium extending at least 2 mm onto the corneal surface, and no history of ocular surgery or ocular surface disease. Patients were excluded if they had experienced ocular trauma, a keratoconus diagnosis, active inflammation, dry eye syndrome, or used contact lenses within 15 days of the evaluation. The study included 25 eyes from 25 eligible patients. All patients underwent a comprehensive ophthalmologic examination, which included best corrected visual acuity, slit-lamp biomicroscopy, and intraocular pressure measurements. The horizontal extension of the pterygium onto the cornea was measured under the slit lamp with a caliper aligned with the lesion's limbus and apex.

Imaging protocols

All patients underwent corneal imaging with the Pentacam HR and Corvis ST before and three months after surgery.

Tomographic data were collected with the Pentacam HR, a rotating Scheimpflug camera system that measures anterior and posterior elevation, corneal curvature, pachymetric progression, and risk indices. Three scans were taken per eye, and only measurements with an "OK" quality index were considered. The highest-quality scan from each patient was used for analysis. The parameters recorded were flat and steep simulated keratometry (K1 and K2), maximum keratometry (Kmax), anterior and posterior elevation maps, corneal astigmatism, thinnest pachymetric point, BAD-D, and TKC.

Biomechanical measurements were taken with the Corvis ST, which employs a high-speed Scheimpflug camera that records corneal deformation in response to a calibrated air pulse at 4,300 frames per second. The deformation amplitude, peak distance, applanation times and lengths, radius at highest concavity, and composite indices such as the CBI and TBI were all investigated. The study also included five advanced Corvis parameters: DA Ratio, integrated Radius Ambrosio Relational ARTh, SP-A1, and SSI. Each patient underwent three consecutive scans under consistent illumination, with the highest-quality scan being used for analysis.

Surgical technique

All procedures were carried out by a single experienced surgeon using the Moscovici dissection technique. A 30-gauge needle was used to inject a subepithelial air bubble into the superior bulbar conjunctiva while under topical anesthesia, allowing for the atraumatic separation of the autograft. The pterygium's body and head were removed as well as the Tenon's capsule beneath them. Following hemostasis, the conjunctival graft was harvested, oriented correctly, and secured to the scleral bed with fibrin glue (Tisseel, Baxter). No sutures used[2]. For 4 weeks following surgery, patients were given topical moxifloxacin and dexamethasone four times per day.

Follow-up and outcome measures

At 3 months, all patients returned for their postoperative evaluations. The 3-month time point was chosen because keratometric and topographic parameters have been shown to stabilize in most eyes after pterygium excision with conjunctival autografting at this time[4,16]. The primary outcome was a change in corneal tomographic and biomechanical indices from baseline. Secondary analyses included a comparison of the proportion of eyes that exceeded established TBI and CBI screening thresholds prior to and following surgery.

Statistical analysis

The statistical analyses were done with SPSS version 26.0 (IBM Corp., Armonk, NY, USA) and Minitab version 21.2 (Minitab, LLC, State College, PA, USA). The Kolmogorov-Smirnov test was used to determine whether continuous variables were normal. For paired comparisons, the Wilcoxon signed-rank test was used as the primary analysis, with the paired Student's t-test included for transparency. In addition to paired comparisons of continuous variables, the proportions of eyes that exceeded established keratoconus screening thresholds were determined before and after surgery. Eyes were classified as TBI-positive when TBI ≥ 0.29 and as CBI-positive when CBI ≥ 0.5, according to previously established cutoffs[13]. The proportions at each time point were compared with McNemar's test. The proportion of eyes with topographic keratoconus classification (TKC) other than 0 was also compared at different time points. Statistical significance was defined as $p<0.05$.

Sample size estimation

Using a paired pre-post design, a two-sided α of **0.05,** and **80% power**, we estimated that **22 eyes** are needed to detect a **moderate within-eye effect** (Cohen's $d_z \approx$ **0.65**) in key screening metrics (e.g., **BAD-D** and **TBI**). To account for potential losses and poor image quality, we intended to include **25 eyes**. This sample size was deemed appropriate for an exploratory prospective study focusing on changes within the eye following pterygium excision.

RESULTS

Preoperative characteristics

The study included 25 eyes from 25 patients (14 females and 11 males) diagnosed with primary nasal pterygium. The average patient age was 54.8±9.1 yr (range: 41-70 yr). Clinical measurements showed that all pterygia extended at least 2.0mm onto the cornea. There were no cases of reports of recurring pterygium, severe dry eye disease, or previous ocular surgery.

Baseline corneal tomography frequently revealed localized anterior surface distortion, near the pterygium, often accompanied by asymmetric curvature patterns. Several eyes had tomographic profiles similar to early keratoconus, including elevated BAD-D and increased keratoconus screening indices (particularly TBI). However, no participant met the clinical criteria for definitive keratoconus, which were defined in this study as the presence of slit-lamp biomicroscopic signs (such as Vogt striae, Fleischer ring, or apical scarring)[11-14].

Tomographic and biomechanical changes after surgery

Three months after pterygium removal, anterior corneal tomography parameters showed different responses. BAD-D levels decreased significantly from 1.69±1.22 to 1.36±0.90 (Wilcoxon p=0.027). Pentacam improved irregularity indices, with ISV decreasing from 51.16±44.21 to 36.88±42.94 (p<0.001) and IVA from 0.39±0.29 to 0.30±0.32 (p=0.006). In contrast, Kmax (46.02±2.13 to 46.10±1.93 D; p=0.565) and corneal astigmatism (2.66±4.17 to 2.53±4.59 D; p=0.821) remained stable. In terms of topographic keratoconus classification, 8 of 25 eyes (32%) were TKC-positive (any category other than zero) preoperatively, compared to 3 of 25 (12%) postoperatively (McNemar test, p=0.125; Table 1 and Figure 1).

Corvis ST composite screening indices exhibited a differential response pattern. The mean CBI decreased from 0.494±0.353 to 0.384±0.298 (Wilcoxon p=0.048). The proportion of eyes classified as CBI-positive (≥0.5) decreased from 48.0% (12/25) preoperatively to 28.0% (7/25) after surgery (McNemar test, p=0.125). In contrast, mean TBI did not change significantly (0.519±0.313 to 0.534±0.323; p=0.909), and the proportion of eyes classified as TBI-positive (≥0.29) remained at 76% (19/25) before and after surgery (McNemar test, p=1.000; Table 1 and Figures 2-4). Of the 19 eyes classified as TBI-positive preoperatively, 18 (94.7%) remained TBI-positive postoperatively ("persistent TBI elevation"); only one eye normalized, and one more eye that was TBI-negative preoperatively became TBI-positive postoperatively. Figure 4 shows individual paired data for these indices as well as BAD-D.

Parameters intended to reflect intrinsic corneal stiffness remained statistically unchanged following excision. Integrated Radius did not change significantly between time points (0.47±1.26 to 0.30±0.90; Wilcoxon p=0.131). Tonometric measurements remained stable, with IOPnct (15.46±4.43 to 16.78±7.00 mmHg; p=0.626) and bIOP (14.57±3.25 to 15.93±6.05 mmHg; p=0.597) not changing significantly. Other stiffness-related parameters (DA Ratio, ARTh, SP-A1, and SSI) had no significant postoperative changes (Table 1).

Table 1. Tomographic and biomechanical parameters before and 3 months after pterygium excision in 25 eyes

Parameter	Preoperative	Postoperative	p-value
Kmax (D)	46.02±2.13	46.10±1.93	0.565
Astigmatism (D)	2.66±4.17	2.53±4.59	0.821
BAD-D	1.69±1.22	1.36±0.90	0.027*
ISV	51.16±44.21	36.88±42.94	<0.001*
IVA	0.39±0.29	0.30±0.32	0.006*
TKC positive, n (%)	8 (32.0)	3 (12.0)	0.125
CBI	0.494±0.353	0.384±0.298	0.048*
CBI ≥0.5, n (%)	12 (48.0)	7 (28.0)	0.125
TBI	0.519±0.313	0.534±0.323	0.909
TBI ≥0.29, n (%)	19 (76.0)	19 (76.0)	1.000
Integrated radius	0.47±1.26	0.30±0.90	0.131
IOPnct (mmHg)	15.46±4.43	16.78±7.00	0.626
bIOP (mmHg)	14.57±3.25	15.93±6.05	0.597

BAD-D= Belin/Ambrósio Enhanced Ectasia Display Total Deviation; bIOP, biomechanically corrected IOP; CBI= Corvis Biomechanical Index; IOPnct= non-contact tonometry IOP; ISV= Index of Surface Variance; IVA, Index of Vertical Asymmetry; Kmax, maximum keratometry; TBI= Tomographic and Biomechanical Index; TKC= Topographic Keratoconus Classification (positive, any category other than 0). Continuous variables are reported as mean ± standard deviation; categorical variables as n (%). p values from the Wilcoxon signed-rank test (continuous) or McNemar's test (categorical).
*Statistically significant (p<0.05).

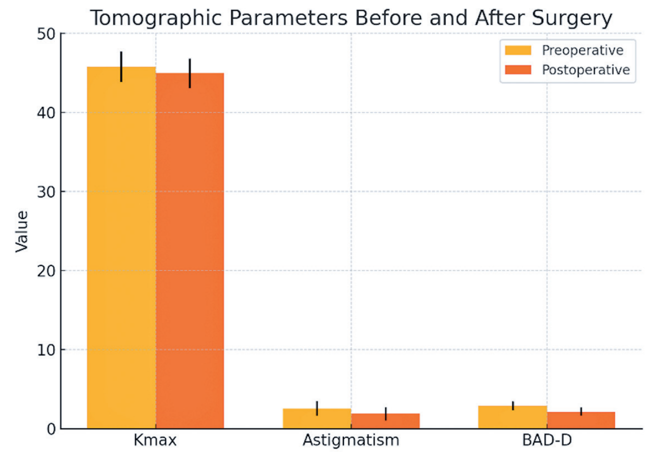

Figure 1. Changes in tomographic parameters (Kmax, astigmatism, and BAD-D) before and after pterygium excision. Bars represent group means ± standard deviations. A statistically significant postoperative reduction was observed for BAD-D, whereas Kmax and corneal astigmatism did not differ significantly between the two time points.

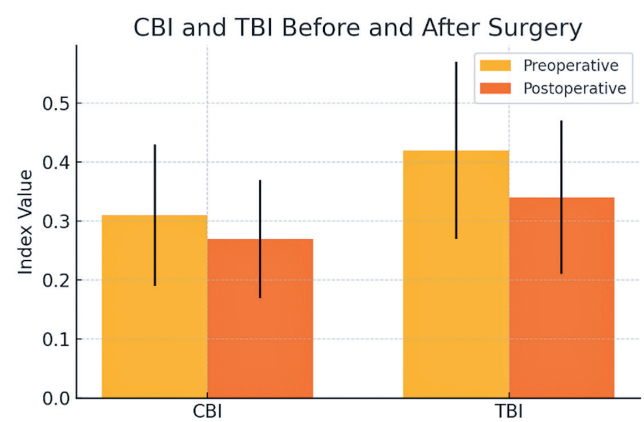

Figure 2. Composite biomechanical indices (CBI and TBI) derived from Corvis ST before and after surgery. The CBI showed a postoperative reduction (Wilcoxon, *p*=0.048), whereas the TBI did not differ significantly between time points (*p*=0.909), illustrating the differential postoperative response across the composite screening indices.

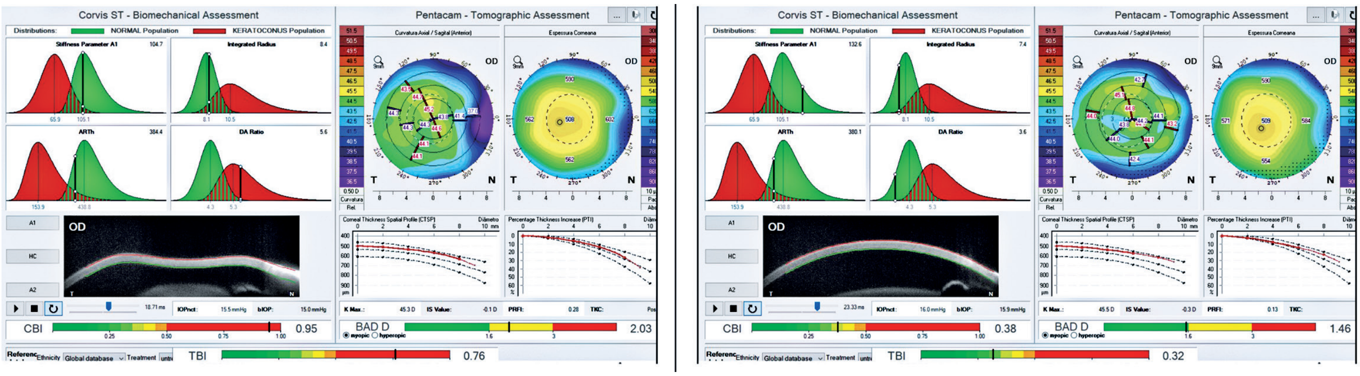

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Figure 3. (A) Preoperative tomographic and biomechanical evaluation showing altered indices. (B) Postoperative tomographic and biomechanical evaluation showing postoperative changes in the tomographic indices.

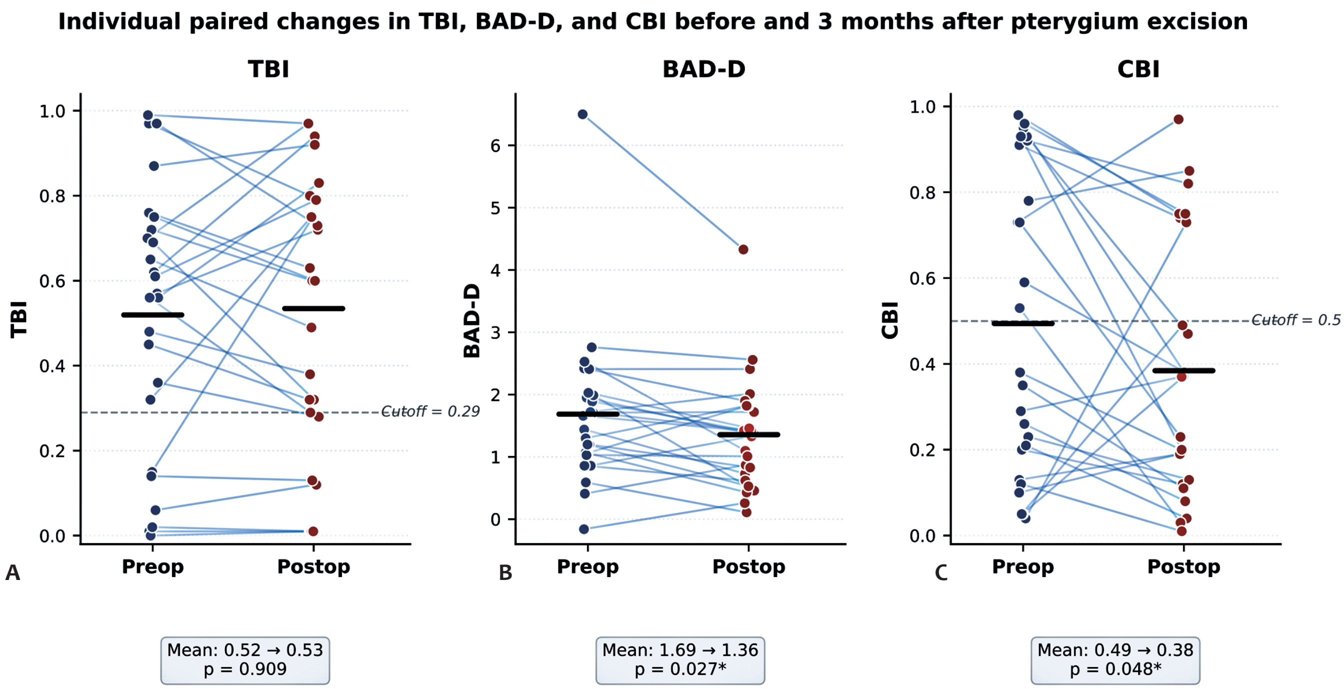

Figure 4. Individual paired (spaghetti) plots of (A) TBI, (B) BAD-D, and (C) CBI before and 3 months after pterygium excision. Each line represents one eye, illustrating the direction and magnitude of postoperative changes and the differential postoperative response across the indices.

Figure 3 shows a representative case before and after pterygium excision.

Subgroup analysis

Because horizontal pterygium extension in millimeters was not consistently registered in the standardized study database in a way that would allow reliable retrospective extraction for all 25 eyes, planned correlation analyses between pterygium extension and tomographic/biomechanical changes were unable to be performed, which was acknowledged as a study limitation. Eyes that remained TBI-positive postoperatively (n=18) had a mean preoperative TBI of 0.68±0.20, compared to 0.16±0.14 in eyes that remained TBI-negative (n=5); the single eye that normalized had a preoperative TBI of 0.48, while the single eye that became newly TBI-positive had a preoperative TBI of 0.15.

Complications

There were no complications either during or after the procedure. At the 3-month visit, all conjunctival grafts remained stable with no recurrences, graft retraction, or epithelial defects. There was no additional surgical or medical intervention required for any of the patients.

DISCUSSION

This prospective study demonstrates that primary pterygium can cause significant changes in corneal imaging and biomechanical screening results, mimicking patterns commonly associated with ectatic disease[5,8]. Importantly, the current data show a differential postoperative response among screening indices: anterior tomographic metrics such as BAD-D and Pentacam irregularity indices, as well as the proportion of eyes classified as CBI-positive decreased after surgical excision, whereas TBI remained elevated in the majority of eyes. This pattern emphasizes the importance of careful diagnostic timing and interpretation when keratoconus screening is performed in the presence of ocular surface lesions as well as the fact that postoperative reassessment does not always reclassify previously screening-positive eyes[3,15,20].

In our cohort, pterygium removal resulted in significant postoperative reductions in BAD-D and Pentacam irregularity indices (ISV and IVA) as well as a numerical decrease in the proportion of eyes classified as TKC-positive (from 32% to 12%). However, due to the limited sample size[1,4-6], this did not reach statistical significance. Mean Kmax and corneal astigmatism did not differ between time points, which is likely due to the wide preoperative variability in these parameters in eyes with pterygium and the small sample size, rather than the lack of clinical change. These results are consistent with previous research showing that pterygium distorts anterior corneal curvature and causes irregular astigmatism[1,4,6]. The current study provides a clinically relevant biomechanical perspective by investigating how surface-driven distortion affects Corvis-derived keratoconus screening indices in vivo. Our findings support the hypothesis that anterior surface distortion contributes to apparent abnormalities in keratoconus screening indices in eyes with pterygium, but they also show that this contribution varies across indices[5,9].

One of the most clinically relevant findings was the difference in postoperative behavior between the two AI-derived composite screening indices. Using the previously proposed positivity threshold of CBI ≥0.5[13], the proportion of eyes classified as CBI-positive decreased from 48% preoperatively to 28% postoperatively, and the mean CBI decreased significantly (Wilcoxon signed-rank test, $p=0.048$). In contrast, the TBI showed no change in its mean value or the proportion of eyes above the established positivity threshold of TBI ≥0.29: 19 of 25 eyes (76%) were classified as TBI-positive both before and after surgery, and 18 of 19 preoperatively TBI-positive eyes remained TBI-positive at 3 months[11-13]. This pattern suggests that the TBI, which integrates tomographic and biomechanical data using artificial intelligence algorithms, may be especially sensitive to abnormalities that cannot be fully resolved by removing the visible pterygium itself. While this high sensitivity is useful for detecting early ectatic disease, it may also increase the likelihood of false-positive keratoconus screening rates in eyes with a history of nonectatic anterior segment abnormalities, such as pterygium, even after lesion removal[5,11,12]. The CBI, which becomes dynamic deformation response metrics with corneal thickness profiles, may be more sensitive to postoperative reductions in anterior surface distortion than the TBI. However, in this small sample[13,18] the McNemar comparison of CBI-positivity rates failed to reach statistical significance ($p=0.125$).

Our findings also show that the deeper corneal stroma is stable[8,22]. No significant postoperative changes were observed in parameters such as DA ratio, integrated radius, ARTh, SP-A1, or SSI, which reflect intrinsic biomechanical properties and may be less affected by surface shape or epithelial remodeling[14-16]. In particular, SSI, which is derived from finite element modeling and is intended to be less dependent on corneal geometry, did not differ between time points, supporting the hypothesis that the lesion does not impair intrinsic stromal stiffness[10,14]. Taken together, the postoperative reduction in anterior surface tomographic abnormalities, the partial decrease in CBI-positivity, the persistent elevation of TBI in most eyes, and the stability of stiffness-related parameters point to a heterogeneous origin of the keratoconus-like screening pattern in eyes with pterygium: a component related to anterior surface and geometric irregularity, which is more readily attenuated after surgery, and a residual component captured by the TBI that may persist after lesion removal[14-16].

These findings have significant implications for clinical decision-making[15,20]. Clinicians should be aware that anterior surface lesions such as pterygium can produce tomographic and biomechanical screening profiles similar to early keratoconus, potentially leading to diagnostic uncertainty or unnecessary exclusion from corneal procedures based solely on keratoconus screening[11-13]. Our data show that postoperative reductions in composite screening indices do not always imply complete normalization in every eye: 18 of 19 TBI-positive eyes (94.7%) remained TBI-positive at 3 months. Postoperative TBI and CBI values should not be interpreted in isolation, but rather in conjunction with slit-lamp findings, full tomographic context, epithelial remodeling (if available), and long-term stability. In eyes with residual borderline values, a follow-up visit may be necessary before using keratoconus screening results to guide refractive or cataract surgery planning[19,20]. It is unclear whether a longer follow-up (for example, 6 months) would result in a further reduction in screening indices, and future research is needed. Our protocol included a reassessment at 3 months, which is when most eyes' keratometric and topographic parameters are reported to be stable following pterygium excision[16].

While our study provides new evidence in this area, there are some limitations to consider. First, the lack of pre-pterygium measurements is a significant methodological limitation. Because corneal imaging before the development of pterygium was not available, the postoperative changes observed in this study should not be interpreted as definitive evidence of true reversibility or return to a predisease baseline. Rather, they indicate that pterygium-associated tomographic and biomechanical screening abnormalities decrease slightly after surgical excision, with a variable pattern across indices. Second, horizontal pterygium extension in millimeters was not consistently recorded in the standardized study database in a way that would allow reliable retrospective extraction for all 25 eyes, preventing planned correlation analyses between pterygium size and the magnitude of tomographic or biomechanical changes; this analysis will be included prospectively in future studies on this topic. Third, while an a priori sample size estimation suggested including 25 eyes for paired pre-post comparisons, the sample size was small, limiting subgroup analyses and the statistical power for binary comparisons (e.g., McNemar comparisons of CBI-positivity and TKC reclassification rates); thus, findings with marginal p-values should be interpreted with caution. A postoperative reassessment was only performed after 3 months; longer follow-up would be beneficial to confirm whether residual TBI elevation persists or decreases over time. The lack of epithelial thickness mapping (e.g., OCT epithelial maps) limits our ability to distinguish between epithelial compensation from stromal effects and better understand the mechanisms underlying the partial tomographic improvement. Furthermore, the contralateral eyes were not used as internal controls[4,5,7,19,25].

Despite these limitations, the convergence of a postoperative reduction in anterior tomographic indices with the stability of deeper biomechanical parameters lends credence to the hypothesis that pterygium can mimic keratoconus-like screening patterns, at least in part, by distorting the anterior surface without compromising stromal material stiffness[14-16]. At the same time, the persistence of TBI elevation in the majority of preoperatively positive eyes suggests that not all of the screening abnormalities seen in these patients are due to a directly reversible surface artifact. This distinction is clinically significant: keratoconus screening results in eyes with pterygium should be interpreted in context, and a positive screening result after lesion removal should not be interpreted solely as residual artifact[11-13]. Future studies that include epithelial thickness mapping, fellow-eye controls, larger cohorts stratified by pterygium size, and longer follow-up are needed to refine the response patterns described here and their clinical implications.

Primary pterygium has been linked to tomographic and biomechanical screening abnormalities that may resemble keratoconus-like patterns, contributing to false-positive keratoconus screening rates in eyes with this lesion[5,11-13]. Following surgical excision, anterior tomographic parameters (BAD-D, ISV, IVA) and the proportion of CBI-positive eyes decreased. In contrast, TBI levels remained elevated in 18 of 19 preoperative TBI-positive eyes, and stiffness-related parameters (DA ratio, integrated radius, ARTh, SP-A1, and SSI) did not change significantly[14-16]. These findings show a difference in postoperative response among screening indices and suggest that pterygium-related anterior surface distortion can contribute to keratoconus-like screening patterns without necessarily reflecting intrinsic stromal biomechanical weakening, and that postoperative TBI values should not be interpreted in isolation. Post-excisional reassessment may improve diagnostic interpretation in this setting, while also acknowledge that persistent TBI elevation can occur, necessitating an integrated clinical and tomographic context[19,20,26-30].

AUTHORS' CONTRIBUTIONS:

Significant contribution to conception and design: Pablo Felipe Rodrigues; Bernardo Kaplan Moscovici; Renato Ambrósio Jr.; Mauro Campos; Walton Nose.

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Manuscript drafting: Pablo Felipe Rodrigues; Felipe A. Casseb dos Santos; Bernardo Kaplan Moscovici.

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Final approval of the submitted manuscript: Pablo Felipe Rodrigues; Felipe A. Casseb dos Santos; Bernardo Kaplan Moscovici; Renato Ambrósio Jr.; Mauro Campos; Walton Nose.

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