

# DIAGNOSTIC ACCURACY OF THE BELIN/AMBROSIO ENHANCED ECTASIA TOTAL DEVIATION DISPLAY (BAD-D) IN SCREENING KERATOCONUS TAKING TOMOGRAPHIC AND BIOMECHANICAL INDEX (TBI) AS THE GOLD STANDARD

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## ABSTRACT

**Objective:** To find out the diagnostic accuracy of the Belin/ Ambrosio enhanced ectasia index test in keratoconus diagnosis

**Material and methods:** In this cross sectional study, both eyes of five hundred patients were included. Patients were included in a systematic random manner from amongst those coming to Amanat eye hospital Peshawar from July 2018 to June 2019 to get rid of their glasses or aiming remedy for corneal bulging. Amanat eye hospital is located at university road in Peshawar providing ocular diagnostic and treatment services. The tools used for the study were the Oculus Pentacam HR and the Corvis ST. The collected data was analyzed statistically using SPSS version 23.

**Results:** The mean BAD-D value was 3.08+/- 4.45 SD, the SEM was 0.14, 95% confidence interval (CI) of 2.80 to 3.35. The range was 0 to 40.21. The mean TBI value was 0.46+/\_ 0.39 SD, SEM was 0.12 with a 95% CI of 0.22 to 0.70. The range of TBI was 0 to 1.00. For BAD-D, sensitivity was 75.6 per cent, specificity was 100 %, positive predictive value was 100% and the negative predictive value was 72.3%.

**Conclusion:** In terms of specificity and sensitivity, the current study showed acceptable diagnostic accuracy of BAD-D. It is recommended that its result should be interpreted along with other topographic, and tomographic parameters.

**Key words:** Corvis biomechanical index, Belin/Ambrosio enhanced ectasia total deviation display; Tomographic and biomechanical index.

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## INTRODUCTION

In this era, diagnosing subclinical corneal ectasia has become increasingly important because of the introduction of new treatment options for refractive disorders such as laser in situ keratomileusis, photo refractive keratectomy, femto LASIK, and small incision lenticule extraction<sup>1,2,3,4</sup>. The importance of excluding the possibility of coexisting corneal ectatic states along with refractive error can

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be understood by the fact that there is a deterioration of vision due to increase in corneal bulging after corneal laser procedures in such cases<sup>5</sup>. The recent observation that in corneal ectasia, riboflavin dropping of the cornea followed by ultraviolet light therapy can halt the advancement of this ailment to more developed stages has further increased the significance of early ectasia detection<sup>6,7</sup>. Keratoconus usually involves both eyes of a patient in an asymmetric way, in which there is thinning and protrusion of the central and para central cornea showing up around pubescence<sup>8</sup>. Keratoconus patients generally present with variable amount of inadequate vision which cannot be corrected precisely with refraction. In fully developed cases, on clinical examination, there is irregular scissor reflex on retinoscopy because of oblique astigmatism and the distant direct ophthalmoscopy can elicit central oil droplet reflex. Yet, in

the beginning stage, which is likewise called sub-clinical keratoconus, or forme fruste keratoconus, because of the unclear clinical picture, the diagnosis can be made with the assistance of screening tests which have high degree of diagnostic accuracy<sup>9</sup>.

Nowadays, various devices are utilized for diagnosing keratoconus, incorporating corneal surface, shape and curvature measurements. They include the Orbscan II, the Oculus Pentacam, Galilei G4, and Sirius. The aforementioned instruments measure corneal shape, thickness, and rise of the front and back surfaces of the cornea. In the near past, it was observed that in keratoconus, the corneal response to biomechanical influences is altered before variations taking place in corneal thickness and shape<sup>10</sup>. Currently, the response of the cornea to biomechanical factors is studied with two devices, one is the Ocular Response Analyzer and the other is the Corvis. Pentacam HR<sup>11</sup> depends on Scheimpflug slit picture photography. It measures the corneal thickness in a harmless manner and uses a 475-nm monochromatic cut of light to enlighten the cornea and a 1.45-megapixel camera for photography. The camera rotates about the line of fixation of the eye during the scanning process. There are different scanning programs in Pentacam which include a 25-picture one second scan, a 50-picture two seconds scan, and a cornea fine 50 pictures in one second scan. Based on the information derived from these photos, the system computes a 3D model of the anterior segment of eye from up to 138,000 real elevation points. Another camera detects eye movements and necessary corrections are made thereafter.

The BAD-D<sup>12</sup> is a composite presentation of the height and thickness data of the cornea recorded by Pentacam ST. Deviation from the mean normal values are recorded in standard deviation as; deviation of the front and back corneal height (df and db respectively), thickness distribution (dp), thinnest value (dt) and superio-inferior relocation of the thinnest area with respect to the corneal apex (dy). The d values are calculated in such a way that a zero figure represents the average of the normal individuals and 1 shows one standard deviation towards the ailment. At the end a D value is determined dependent on a regression analysis that measures each parameter differently. If a value is underneath 1.6 from the population mean, it is colored white, yellow (dubious) when it is  $\geq 1.6$  SD from the mean and red (unhealthy) when more than 2.6 SD from the mean.

The blend of thickness and biomechanical response is another test which is named as tomographic and biomechanical index or TBI. The aim of the present study was to look at the diagnostic precision of BAD-D in keratoconus screening taking TBI as the gold standard<sup>13</sup>.

## MATERIAL AND METHODS

This cross sectional study included patients who visited Amanat eye clinic Peshawar during latter half of 2018 to first half of 2019. Amanat eye hospital Peshawar is a private eye care center having outpatient treatment service, diagnostic and surgical treatment facilities. There were two kinds of patients in this study; those who were keen to get rid of their glasses by opting a laser procedure or those who were instructed to have pentacam test because of the frequent changes in glasses and therefore thought of as candidate for riboflavin dropping therapy if found positive for corneal bulging. Those individuals with a history of some corneal laser therapy, or having evident clinical signs of keratoconus were not included. Both genders were included randomly within the age range of 5 to 50 years. Both eyes of 500 patients were included in the study making a total of one thousand cases. The devices used for screening were the Oculus Pentacam to investigate BAD-D and the Oculus Carvis ST for CBI and TBI. The study was carried out under the recommendations of the tenets of declaration of Helsinki.

## RESULTS

In the current study, both eyes of 500 patients were recruited. The number of female and male patients was 182 and 318 with a percentage of 36.4 and 63.6 respectively. The age range of the patients was 5 to 49 years, with a mean and SD of 21.89 +/- 8.434 years, 95% CI for age was 21.15 to 22.63 with SE of 0.377years. The cut off range for BAD-D was 0.00 to 1.6 as normal, 1.7 to 3 as suspicious and more than 3 as diseased. For TBI, the cutoff normal range was 0.00 up to 0.25, suspicious range was 0.26 to 0.5 and diseases reference range was 0.51 to 1. The result of BAD-D is given in table 1. The mean BAD-D value was 3.080 +/- 4.450 sd. The SE was 0.140, with a 95% CI of 2.805 to 3.356. The minimum BAD-D value was 0.00 and the maximum value was 40.21. The result of TBI is given in table 2. The mean TBI value was 0.465 +/- 0.392 SD. The SE was 0.124 with a 95% CI of 0.222 to 0.708. The minimum TBI value was 0.00 and the maximum value was 1.00.

## DISCUSSION

In this study, we assessed the diagnostic value of BAD-D in corneal ectasia diagnosis by finding out their sensitivity, specificity and predictive values against TBI from the collected data. In the present study, the sensitivity and the specificity of BAD -D was 75.6% and 100% respectively. The positive and negative predictive value of BAD-D was 100% and 72.3% respectively.

Wang YM study results for the sensitivity of BAD-D in forme fruste keratoconus was 52.6% with a specificity of 80.3%<sup>16</sup>. Both the markers have lower

**Table 1: BAD-D**

No	Category	Frequency OD	Frequency OS	Total	Percentage
1	Normal	274	264	538	53.8
2	Suspicious	125	139	264	26.4
3	Diseased	101	97	198	19.8
Total		500	500	1000	100

**Table 2: TBI**

S. No	Category	Frequency OD	Frequency OS	Total	Percentage
1	Normal	192	197	389	38.9
2	Suspicious	114	113	227	22.7
3	Diseased	194	190	384	38.4
Total	Total	500	500	1000	100

**Table 3: Evaluation of BAD-D by comparing it with TBI**

s.no	BAD-D result	Disease present	Disease absent	Total	Sensitivity=%75.6 Specificity=%100 Positive predictive value=%100 Negative predictive value=%72.3
1	Positive test (suspicious plus diseased)	a (true positive) 462	B (false positive) 0	a+b 462	
2	Negative test	c (false negative) 149	d (true negative) 389	c+d 538	
3	Total	611	389	a+b+c+d 1000	

**Table 4: Comparison of BAD-D with TBI for p value calculation**

S no		BAD-D observed(expected)	TBI Observed(expected)	Total	P value (chi square test)=0.06
1	Normal	a 538 (463.5)	B 389 (463.5)	927	
2	Suspicious plus diseased	C 462 (536.5)	D 611 (536.5)	1073	
3	Total (observed)	1000	1000	2000	

values in their study than our study, the explanation being their comparison of just the forme fruste keratoconus with normal individuals whereas our study compares both subclinical and clinical ectasia cases with normal individuals. Subclinical cases have parameters nearer to the normal population than established ectasia cases; therefore, subclinical cases sensitivity and specificity results are less than those of established keratoconus cases.

Muftuoglu noted 60% sensitivity and 90% specificity of BAD-D for subclinical KC versus normal eyes<sup>17</sup>. Steinberg reported 69% sensitivity and 79% specificity for BAD-D when comparing subclinical keratoconus with normal subjects<sup>18</sup>. Ambrosio Jr R documented sensitivity and specificity of 87% and 92.1% respectively for BAD-D in his study before performing LASIK procedure<sup>19</sup>. Sedaqatl found a sensitivity and specificity of 100% for BAD-D, but he compared patients having frank keratoconus with normal population, in which the difference is more clear and pronounced<sup>20</sup>. This data show reasonable specificity of BAD-D, which indicate that its positive

result is trustworthy. However, with a sensitivity of 75.6%, this study may highlight the chances of false negative results in early stage of subclinical ectasia. So, if a patient is labeled negative with BAD-D test and there is clinical suspicion of forme fruste keratoconus, the test should be interpreted in combination with other parameters measuring corneal thickness and curvature; and should also be correlated with clinical findings.

**CONCLUSION**

The current study showed acceptable diagnostic accuracy of BAD-D in terms of specificity (100%), and sensitivity (75.6%), which imply that if this test is used alone for keratoconus screening, some cases of subclinical keratoconus may be missed. So, the author recommends that its result should be interpreted in combination with clinical history, topographic and biomechanical parameters.

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## AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under

**Hanan F:** Data Collection, Analysis, revision, desining and writing

**Hussain M:** Analysis and revision

**Shah Z:** revision

**Asrar A:** revision

**Qureshi S:** Data collection and revision

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.