

Effects of Different Types of Primary Pterygium on Changes in Oculovisual Function

(Jenis Pterigium Primari dan Kesannya pada Perubahan Fungsi Okulovisual)

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ABSTRACT

Pterygium are known to cause reduction in oculovisual function. However, the effects are varying due to its various morphological factors, thus, the impact on patient are difficult to predict which indirectly not all pterygium need to be excised. To describe the effects of different types of pterygium on changes in oculovisual function. Ninety-three (93) primary pterygium eyes from 93 patients were recruited in this study. Diagnosis and classification of primary pterygium were done by a consultant ophthalmologist (KMK). Standard optometric examinations were performed in all participants. Best-corrected visual acuity (BCVA) and contrast sensitivity (CS) was subjectively measured using computerised M&S Technologies Smart System II, performed by a single operator on the same visit. Pterygium excision was done based on a standardised method performed by a single surgeon (KMK). At third month post-surgical, repeated measurements of BCVA and CS were performed. Difference between pre and post-surgical was taken as magnitude changes for each pterygium type. Paired T-test and ANOVA were employed to evaluate the difference between pre- and post-surgical and pterygium types for both BCVA and CS parameters. Overall mean ($n = 93$) of BCVA and CS were found significantly associated with advance pterygium ($P < 0.001$). Paired T-test and ANOVA results showed a significant difference in BCVA and CS values between pterygium groups in pre- and post-surgical sessions and between pterygium types (both $P < 0.001$). Reduction of oculovisual function in pterygium patient is expected in advance pterygium. Management of pterygium should be coherent with pterygium types.

Keywords: Best-corrected visual acuity (BCVA); contrast sensitivity; morphology; primary pterygium; pterygium excision

ABSTRAK

Untuk mengkaji jenis pterigium yang mampu mengubah fungsi okulovisual. Sebanyak 93 mata daripada 93 pesakit pterigium primer telah direkrut untuk kajian ini. Diagnosis dan pengelasan pterigium primer dilakukan oleh pakar perunding oftalmologi (KMK). Semua peserta kajian telah menjalani pemeriksaan optometri piawai. Ketajaman visual yang diperbetulkan terbaik (BCVA) dan sensitiviti kontras (CS) diukur pada sesi yang sama untuk setiap sesi oleh seorang operator (MRH) secara subjektif menggunakan perisian M&S Technologies Smart System II. Pembedahan pterigium dilakukan oleh seorang pakar bedah (KMK) menggunakan kaedah piawai. Setelah 3 bulan pos-pembedahan, pengukuran BCVA dan CS dilakukan semula. Perubahan untuk setiap jenis pterigium ditakrifkan sebagai perbezaan magnitud antara pra dan pos-pembedahan. Ujian T-berpasangan dan ANOVA digunakan untuk menganalisis perbezaan antara pra dan pos-pembedahan untuk BCVA dan CS. Min keseluruhan untuk BCVA dan CS ($n = 93$) berkolerasi secara signifikan dengan lanjutan pterigium ($P < 0.001$). Ujian T-berpasangan dan ANOVA menunjukkan perubahan signifikan pada nilai BCVA dan CS antara jenis pterigium ketika pra dan pos-pembedahan dan antara jenis pterigium (kedua-dua $P < 0.001$). Untuk pesakit pterigium, pengurangan fungsi okulovisual dijangkakan berlaku pada peringkat lanjutan pterigium. Pengurusan pterigium seharusnya mengambil kira jenis pterigium.

Kata kunci: Kelengkungan kornea; ketajaman visual yang diperbetulkan terbaik (BCVA); morfologi; pterigium; sensitiviti kontras

INTRODUCTION

Pterygium is an abnormal benign, elevated, superficial, wedge-shaped fibrovascular proliferative lesion of the bulbar conjunctiva which extends on the corneal surface (Errais et al. 2008; Hilmi et al. 2018a; Manzar & Mahar 2013). A pterygium occurs more commonly in people who

have had chronic ultraviolet (UV) ray exposures (Chui et al. 2011; Liu et al. 2013; Maharjan et al. 2014; Marmamula et al. 2013) and those who live in hot, dry windy or dusty environment (Pan et al. 2018). It is a fact that pterygium is an essential factor which contributes to induced irregular corneal astigmatism as pterygium invades into the cornea,

it may cause visual disturbance due to abnormal corneal curvature (Zare et al. 2010). However, it is worth to note that clinically not the all large size of pterygium induced significant astigmatism as small pterygium size could give similar effects. Hence, degrees of severity in visual impairment were also tricky to predict as the size and width does not necessarily correlate with each other. This could happen due to its morphology (fleshiness) which could induce an external force on the corneal curvature.

Several clinical gradings have been proposed in evaluating pterygium. Pterygium can be assessed based on several methods such as via its fleshiness appearance (Che Azemin et al. 2016; Mohd Radzi et al. 2017; Tan et al. 1997), extension or length (Gumus et al. 2011; Han et al. 2016; Lawan et al. 2018; Lin & Stern 1998; Mohammad-Salih & Sharif 2008; Nejima et al. 2015; Tan et al. 1997), its size (Altan-Yaycioglu et al. 2013; Farhood & Kareem 2012; Gumus et al. 2012; Hilmi et al. 2018b; Kheirkhah et al. 2012; Ozgurhan et al. 2015; Vives et al. 2013) and based on its encroachment relative to the corneal size (Gumus et al. 2011; Mohammad-Salih & Sharif 2008; Zare et al. 2010). In 1997, Tan et al. proposed a classification of pterygium based on its clinical appearance (Figure 1). This classification is based on three (3) types or grades known as type I - atrophy, type II - intermediate and type III - fleshy. This classification is based on loss of translucency of pterygium tissue which relates to increased fleshiness that could signify the abnormal fibrovascular growth of pterygium.

Visual impairment due to changes on the ocular surface is commonly measured using best-corrected visual acuity (BCVA) and contrast sensitivity function (CS). BCVA is defined as a measurement of visual function which describes the sensitivity of optical, retinal and neural functions of the eye (Thurman et al. 2016). Hence, BCVA represents the clarity and sharpness of the central vision. However, previous works (Altan-Yaycioglu et al. 2013; Farhood & Kareem 2012; Gumus et al. 2012, 2011; Han et al. 2016; Hilmi et al. 2018c; Kheirkhah et al. 2012; Lawan et al. 2018; Lin & Stern 1998; Mohammad-Salih & Sharif 2008; Nejima et al. 2015; Ozgurhan et al. 2015; Vives et al. 2013) had proved that the progression of pterygium would induce corneal astigmatism based on measurement of anterior corneal curvature.

In contrast, CS is defined as a measurement of visual function specifically on variation in luminance, used to distinguish between finer and finer increments of luminance from the background (Pelli & Bex 2013). Although both CS and BCVA measures visual functions, CS differs from BCVA as it combines size and contrast in its evaluation, while BCVA focused on letter size. Previous studies (Hilmi et al. 2018b; Malik et al. 2014; Oh & Wee 2010) had commented that relying solely on BCVA in measuring visual performance is inadequate; hence CS need to be included in the assessment. To the best of our knowledge, lack of evidence found that address the effects of both BCVA and CS in different types of primary pterygium. This study would like to address the clinical importance of

reduction in both BCVA and CS based on its pterygium types as potential decision-making process in managing pterygium patients, in which should not only consider surgical excision as the sole management. Hence, this study aims to evaluate the effects of different types of pterygium (type I, II and III) on changes in oculo-visual function utilising BCVA and CS.

MATERIALS AND METHODS

Ninety three primary pterygium eyes from 93 patients were recruited in this study who visits a University eye-specialist in order to display a wide range of severity of pterygium patients. All participants in this study were selected based on specific criteria which includes established diagnosis of primary pterygium, both genders were included with age ranges from 20 to 70 years and free from any history of ocular trauma, ocular surgery, contact lens wear, and any ocular anterior segment disease other than pterygium which may affect vision (Azemin et al. 2014; Che Azemin et al. 2015, 2014; Mohd Radzi et al. 2017). Patients with significant ocular surface diseases such as recurrent pterygium, corneal opacity or irregularity due to diseases other than pterygium. A condition in obstruction of the central cornea by pterygium were also excluded. Diagnosis and classification of primary pterygium were performed by a single ocular surface expert (KMK). The study was conducted according to the recommendation of the tenets of the Declaration of Helsinki and approved by the International Islamic University Malaysia (IIUM) ethical research committee (IREC) (IIUM/310/G13/4/4-125). Written and informed consent was obtained from all participants before any procedures performed.

Contrast sensitivity function (CS) and VA were measured using M&S Technologies Smart System II (SSII, Park Ridge, IL, USA). Both measurements were done by a single operator and performed on the same visit. Both BCVA and CS were measured using the M&S Smart System II (MSSS-II; M&S Technologies Inc. Niles, IL, US) in a dim room with a standardised luminance of 85 cd/m² and colour temperature of 3300K as suggested by the manufacturer guideline (M&S Technologies Inc. 2011) and previous works (McClenaghan et al. 2007; Mohd Radzi et al. 2017). The usage of M&S Smart System II (MSSS-II; M&S Technologies Inc. Niles, IL, US) in measuring CS was found comparable with the gold-standard Pelli-Robson chart (Chandrakumar et al. 2013; Hilmi et al. 2018b). Then, all participants undergo pterygium excision using fibrin glue adhesive technique (Kurian et al. 2015), performed by a single surgeon (KMK). At third month post-surgical, all participants undergo similar procedures as in pre-surgical session. The difference between pre and post-surgical was taken as magnitude changes for each pterygium type. All data were then being exported to statistical software.

Statistical analyses were performed using IBM SPSS (Predictive analytics software) (Version 19, SPSS Inc., Chicago, IL, USA). Paired T-test was employed to evaluate

the difference between pre and post-surgical for both BCVA and CS for all pterygium types. One-way analysis of variance (ANOVA) was employed to evaluate if there is any significant difference between all pterygium groups for both BCVA and CS parameters. Bonferroni post-hoc analysis was employed to determine which pair was significant. A significance level of $P < 0.05$ was set as the confidence level.

RESULTS AND DISCUSSION

The analysis includes 93 participants, with 50.5% ($n = 47$) were men. Normality testing was evaluated using the ratio of skewness and kurtosis (George & Mallery 2010), with ± 2.50 was taken as the normal distribution. Normality testing showed normal data distribution in all pterygium types. All participants were organised based on the pterygium types based on Tan's classification of pterygium (Tan et al. 1997).

The mean of BCVA and CS for type I were 0.12 ± 0.05 LogMAR and $6.40 \pm 0.81\%$, respectively. Increasing trends were found with type II showed higher BCVA and CS compared to type I with 0.45 ± 0.22 LogMAR and $21.38 \pm 9.29\%$, respectively. Based on our findings, type III was found the highest BCVA and CS values with 0.73 ± 0.22 LogMAR and $44.58 \pm 10.57\%$, respectively. Paired T-test results showed there was a significant difference in at least one pair of the group which indicates a significant difference in BCVA and CS values between pterygium

groups ($P < 0.05$) in pre- and post-surgical sessions. Comparative analyses for pre- and post-surgical excision for BCVA and CS for each pterygium type were summarised in Table 1.

With regards to magnitude changes for each pterygium type, ANOVA results showed there is a significant difference in at least one pair of the group which indicates a significant difference in BCVA and CS values between pterygium groups ($P < 0.001$). Based on Bonferroni post-hoc analysis, there was a significant difference between type I and II (0.02 ± 0.04), II and III (0.33 ± 0.20), and I and III (0.58 ± 0.21) for BCVA value (all $P < 0.001$). Likewise, for CS values, Bonferroni post-hoc analysis revealed a significant difference between type I and II (0.33 ± 0.76), II and III (15.19 ± 9.35), and I and III (37.87 ± 9.99). Comparative analyses for magnitude changes in BCVA and CS for each pterygium type were summarised in Table 2.

Best-corrected visual acuity (BCVA) is a common visual parameter in assessing pterygium. However, it is rarely contrast sensitivity (CS) been discussed and addressed as part of an assessment for pterygium. Hence, this study aims to evaluate the effects of different types of pterygium (type I, II and III) on oculovisual function utilising two (2) visual performance parameters (BCVA and CS). This study employed an approximately similar number of samples for each pterygium types (type I; $n = 31$, type II; $n = 32$, type III; $n = 30$) to evaluate the difference in BCVA and CS relative to pterygium types.

TABLE 1. Comparative analyses between pre and post-surgical excision for BCVA and CS based on pterygium types ($n = 93$)

| Variables | Type of pterygium (mean \pm SD) | | | | | | P-Value* |
|---------------|-----------------------------------|-----------------|------------------|-----------------|-------------------|-----------------|--|
| | Type Ia (n=30) | | Type IIb (n=32) | | Type IIIc (n=31) | | |
| | Pre | Post | Pre | Post | Pre | Post | |
| BCVA (LogMAR) | 0.12 ± 0.05 | 0.11 ± 0.03 | 0.45 ± 0.22 | 0.12 ± 0.04 | 0.73 ± 0.22 | 0.15 ± 0.06 | ^a $p = 0.023^b$ $p < 0.001^c$ $p < 0.001$ |
| CSF (%) | 6.40 ± 0.81 | 6.07 ± 0.37 | 21.38 ± 9.29 | 6.19 ± 0.54 | 44.58 ± 10.57 | 6.71 ± 1.32 | ^a $p = 0.023^b$ $p < 0.001^c$ $p < 0.001$ |

* Paired t-test, significance level set at 0.05 (2-tailed); a P-value between pre and post-surgical for group type I;

b P-value between pre and post-surgical for group type II; c P-value between pre and post-surgical for group type III

TABLE 2. Comparative analyses for magnitude changes in BCVA and CS for each pterygium type ($n = 93$)

| Variables | Type of pterygium (mean \pm SD) | | | ANOVA | |
|---------------|-----------------------------------|-----------------------------|------------------------------|-------------|--|
| | Type I ^a (n=30) | Type II ^b (n=32) | Type III ^c (n=31) | P-value* | Post-hoc# |
| BCVA (LogMAR) | 0.02 ± 0.04 | 0.33 ± 0.20 | 0.58 ± 0.21 | $p < 0.001$ | ^a $p < 0.001^b$ $p < 0.001^c$ $p < 0.001$ |
| CSF (%) | 0.33 ± 0.76 | 15.19 ± 9.35 | 37.87 ± 9.99 | $p < 0.001$ | ^a $p < 0.001^b$ $p < 0.001^c$ $p < 0.001$ |

*Significance level set at 0.05 (2-tailed); # Based on Bonferroni correction post-hoc, significance level set at 0.05 (2-tailed); a P-value between type I and II; b P-value between type II and III; c P-value between type I and III

This study showed that the increase of pterygium types showed a decrease in both BCVA and CS values.

The decrease in both BCVA and CS values indicate lower visual performance. Results showed type III pterygium induced most decrement in BCVA with 0.73 ± 0.22 LogMAR compared to type II and I with 0.45 ± 0.22 LogMAR and 0.12 ± 0.05 LogMAR, respectively. Based on our findings, it is postulated that fleshiness appearance in type III pterygium could be the cause of the reduction as the whitish appearance of pterygium which gives rise to obscured episcleral vessels could be due to the presence of fibrovascular tissue due to excessive proliferative disorders (Džunic et al. 2010; Reda et al. 2018; Ribatti et al. 2009). The excessive proliferative growth of pterygium could induce corneal compression which may also lead to the reduction in BCVA.

This study also found that CS values decreased incoherent with types of pterygium. Pterygium type III induced most reduction in contrast sensitivity with $44.58 \pm 10.57\%$ compared to type II and I with $21.38 \pm 9.29\%$ and $6.40 \pm 0.81\%$, respectively. To the best of our knowledge, information on CS related to pterygium is scarce (Hilmi et al. 2018b; Oh & Wee 2010). However, it is suggested that a decrease in CS could be due to types of pterygium, which indirectly inducing scattering of light due to translucence corneal surface in the pterygium region. Although these findings look promising, it needs to be highlighted that both BCVA and CS only measures changes on the central cornea, approximately 5 mm centrally. The overall effect of pterygium progression is still unknown as the measurement could only cover the central and mid-peripheral cornea. Hence, the effects of other morphology such as size, width and extension of pterygium would also be essential to be addressed.

Researchers has been looking at various pterygium morphology in deciphering the cause of visual degradation in pterygium, and the reason of why each pterygium effect is different from one to another. In the past decades, pterygium morphologies such as length, its total area and size were found significantly correlated in reduction in oculovisual function (Altan-Yaycioglu et al. 2013; Farhood & Kareem 2012; Gumus et al. 2011; Kheirhah et al. 2012; Lin & Stern 1998; Muhammad-Salih & Sharif 2008; Vives et al. 2013). However, clinical evidences showed that a large or longer pterygium does not always gave a significant impact on oculovisual function. Previous work (Muhammad-Salih & Sharif 2008) reported that pterygium total area of $> 6.25 \text{ mm}^2$ induced significant reduction in oculovisual function in form of corneal astigmatism of 2 D, as supported by recent studies (Altan-Yaycioglu et al. 2013; Vives et al. 2013). However, Avisar et al. (2000) and Lin and Stern (1998) reported contradictory findings with pterygium total area of $>16\%$ and $> 45\%$ induced significant corneal astigmatism of > 1 D, respectively. On top of that, Lin and Stern (1998) also commented that pterygium total area $< 45\%$ of corneal radius were only weakly correlated ($r = 0.180$, $P < 0.05$) while total area of $> 45\%$ were highly correlated

with reduction in oculovisual function in form of corneal astigmatism ($r = 0.960$, $P < 0.001$).

With regards to pterygium length, several studies (Kampitak 2003; Muhammad-Salih & Sharif 2008) reported that the correlation between length of pterygium and induced reduction in oculovisual function in form of corneal astigmatism was found significant with ≥ 2 mm would induced ≥ 2 D. However, recent work (Farhood & Kareem 2012) reported contradict findings with ≥ 2 mm would induced ≥ 1 D. These evidences indicate that relying on length and size are inadequate to determine the impact of pterygium on changes in oculovisual function. These could be due to the characteristics of pterygium which does not abide to any specific shapes and length. An attempt was made (Mohd Radzi et al. 2019) recently to quantify both total area and length using image analysis. It was found that the combination of these two morphologies could predict approximately 32% changes in oculovisual function. However, it was noted that the fleshiness (translucence) of pterygium could be the possible key to solve the problem as different types of pterygium was found able to predict a large range of reduction in oculovisual function, as suggested in this study findings. This could explain the reason why previous studies findings (Altan-Yaycioglu et al. 2013; Avisar et al. 2000; Farhood & Kareem 2012; Gumus et al. 2011; Kampitak 2003; Kheirhah et al. 2012; Lin & Stern 1998; Muhammad-Salih & Sharif 2008; Vives et al. 2013) were varied from one to another.

Previous work (Oh & Wee 2010) commented that pterygium progression induced reduction in oculovisual function could be due to two factors; BCVA and CS. However, direct comparison could not be made as the study did not adopt similar classification as in this current work. A recent work (Sandra et al. 2014) attempt to evaluate both BCVA and CS in different types of pterygium based on Tan's classification of pterygium. Interestingly, the authors found that there was no significant difference between all three types of pterygium on changes in BCVA and CS, which contradict with the current work findings. This happen due to number of samples recruited in the previous work (Sandra et al. 2014) were mainly type I pterygium (atrophic), with very limited samples for type II (intermediate) and type III (fleshy). While this current work evaluates the changes in approximately similar number of samples for each type of pterygium type. Thus, comparison on changes on oculovisual function is well-presented in this current work.

Based on these evidences, recent studies had proposed the potential pterygium morphologies that could provide better insight on the impact of pterygium on oculovisual function. Potential pterygium morphologies were introduced which known as pterygium thickness (Hilmi et al. 2018c), redness (Mohd Radzi et al. 2017) and net pterygium total mass (NTPM) (Mohd Radzi et al. 2019). This approach aimed to combine all possible morphologies in order to have a comprehensive prediction on how pterygium affect oculovisual function. It was noted that by

adopting Tan's classification of pterygium (Tan et al. 1997), better prediction can be made based on the pterygium types as the characteristics for each pterygium type are varies from one to another, and with different type of pterygium could have various morphological characteristics, it is now important for clinicians to note that types of pterygium need to be evaluated alongside with its morphological characteristics in order to have better view on managing pterygium patients.

CONCLUSION

Both BCVA and CS are important factors that can be used to differentiate the levels of reduction in oculo-visual function based on pterygium types. Pterygium management should be based on pterygium types and levels of reduction in oculo-visual function.

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