ASSOCIATION OF NET PTERYGIUM TISSUE MASS (DRYWEIGHT) IN DETERMINING CHANGES IN OCULOVISUAL FUNCTIONS AND ANTERIOR CORNEAL CURVATURE RELATIVE TO PTERYGIUM TYPES

NOOR SYAHIRA BINTI CHE ROSLI
DEPARTMENT OF OPTOMETRY AND VISUAL SCIENCE, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JLN SULTAN AHMAD SHAH BANDAR INDERA MAHKOTA 25200 KUANTAN, PAHANG, MALAYSIA
syahirarosli5346@gmail.com

MOHD RADZI HILMI, PhD (Corresponding author)
DEPARTMENT OF OPTOMETRY AND VISUAL SCIENCE, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JLN SULTAN AHMAD SHAH BANDAR INDERA MAHKOTA 25200 KUANTAN, PAHANG, MALAYSIA
mohdradzihilmi@iium.edu.my

KHAIRIDZAN MOHD KAMAL, MD, MS (Ophthal)
DEPARTMENT OF OPHTHALMOLOGY, KULLIYYAH OF MEDICINE, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JLN SULTAN AHMAD SHAH BANDAR INDERA MAHKOTA 25200 KUANTAN, PAHANG, MALAYSIA
khairidzan@iium.edu.my

MD MUZIMAN SYAH MD MUSTAFA, PhD
DEPARTMENT OF OPTOMETRY AND VISUAL SCIENCE, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JLN SULTAN AHMAD SHAH BANDAR INDERA MAHKOTA 25200 KUANTAN, PAHANG, MALAYSIA
syah@iium.edu.my

ABSTRACT

Introduction: Dryweight in pterygium is more towards the fleshy appearance of the fibrous tissue. **Aim:** The goal of this study was to determine the predictive ability of net pterygium tissue mass (dryweight) on predicting changes in anterior corneal curvature and oculovisual functions relative to pterygium types. **Methodology:** A total of 93 primary pterygium patients who visited an ophthalmology clinic were selected as participants. The net pterygium tissue mass were obtained via freeze dry method subsequent to pterygium excision using fibrin glue adhesive method. Best corrected visual acuity (BCVA) and contrast sensitivity function (CSF) were measured by using M&S Smart System II as measurement for oculovisual function, while the changes of anterior corneal curvature was measured using corneal topography. **Results:** The mean and standard deviation for BCVA, CSF and SimK were 0.44 ± 0.30 LogMAR, 24.28 ± 17.66 % and 4.64 ± 4.18 D respectively. This study found that the predictive ability of pterygium dryweight with BCVA were strong in Type I and Type III while moderate in Type II with 13.10% (R^2 = 0.131, $p < 0.05$) in Type I. Slight increase trend were noted in both Type II with 53% (R^2 = 0.530, $p < 0.05$) and Type III, with 21.60% (R^2 = 0.216, $p < 0.05$). For CSF, the predictive ability of pterygium dryweight were strong in all types with Type I, Type II and III reported 21.6% (R^2 = 0.216, $p < 0.05$), 31.8% (R^2 = 0.318, $p < 0.05$), 28.9% (R^2 = 0.289, $p < 0.05$) respectively. The predictive ability of pterygium dryweight for SimK were strong in all types with contribution of 44.7% (R^2 = 0.447, $p < 0.05$), 47.7% (R^2 = 0.477, $p < 0.05$), 39.1% (R^2 = 0.391, $p < 0.05$) respectively. **Conclusion:** Net pterygium tissue mass (dryweight) is a strong factor in

predicting changes of oculovisual functions and anterior corneal curvature in relation to pterygium types.

Keywords: Pterygium, dryweight, best corrected visual acuity, contrast sensitivity function, anterior corneal curvature.

INTRODUCTION

Pterygium is a wing-shaped abnormal growth of the fibrovascular tissue characterized by a benign proliferation of local conjunctiva that often crosses the limbal of cornea and extends into corneal surface (Chui et al., 2011). Based on the anatomical structure, pterygium can be divided into cap (the leading edge which also known as pterygium apex), head (the vascular area that invades the cornea) and body in which the connective tissue spreading on top of the cornea (Liu et al., 2013; Anguria et al., 2014). At early stage, pterygium is usually asymptomatic. However, dry eye related manifestations may be present, such as burning, itching, and/or tearing.(Liu et al., 2013; Hilmi et al., 2019; Hilmi et al., 2019). This could happen due to unstable tears distribution (Hilmi et al., 2019). It is an established fact that as pterygium progresses, it induced unwanted corneal astigmatism, reduction in contrast sensitivity function as well as visual acuity (Coroneo, DiGirolamo & Wakenfield, 1999; Chandrakumar et al., 2013).

Currently, the pathogenesis of pterygium is still debatable, however hereditary, inflammation and environmental factors, including long-term exposure of ultraviolet (UV) on the ocular surface were noted as possible etiologies (Coroneo, DiGirolamo & Wakenfield, 1999; Liu et al., 2013; Anguria et al., 2014). There are few grading scales available in which has and can be used to classify the type of pterygium. In 1997, Tan and his co-workers (Tan et al., 1997) proposed a clinical grading of pterygium which was based on the translucency appearance of pterygium tissue. The authors described pterygium into three types; Type I pterygium (atrophic- the episcleral vessels unobscured), Type II pterygium (intermediate- the episcleral vessels partially obscured) and Type III pterygium (fleshy- the episcleral vessels are totally obscured). Other than that, pterygium also can be classified based on the size, encroachment and extension of its tissue onto cornea (Maheswari, 2003; Popat et al., 2014; Shelke et al., 2014). Thus, this study aimed to evaluate the effects of pterygium types on changes in oculovisual function based on the net pterygium tissue mass (NTPM).

MATERIALS AND METHODS

A cross-sectional prospective study was conducted in a University-based Ophthalmology Clinic (IIUM Eye Specialist Clinic, IIUM Kuantan). All participants were recruited based on voluntary sampling. Participant who fulfill the inclusion criteria were selected in this study. The inclusion and exclusion criteria of this study are participant who has an established diagnosis of primary pterygium, both gender with age range from 20 to 70 years old, both unilateral and bilateral pterygium is included, double head pterygium is excluded, free from any history of ocular trauma, surgery, free from any ocular diseases and never wear contact lenses (Mohd Radzi et al., 2017; Hilmi et al., 2019). Diagnosis of pterygium was done by a consultant ophthalmologist (KMK). The sample size for his study was calculated by using Power and Sample Size Calculation Software Version 3.1.2. (PS Software, Nashville, TN, USA).

Prior to study commencement, informed consent was obtained with approval obtained by International Islamic University Malaysia (IIUM) research ethical committee (IREC) (IIUM/310/G13/4/4-125) and this study comfort to the recommendation of the tenets of the Declaration of Helsinki. Standard optometric examination were performed in all participants which includes dry refraction, auto-refraction, best corrected visual acuity (BCVA), slit-lamp examination and contrast sensitivity function (CSF) were measured. BCVA and CSF were evaluated using M&S Smart System II. Changes on anterior corneal curvature was evaluated using Zeiss Atlas 995^{TM} Corneal Topographer (Carl Zeiss Meditec Inc, Dublin, US). Freeze-dried pterygium tissue samples known as net pterygium tissue mass (NTPM) were obtained based on methodology that has been described in detail (Hilmi et al., 2019).

All statistical analyses were done using IBM predictive analytical software (SPSS). Changes in BCVA, CSF and SimK value between pre and 3-months post-surgical excision of pterygium (Mohd Radzi et al., 2017). Comparison between pre- and post-surgical excision was done using paired T-test, while Pearson's correlation test was performed to determine the association of oculovisual functions parameters (BCVA and CSF) and anterior corneal curvature (SimK) induced by NPTM relative to the pterygium types. Comparative analysis on magnitude changes in BCVA, CSF and SimK values between all pterygium types were done using one-way analysis of variance (ANOVA). Magnitude changes in all parameters were based on changes between baseline (pre-surgical) with 3-months post-surgical. P < 0.05 was set as the level of significance.

RESULT

Out of 93 patients involved in this study, 50.5% (n = 47) was male and 49.5% (n = 46) were females. All pterygium were classified based on Tan's classification of pterygium (Tan et al., 1997) which comprised of 30 (Type I - atrophic), 32 (Type II - intermediate) and 31 (Type III - fleshy) primary pterygium. All data were normally distributed based on ratio of skewness and kurtosis of within 2.50 (George and Mallery, 2010). At baseline, the mean and standard deviation (SD) for BCVA, CSF and SimK were 0.44 ± 0.30 LogMAR, 24.28 ± 17.66% and 4.64 ± 4.18D respectively. Paired t-test revealed that there were significant differences between BCVA, CSF and SimK between the baseline pre-surgical and post-surgical 3 months ($p < 0.05$), as shown in Table 1 below.

Table 1. Comparison of BCVA, CSF and SimK between Pre & Post-pterygium Excision (N=93)

Variables	Baseline (mean ± SD)	Post 3 months (mean ± SD)	P-value*
BCVA (logMAR)	0.44±0.30	0.12±0.04	< 0.05
CSF (%)	24.28±17.66	6.32±0.89	< 0.05
Sim K (D)	4.64±4.18	0.57±0.45	< 0.05

*Paired T-test

Based on Pearson's correlation test, increasing trend was noted with stronger association was found with increase of pterygium types. For BCVA, moderate association was found for type I pterygium with 0.361 and increase steadily with 0.464 for type II. Type III pterygium was found strongly associated with changes in BCVA. For CSF, moderate association was found in all pterygium types (type I: 0.465,type II: 0.537 and type III: 0.564). Whereas for changes in SimK, strong association was found in all pterygium types (type I: 0.669, type II: 0.626 and type III: 0.690). Correlation findings were summarized in Table 2 below.

Table 2. Association of NPTM with Changes in BCVA, CSF and SimK (N = 93)

Variables	Correlation, r			*p*-value		
	Type I	Type II	Type III	Type I	Type II	Type III
BCVA	0.361	0.464	0.728	$p < 0.05$	$p < 0.05$	$p < 0.05$
CSF	0.465	0.537	0.564	$p < 0.05$	$p < 0.05$	$p < 0.05$
SimK	0.669	0.626	0.690	$p < 0.05$	$p < 0.05$	$p < 0.05$

Based on Paired T-test findings, magnitude changes for all measured parameters were found statistically significant with increasing trends of changes towards higher grade of pterygium. Type III pterygium was found induce the largest changes followed by type II and I respectively for all parameters measured. The magnitude changes are shown in Table 3 below.

Table 3. Magnitude Changes of BCVA, CSF and SimK between Type I, Type II and Type III Pterygium

Variables	Types of Pterygium (n=93) Mean ± SD			P<0.05*
	Type I (n=30) Type II (n=32) Type III (n=31)	Type II (n=32)	Type III (n=31)	
BCVA (logMAR)	0.02 ± 0.04	0.33 ± 0.20	0.58 ± 0.21	a: < 0.05 b: < 0.05 c: < 0.05
CSF (%)	0.33 ± 0.76	15.19 ± 9.35	37.87 ± 10.00	a: < 0.05 b: < 0.05 c: < 0.05
SimK (D)	1.30 ± 0.64	2.90 ± 1.57	7.97 ± 4.16	a: > 0.05 b: > 0.05 c: < 0.05

*ANOVA: One way analysis of variance

a: Pair of Type I and Type II
b: Pair of Type II and Type III
c: Pair of Type I and Type III

DISCUSSION

Previous studies stated that presence of pterygium could lead to the changes in the appearance of the corneal itself as well as can induce increment of corneal astigmatism (Coroneo et al., 1999), reduction in both contrast sensitivity function and visual acuity (Oh and Wee, 2010; Mohd Radzi et al., 2017). However, it is difficult to determine the actual impact of pterygium on the oculuvisual function as each pterygium is unique and different for each patient. Previous reports (Tan et al., 1997; Sandra et al., 2014) commented that pterygium recurrence could be related to the fleshiness appearance of the pterygium. The whitish fleshiness appearance of pterygium has been suggested as the active site of proliferation of fibroconnective pterygium tissue (Sandra et al., 2014; Mohd Radzi et al., 2017). An attempt was made recently (Mohd Radzi et al., 2019) to quantify the dry-weight of tissue known as Net Pterygium Tissue Mass (NPTM), to signify the actual pterygium tissue mass that present on the corneal surface. Thus, this study aimed to determine the impact of NPTM on changes in BCVA, CSF and SimK in primary pterygium patients.

BCVA is an important parameter as it represents the visual status of the eye. It is an established fact that pterygium affects visual acuity as it progresses (Maheshwari, 2007; Chui et al., 2011; Anguria et al., 2014, Mohd Radzi et al., 2017). And it is worth to note that as BCVA affected, CSF could also be affected as anterior corneal curvature changed due to corneal compression as pterygium progresses from lim-bus towards central cornea. Previous works (Oh and Wee, 2010; Sandra et al., 2014; Mohd Radzi et al., 2017) had reported that changes in CSF is important factor as in some pterygium, BCVA not significantly affected, while CSF effect was more prominent. This could be due to types of pterygium which could be atrophic or intermediate, in which less whitish appearance presence which in return does not fully covered the visual axis. Another reason for this is the thickness of pterygium (Mohd Radzi et al., 2018) which also contribute this notion. A thicker pterygium tissue could further signify active proliferative disorders in which could lead to higher grade of pterygium such as type III ptergyium. Sandra et al., (2014) had commented that type I could be less affected in both BCVA and CSF compared to type II, and recent study (Hilmi et al., 2018; Norazmar et al., 2019) showed clear demarcation effect between type I and III, which suggest fleshy pterygium could induce more effect on both BCVA and CSF. This current study findings also in agreement with both studies (Sandra et al., 2014; Norazmar et al., 2019).

With regards to changes in SimK, it needs to be emphasised that pterygium morphology can varies from a pterygium to another. A patient might come with smaller pterygium size, in which should not significantly affect vision. However, clinical evidence (Hilmi et al., 2018) showed that it does not follow specific rules such as a larger size, would likely to have worse BCVA and CSF, or vice versa. Thus, fleshiness appearance is an important criteria as it could signify higher percentage of NTPM. Previous studies (Maheshwari, 2007; Mohd Radzi et al., 2017) has reported that corneal compression occur due to indentation of corneal curvature. Although it was not stated reason of this, it can be postulated that pterygium tissue could be the possible reason as pterygium tissue is an active proliferative tissue (Hilmi et al., 2019; Norazmar et al., 2019; Hilmi et al., 2019; Hilmi et al., 2019). In fact, there are several studies (Azemin et al., 2014; Che Azemin et al., 2014; Che Azemin et al., 2015; Che Azemin et al., 2016) that commented on the angiogenesis factor of pterygium in which reflects the presence of fibrovascular components of pterygium which in line with classification of pterygium itself.

This present study results revealed that there are significant correlation and relationship between the NPTM (dryweight) on BCVA, CSF and SimK ($p<0.05$). Changes in oculovisual function (BCVA and CSF) have been described previously based on the size, area, length and redness of pterygium tissue. (Maheswari, 2007; Popat et al., 2014; Shelke et al., 2014). To the best of our knowledge, no study has been done on evaluating NPTM (dryweight) with regard to changes in BCVA, CSF and SimK based on pterygium types. This present study would like to highlight that types of pterygium is an important factor that needs to be evaluated in determining the cause of changes in BCVA, CSF and SimK.

CONCLUSION

Types of pterygium is an important characteristic that need to be evaluated in order to have better understanding on how does pterygium affects oculovisual functions.

ACKNOWLEDGEMENT

This study was funded by International Islamic University Malaysia (IIUM) under Research Initiative Grant Scheme (RIGS16-129-0293).

REFERENCES

Chui, J., Coroneo, M.T., Tat, L.T., Crouch, R., Wakefield, D., DiGirolamo, N. (2011) Ophthalmic terygium: A stem cell disorder with premalignant features, Am J Pathology, Vol. 178, No.2, pp. 817 – 827.

Liu, L., Wu, J., Geng, J., Yuan, Z., Huang, D. (2013) Geographical prevalence and risk factors for pterygium: a systematic review and meta-analysis, BMJ Open, Vol. 3: :e003787. doi:10.1136/bmjopen-2013-003787

Anguria, P., Kitinya, J., Ntuli, S., Carmichael, T. (2014) The role of heredity in pterygium development, Int J Ophthalmol, Vol. 7, No. 3, pp. 563 – 573.

Hilmi, M.R., Khairidzan, M.K., Ithnin, M.H., Azami, M.H. (2019). Comparison Between Tear Ferning Pattern, NIKBUT, TFBUT and Schirmer I Test in Normal and Primary Pterygium Eyes, La Clinica Terapeuti-ca, in press

Coroneo, M.T., DiGirolamo, N & Wakefield, D. (1999). The Pathogenesis of Pterygia. Vol. 10. pp. 282-288.

Tan, D.T., Chee, S.P., Dear, K.B., Lim, A.S. (1997) Effect of pterygium morphology on pterygium recurrence in a controlled trial comparing conjunctival autografting with bare sclera excision, Arch Ophthalmol, Vol. 115, pp. 1235 – 1240.

Maheshwari S. (2007) Pterygium-induced corneal refractive changes. Indian. J. Ophthalmol, Vol. 55(5), pp. 383 - 386.

Popat, K.B., Sheth, H.K., Vyas, V.J., Rangoonwala, M.M., Sheth, R.K., Shah, J.C. (2014). A Study on Changes In Keratometry Readings and Astigmatism Induced by Pterygium Before and After Pterygium Excision Surgery. J. Res. Med. Dent. Sci, Vol. 2(3), pp. 37 - 42.

Shelke, E., Kawalkar, U., Wankar, R., Nandedkar, V., Khaire, B., Gosavi, V. (2014). Effect of Pterygium Excision on Pterygium Induced Astigmatism and Visual Acuity. Int. J. Adv. Health Sci, Vol. 8(8), pp. 1 - 3.

George D, Mallery M. SPSS for Windows Step by Step, A Simple Guide and References, Boston: Pearson, 2010, pp. 95 - 105.

Chandrakumar, M., Colpa, L., Reginald, Y.A., Goltz, H.C., Wong, A.M.F. (2013). Measuring Contrast Sensitivity Using The M&S Smart System II Versus The Pelli-Robson Chart. Ophthalmology, Vol. 10. pp. 2160- 2161.

Oh, J.Y., Wee, W.R. (2010) The effect of pterygium surgery on contrast sensitivity and corneal topographic changes. Clin. Ophthalmol, Vol. 26(4), pp. 315 – 319.

Hilmi, M.R., Khairidzan, M.K., Zulfaezal, M.Z.C., Ithnin, M.H., Mustafa, M.M.S.M., Yusof@Alias, F., Ahmad, N. (2018) Corneal Curvature Measurements Utilizing a New Swept-source Optical Coherence Tomography Tomey OA-2000® and Comparison With IOL Master® 500 in Pterygium Patients. Sains Medika, Vol. 9(1):doi:http://dx.doi.org/10.26532/sainsmed.v9i1.2918

Hilmi, M.R., Khairidzan, M.K., Azemin, M.Z.C., Azami, M.H., Ariffin, A.E. (2018) Measurement of Contrast Sensitivity Using the M&S Smart System II Compared with the Standard Pelli–Robson Chart in Patients with Primary Pterygium. Makara. J. Health. Res, Vol. 22(3), pp. 167 - 171.

Mohd Radzi, H., Mohd Zulfaezal, C.A., Khairidzan, M.K., Mohd Izzuddin, M.T., Norfazrina, A.G., Tengku Mohd, T.S. (2017) Prediction of changes in visual acuity and contrast sensitivity function by tissue redness after pterygium surgery. Curr Eye Res, Vol. 42, pp. 852 – 856.

Sandra, S., Zeljka, J., Zeljka, V., Kristian, S., Ivana, A. (2014). The influence of pterygium morphology on fibrin glue conjunctival autografting pterygium surgery, Int Ophthalmol, Vol. 34, No. 1, pp. 75 – 79.

Hilmi, M.R., Khairidzan, M.K., Azemin, M.Z.C., Azami, M.H., Ariffin, A.E. (2018). Utilization of anterior segment optical coherence tomography enhanced high resolution corneal in measuring pterygium thickness. Sains Medika, Vol. 9(2): Doi: 10.26532/sainsmed.v9i2.2982

Hilmi, M.R., Maruziki, N.N., Khairidzan, M.K., Azemin, M.Z.C., Norazmar, N.A., Nasir, M.S., Musa, N.H. (2019) Topographic Changes As Predictor For Determining Anterior Corneal Curvature Stabilization Point Subsequent To Pterygium Excision Using Controlled Partial Avulsion Fibrin Glue Technique. International Journal Of Allied Health Sciences, Vol. 3(2), pp. 734 - 740.

Norazmar, N.A., Hilmi, M.R., Khairidzan, M.K., Azemin, M.Z.C., Maruziki, N.N., Musa, N.H., Nasir, M.S. (2019) Variation In Oculovisual Function Between Unilateral Primary Pterygium And Normal Adults Utilizing Computerized M&S Smart System Ii, International Journal Of Allied Health Sciences, Vol. 3(2), pp. 643 - 648.

Hilmi, M.R., Musa, N.H., Khairidzan, M.K., Azemin, M.Z.C., Maruziki, N.N., Norazmar, N.A., Nasir, M.S. (2019) Changes In Apical Corneal Curvature In Unilateral Primary Pterygium And Normal Adults Using Simulated-K And Corneal Irregularity Measurement, International Journal Of Allied Health Sciences, Vol. 3(2), pp. 588 - 594.

Hilmi, M.R., Nasir, M.S., Khairidzan, M.K., Azemin, M.Z.C., Maruziki, N.N., Norazmar, N.A., Musa, N.H. (2019) Topographic Changes on Anterior Corneal Curvature Between Unilateral Primary Pterygium and Normal Adults Utilizing Shape Factor and Mean Toric Keratometry Corneal Indices, International Journal Of Allied Health Sciences, In press

Che Azemin, M.Z., Mohd Tamrin, M.I., Hilmi, M.R., Mohd Kamal, K. (2016) Inter-grader reliability of a supervised pterygium redness grading system. Adv. Sci. Lett, Vol. 22(10), pp. 2885 - 2888.

Azemin, M.Z.C., Hilmi, M.R., Kamal, M.K. (2014) Supervised pterygium fibrovascular redness grading using generalized regression neural network. In Fujita H (Ed). New Trends in Software Methodologies, Tools and Techniques. Amsterdam: IOS Press, pp. 650–656.

Che Azemin, M.Z., Hilmi, M.R., Mohd Tamrin, M.I., Mohd Kamal, K. (2014) Fibrovascular redness grading using Gaussian process regression with radial basis function kernel. In Biomedical Engineering and Sciences (IECBES), 2014 IEEE Conference on 2014 Dec 8, pp. 113 - 116.

Che Azemin, M.Z., Mohd Tamrin, M.I., Hilmi, M.R., Mohd Kamal, K. (2015) GLCM texture analysis on different color space for pterygium grading. ARPN. J. Eng. Appl. Sci, Vol. 10, pp. 6410 – 6413.

Hilmi, M.R., Khairidzan, M.K., Azemin, M.Z.C., Azami, M.H., Ariffin, A.E. (2019). Corneo-pterygium Total Area Measurements Utilizing Image Analysis Method, J Optom, in press

Hilmi, M.R., Khairidzan, M.K., Azemin, M.Z.C., Ariffin, A.E. (2019). Measurement of Pterygium Tissue Dry Weight Using Two Different Tissue Preparation Techniques in Freeze-Dry Method, Sains Medika, in press

Hilmi, M.R., Khairidzan, M.K., Azemin, M.Z.C., Ithnin, M.H. (2019). Tear Film and Lid Margin Changes in Patients with Different Types of Primary Pterygium, Sains Medika, in press