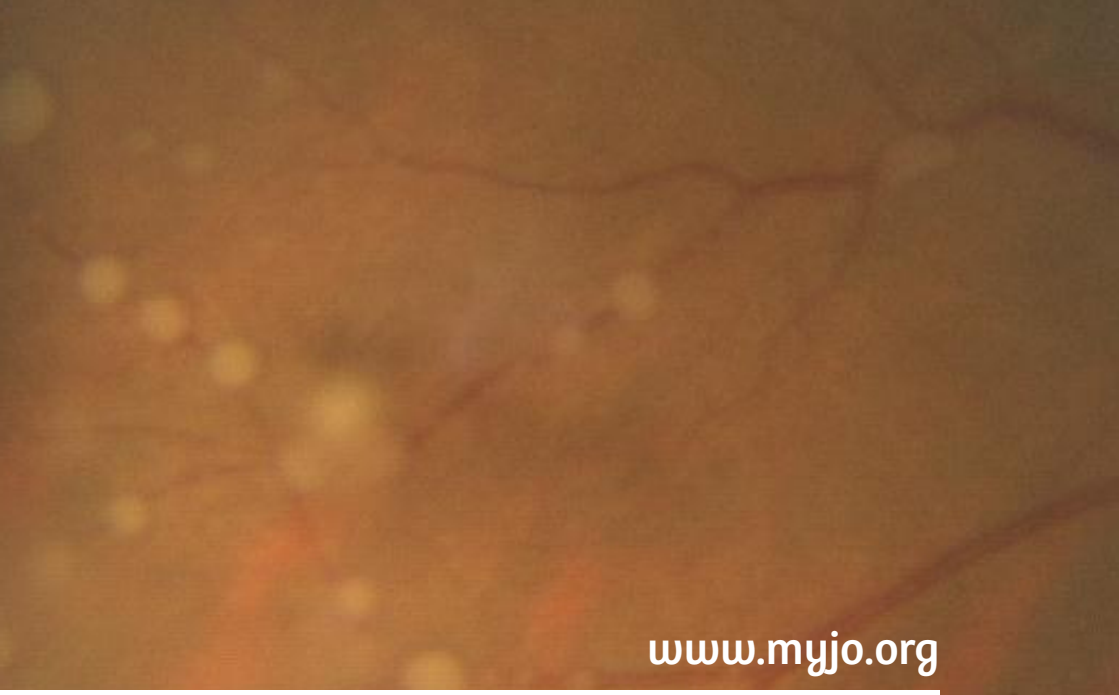

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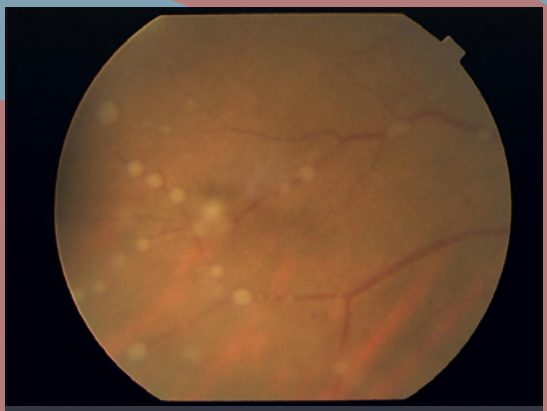

ABOUT THE COVER IMAGE
String of Pearls, by Dr. Norshamsiah Md Din, ophthalmologist from Universiti Kebangsaan Malaysia Medical Center.

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Editorial

Vitrectomy for advanced proliferative diabetic retinopathy: 30 years on

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The scourge of diabetes mellitus continues to ravage the world. South East Asia ranks second among seven geographical regions in absolute numbers of patients with diabetes.[1] In Malaysia, the prevalence of type 2 diabetes mellitus (T2DM) has risen progressively from 11.6% in 2006, to 15.2% in 2011,[2] and 17.5% in 2015.[3] Globally, diabetic retinopathy continues to be among the top five causes of moderate to severe visual impairment.[4] It is among the top three in Malaysia.[5] Globally, about a quarter of T2DM suffers from diabetic retinopathy.[6] Among diabetic patients registered in the Diabetic Eye Registry of Malaysia in 2007, 36% suffers from diabetic retinopathy, 15% from sight-threatening retinopathy, and 7% from proliferative diabetic retinopathy (PDR).[7]

The Diabetic Retinopathy Vitrectomy Study (DRVS) was the first landmark study comparing vitrectomy *vs* observation among patients with advanced PDR. Published in 1985, DRVS Report 2 found no difference in outcome between early vitrectomy *vs* deferring for a year for vitreous haemorrhage secondary to PDR of T2DM with baseline vision of 5/200 or worse.[8] Early vitrectomy was advantageous for PDR patients with useful vision but mainly those with extensive neovascularization.[9] In fact, 20% in both arms of the study had lost light perception by 2 years.

Over the last three decades, significant advancements have contributed to better outcomes for patients with PDR: better laser photocoagulators, anti-vascular endothelial growth factors (anti-VEGF), and better vitrectomy instrumentation.[10] Used in combination, vitrectomy surgeons have achieved progressively better outcomes for advanced PDR patients,[11] with anatomic success rates improving from 66–88% (prior to 1990) to 83.0–92.6% (after 2000) and less than 25% of patients suffering vision loss.[2]

Surgical approaches to diabetic tractional retinal detachment (DM-TRD) have advanced over the years from membrane peeling and segmentation, to delamination (with either en bloc dissection[13] or bimanual technique[14]), and the shaving technique.[15] For a young vitrectomy surgeon just starting out, these techniques may

seem confusing — which should I learn and which shall I use? As DM-TRD comes in various configurations, these techniques are best understood as different tools in the surgeon's toolbox. In the following paragraphs, I will summarise them and propose a unified approach based on the pathogenesis of DM-TRD.

The vasoproliferative action of VEGF causes new endothelial buds to sprout from existing vessels, crossing the internal limiting membrane to adhere to the posterior hyaloid, forming vascular pegs and holding the posterior hyaloid down onto the retinal surface. These vascular pegs are concentrated along the larger retinal vessels, especially the vascular arcades and first two orders of retinal vessels radiating from the optic disc and the arcades. As the posterior hyaloid separates, these vascular pegs prevent posterior vitreous detachment (PVD) from occurring normally. Forces of partial PVD act on these vascular pegs, causing them to bleed. As a result, scar tissue bridges these pegs to form tractional membranes. Tractional membranes along the vascular arcades give rise to the typical wolf-jaw configuration. The tractional membranes and posterior hyaloid that span across the superior and inferior arcades form the table-top traction. Tractional membranes running along the radial vessels form radial tractional membranes. As the radial vessels taper towards the retinal periphery, the vascular pegs become tinier and weaker in the periphery, allowing more hyaloid separation to occur beyond the retinal mid-periphery. Posterior hyaloid traction bridging the wolf-jaw traction and the vitreous base form anteroposterior (AP) traction.[16]

Hence, a unified concept of vitrectomy for diabetic TRD is to remove the anchoring forces of the vascular pegs, thereby allowing complete PVD to take place from the posterior pole to the periphery, using whatever techniques available at the surgeon's disposal.[17]

However, when confronted with a myriad of different DM-TRD configurations, the young vitrectomy surgeon often asks: where do I start? Between the temporal termination of the superior and inferior vascular arcades, the surgeon can usually find a surgical plane between the diabetic tractional membrane and the retina, other than cases of table-top TRD (Fig. 1a). This is due to the lack of larger retinal blood vessels at the temporal macular edge and macula, hence the paucity of vascular pegs. Through the temporal entry point, one can remove the posterior hyaloid over the macula with ease. Next, the surgeon could work along the vascular arcades (Fig. 1b). If the pegs are far apart, *segmentation* is quick and effective. If the pegs are close together, the surgeon can employ *delamination* techniques. With the *en bloc* method, the AP traction is left untouched, using it as the "third hand", while with the *bimanual* method, the membrane is lifted with a pair of forceps in one hand, cutting the pegs with scissors with the other, aided by chandelier lighting.[18]

The *shaving* technique is particularly useful for broad sheets of membrane with multiple, tightly spaced vascular pegs where the delamination technique would be very time consuming. The shaving technique is made possible by small gauge vitrectors (25-G or 27-G) where the ports are located very close to the tip.[11]

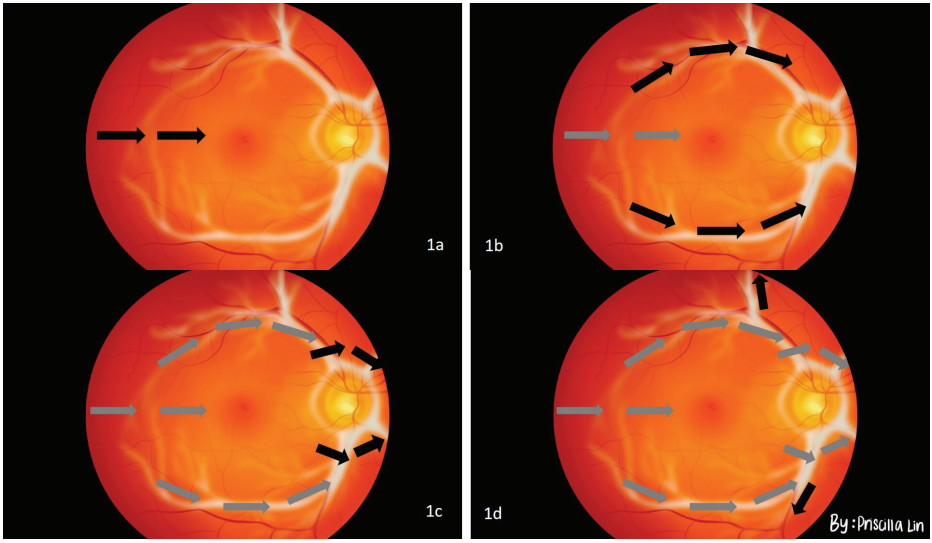

Fig. 1. Sequential surgical approach for diabetic tractional membranes: (*a*) temporal macula entry point; (*b*) dissection along the superior and inferior arcades; (*c*) dissection around the optic nerve head; and (*d*) dissection along the radial traction bands.

In addition, the smaller port opening offers better flow control (port-based flow limitation). Combined with high-speed cutting,[19] the surgeon can exercise flow control with exquisite accuracy using the full stroke length of the pedal. On the other hand, it is advisable to skirt around the optic nerve head, as the membranes there tend to bleed profusely (Fig. 1c).

Once the posterior hyaloid is mobilised around the vascular arcade, dissection takes place along the radial traction band (Fig. 1d). Once released, the posterior hyaloid is engaged using the vitreous cutter, extending the PVD centripetally. In the mid-periphery, the vascular pegs are often sparse and weak. This is where membrane peeling is most useful.

When TRD is combined with rhegmatogenous retinal detachment and/or proliferative vitreoretinopathy, meticulous peripheral vitreous shaving with indentation is necessary. In these cases, 23-G cutters may provide better counterforce for indentation.

Preoperative anti-VEGF injection is one of the most important innovations for diabetic vitrectomy. It has been shown to reduce intraoperative haemorrhage, iatrogenic breaks,[20] post-vitrectomy haemorrhage,[21] and operation time.[22] Although anti-VEGF injection is known to worsen TRD, it is uncommon. Occurring in approximately 5% of cases,[23] and not higher than controls, it should not deter the use of anti-VEGF injections preoperatively.[24]

In this issue of Malaysian Journal of Ophthalmology, Dr. Mushawiahti Mustapha

showed that excellent surgical results can be achieved using small-gauge vitrectomy, modern viewing and lighting systems, and preoperative intravitreal bevacizumab injections.[25] In this retrospective case series, more than 96% of cases with diabetic TRD achieved anatomical success, and 85% achieved visual stabilization or improvement at 1 year. These excellent surgical results would serve to encourage early presentation and early referral for surgical intervention.[26]

Just as surgical outcomes are improving, intravitreal pharmacotherapy is also conquering new grounds for PDR management.[27] Intravitreal anti-VEGF therapy for PDR, including those with vitreous haemorrhage[28] and TRD not involving the macula, can achieve surprisingly good results. In a short randomized controlled trial, three consecutive monthly doses of ranibizumab injections reduced the 4-month cumulative vitrectomy rate from 17% to 12%.[29] Persistence in delivering anti-VEGF therapy and judicious use of panretinal photocoagulation can help some patients achieve long-term stability of the retinopathy without surgery.[30] For the vitrectomy surgeon, this poses another dilemma: in cases of vitreous haemorrhage and DM-TRD without obvious macular involvement, should we offer early surgical intervention or intravitreal anti-VEGF therapy?[31]

Thirty years on, it is perhaps time for another major diabetic retinopathy vitrectomy study. We eagerly await the results of DRCR.net Protocol AB.[32]

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In memoriam

Dato' Dr. Ahmad bin Mt Saad (1960–2020)

A mild mannered, skilful glaucoma surgeon, and passionate ophthalmologist

Dato' Dr. Ahmad Mt Saat in 2019.

Dato' Dr. Ahmad bin Mt Saad left us on 3 July 2020, just 2 months before his retirement. Born on September 9, 1960 in Kubang Pasu, Kedah, Malaysia, he received his early education in his beloved state of Kedah. He left Kedah to pursue his medical degree in Universiti Kebangsaan Malaysia (UKM) in 1980, graduating from medical school in 1985. He found his true passion in ophthalmology and pursued his postgraduate training at UKM. He was conferred a Master of Surgery (Ophthalmology) degree in 1994.

He was one of the pioneering glaucoma specialists in Malaysia, having completed his fellowship training in glaucoma at Queen's Medical Centre, University of Nottingham, United Kingdom in 2001. A passionate and skilful glaucoma surgeon, he served as an active member of the Malaysian Society of Ophthalmology and an academician in the College of Ophthalmologists, Malaysia.

He was a thinker and always tried his best to achieve better surgical outcomes. Working alongside him for 12 years in the operation theatre, I saw the evolution of his glaucoma filtering surgery and I would say the current method carries the longest and highest success rate compared to the previous method he had endeavoured. He had good hands coupled with amazing surgical skills. Two pearls of knowledge stand out from my work experience with him: "Complications do occur; the most important thing is how you manage the complication" and "trabeculectomy is the best method for controlling intraocular pressure, provided you do it well."

Dr. Farrah Jaafar
Glaucoma consultant, Hospital Sultanah Bahiyah

He was also a great teacher who trained many of us in Malaysia directly or indirectly. He was appointed as Head of Glaucoma Service, Ministry of Health in 2002. He not only helped develop the glaucoma training module that trained many glaucoma specialists for Malaysia, but was also active as a mentor and examiner for post-graduate ophthalmology training in Malaysia.

He had strong basic science knowledge not only in ophthalmology but also in physics. A knowledgeable person who remained humble and never stopped giving.

Dr. Juanarita Jaafar
Ophthalmologist, Hospital Sultanah Bahiyah

With his gentle, mild mannered, and soft-spoken demeanour, he taught us one does not need to be loud to be heard. He was well liked by his patients with his smiling face and understanding gestures. His main treatment approach was always customized and individualised to their needs; their quality of life was always his highest priority. They shall miss him greatly.

Dato' Dr Ahmad Mt Saad was a dedicated ophthalmologist, devoted husband and father. He was a close friend to many and well loved by people who knew him. He

enjoyed travelling and photography. He was a spiritual man and contributed significantly to the *ummah*.

Dr. Jelinar Mohamed Noor
Senior glaucoma consultant, Hospital Kuala Lumpur

Gone too soon, my dear friend. We were friends for years in every stage of life. You were loved by many, too many. To the many lives you touched, family, friends, colleagues, and everyone in all walks of life, a void will remain forever. Your smiles and your laughter will too be missed. But your life was complete and you were ready to meet your Maker.

Professor Dr. Ropilah Abdul Rahman
Professor in Ophthalmology, Universiti Islam Antarabangsa Sultan Abdul Halim Mu'adzam Shah, Kedah

Hospital Sultanah Bahiyah, Malaysia was his second home. He spent more than 25 years developing and progressing with this hospital in his hometown. He was laid to rest between the hospital and his beautiful home, just beside the mosque he helped build. He left behind his beloved wife Dato' Dr. Siti Sabzah Mohd Hashim, a senior consultant in otorhinolaryngology, four children, and two grandchildren. His eldest is now pursuing postgraduate training as a haematologist and transfusion specialist.

The Malaysian ophthalmology fraternity lost a great ophthalmologist. May your soul rest in peace, Dato' Dr. Ahmad. May Allah grant you Jannah.

With Dr. Stephen Vernon.

With his family.

His conferment as academician in the College of Ophthalmologists, 2018.

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Original article

Small-gauge vitrectomy for advanced diabetic eye disease: outcomes and predictive factors for poor postoperative vision

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Abstract

Objective: To evaluate the anatomical and visual outcomes of small-gauge vitrectomy in patients with advance diabetic eye diseases (ADED) and the predictive factors for poor visual outcome.
Materials and methods: A retrospective study was conducted from 2009 to 2014. Data at baseline, 6 months, and 12 months post-surgery were collected along with baseline demographic data, indications of surgery, systemic associations, visual and anatomical outcome, and postoperative complications. Poor visual outcome was defined as visual acuity worse than 6/36.
Results: A total of 158 eyes from 133 patients were recruited. Mean age was 54.01 ± 11.57 years and mean follow-up was 9.9 ± 3.7 months. Indications for vitrectomy were vitreous haemorrhage (VH, 77 eyes [48.7%]), tractional retinal detachment (TRD) with macular involvement (75 eyes [47.5%]), and other causes in 6 eyes (3.8%). There was visual improvement in 59.3% of patients, 23.6% worsened, and 17.1% stabilized at 12 months post-surgery. Patients with VH (75.4%) showed significant

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improvement compared to patients with TRD (48.3%). Successful anatomical outcomes were achieved in VH (98.2%) and TRD (96.7%). However, patients with TRD were found to have a 2.4-fold higher risk of having poor visual outcomes.
Conclusion: Small-gauge vitrectomy for ADED resulted in excellent visual and anatomical outcomes. Eyes with TRD were at a higher risk of developing poor visual outcomes.

Keywords: diabetes mellitus, diabetic retinopathy, tractional retinal detachment, vitrectomy, vitreous haemorrhage

Vitrektomi gauge kecil untuk penyakit mata diabetes terminal: hasil kajian dan faktor ramalan penentu bagi ketajaman penglihatan yang teruk pasca pembedahan

Abstrak

Objektif: Untuk menilai hasil pelekatan retina secara anatomi dan fungsi penglihatan selepas prosedur vitrektomi gauge kecil pada pengidap penyakit mata diabetes terminal (ADED) dan faktor ramalan penentu untuk hasil ketajaman penglihatan yang teruk.
Bahan dan kaedah: Ini adalah kajian retrospektif dari 2009 hingga 2014. Data pada peringkat garis awal, 6 dan 12 bulan selepas prosedur telah dikumpulkan. Ini termasuk data demografi peringkat garis awal, indikasi untuk menjalankan prosedur, penyakit sistemik, ketajaman penglihatan dan pelekatan retina secara anatomi, serta komplikasi pasca prosedur. Ketajaman penglihatan yang buruk ditakrifkan sebagai lebih buruk daripada 6/36.
Hasil: Sebanyak 158 mata dari 133 pesakit telah terlibat dalam kajian ini. Umur min adalah 54.01 ± 11.57 tahun dan purata masa rawatan adalah selama 9.9 ± 3.7 bulan. Indikasi untuk prosedur vitrektomi adalah pendarahan vitreous (VH, 77 mata [48.7%]), pelekangan retina secara traksi (TRD) dengan penglibatan makula (75 mata [47.5%]), dan penyebab lain pada 6 mata (3.8%). Terdapat peningkatan ketajaman penglihatan pada 59.3% pesakit, 23.6% menjadi bertambah buruk, dan 17.1% stabil pada 12 bulan selepas pembedahan. Pesakit dengan VH (75.4%) menunjukkan peningkatan penglihtan yang ketara berbanding dengan pesakit dengan TRD (48.3%). Hasil kejayaan pelekatan retina secara anatomi dicapai dalam pesakit mengalami VH (98.2%) dan TRD (96.7%). Walau bagaimanapun, pesakit dengan TRD didapati mempunyai risiko 2.4 kali lebih tinggi untuk mempunyai

hasil ketajaman penglihatan yang teruk.
Kesimpulan: Vitrektomi gauge kecil untuk ADED menghasilkan ketajaman penglihatan visual dan kelekatan retina secara anatomi yang sangat baik. Mata dengan TRD mempunyai risiko yang lebih tinggi untuk melarat dan menghasilkan ketajaman penglihatan yang teruk.

Kata kunci: diabetes mellitus, pendarahan vitreous, retinopati diabetes, vitrektomi

Introduction

Diabetic retinopathy (DR) is a chronic, sight-threatening disease of the retinal microvasculature associated with prolonged uncontrolled hyperglycaemia. Prognosis of surgical treatment such as vitrectomy with or without intraocular anti-vascular endothelial growth factor (anti-VEGF) depends mostly on the duration of the disease and structures involved. Overall visual and anatomical outcomes in cases of diabetic vitrectomy have remained fairly stable despite technological advances in surgical instrumentation.[1]

The 20-year-old Diabetic Retinopathy Vitrectomy Study is still the major reference for managing patients with advanced diabetic eye disease (ADED).[2] The indications for diabetic vitrectomy have not changed much since the era of 20-gauge (G) surgery. But the threshold of surgery has reduced with improvement in the safety profile of retinal surgery using small-gauge vitrectomy (23-G and 25-G). Reports on long-term outcomes were mainly from retrospective studies and the majority of these described the traditional sutured 20-G system.[2]

Predictive factors for visual outcome were previously reported to be related to the duration of diabetes, use of insulin, presence of ischaemic heart disease, delay in surgery, and failure to attend clinical appointments.[3] In this study, we aim to evaluate both anatomical and visual outcomes of sutureless small-gauge vitrectomy in ADED cases and the predictive factors for poor visual outcome post-vitrectomy.

Materials and methods

This was a retrospective study of small-gauge vitrectomy for ADED performed between 2009 to 2014 in Hospital Universiti Kebangsaan Malaysia, Kuala Lumpur. Patients' clinical data were obtained from the medical records. Patients' data remained anonymous and subjects were coded accordingly. Indications for vitrectomy were classified based on the predominant factor for poor vision, either non-resolving vitreous haemorrhage (VH) with or without tractional retinal detachment (TRD), TRD involving the macula, and others (epiretinal membrane, vitreomacular traction).

Data collected were as follows: baseline demographic data, visual and anatomical outcomes at 6 and 12 months, predictive factors for poor visual outcomes, and postoperative complications. Patients who defaulted follow-up before 6 months were excluded.

Poor visual outcome was defined as Snellen visual acuity of 6/36 or worse. It was further classified into worsening, better, or stable. Worsening of vision postoperatively was defined as a drop in vision of at least one line compared to the preoperative state. Stable vision was defined as no change in visual acuity, whereas improvement in vision was defined as at least one line of visual improvement on Snellen acuity chart. Anatomical success was defined as flat retina without any intraocular tamponade at the end of the study period. Preoperative and postoperative best-corrected Snellen vision was converted to logarithm (LogMAR) of the minimum angle of resolution units to facilitate statistical comparison. Comorbidities were defined as a history of treated relevant diseases like hypertension, diabetes, and hypercholesterolaemia.

The details of the patients were kept confidential. Statistical analysis was performed using SPSS for Windows, Version 21.0. Demographics were analysed with paired t-test when comparing pre- and postoperative outcomes. Chi-square was used to analyse categorical data. The predictive factors for poor visual outcome were determined using multiple linear regression analysis. *P*-values of < 0.05 were considered statistically significant.

Results

Demographic

There were 174 cases of small-gauge vitrectomy surgeries performed for diabetic-related complications from January 2009 to December 2014. Only 158 eyes (one eye per patient) were identified based on the inclusion criteria. One hundred thirty eyes completed a minimum follow-up of 6 months and 123 eyes completed

Table 1. Clinical profiles of patients

Clinical profile	***n* = 158**
Gender, *n* (%)	
Male	80 (50.6)
Female	78 (49.4)
Age (years), mean ± SD	54.01 ± 11.57

Clinical profile	***n* = 158**
Ethnicity, *n* (%)	
Malay	89 (56.3)
Chinese	50 (31.6)
Indian	16 (10.1)
Others	3 (1.9)
Distance to HUKM (km), mean ± SD	36.45 ± 65.57
20 km	106 (67.1)
> 20 km	52 (32.9)
Indication of vitrectomy, *n* (%)	
VH	77 (48.7)
TRD	75 (47.5)
Others	6 (3.8)
Ocular factors	
Duration of surgery (min), mean ± SD	126.37 ± 53.26
Duration of symptoms (months), mean ± SD	13.34 ± 12.85
Status of lens prior to surgery, *n* (%)	
Phakic	89 (56.3)
Aphakic	3 (1.9)
Pseudophakic	66 (41.8)
Preoperative visual acuity (LogMAR)	1.48 ± 0.642
Systemic factors	
Duration of DM (years), mean ± SD	13.96 ± 8.05
Complication of DM, *n* (%)	
Stroke	9 (5.7)
Ischaemic heart disease	26 (16.5)
Neuropathy	33 (20.9)
Nephropathy	73 (46.2)
Underlying systemic conditions, *n* (%)	
Hypertension	145 (91.8)
Dyslipidaemia	84 (53.2)

DM: diabetes mellitus; HUKM: Hospital Universiti Kebangsaan Malaysia; SD: standard deviation; TRD: tractional retinal detachment; VH: vitreous haemorrhage

12 months of follow-up. Indication of surgery and clinical profiles of the patients are shown in Table 1.

The mean age was 54.01 ± 11.57 years and slightly more than half of the patients were male, with a male-to-female ratio of 1.03:1. The indications for surgery were divided into non-resolving VH with or without TRD but without macular involvement (*n* = 77, 48.7%), TRD involving the macula (*n* = 75, 47.5%), and others, which include epiretinal membrane or vitreomacular traction (*n* = 6, 3.8%)

The mean duration of diabetes was 13.96 ± 8.05 years and duration of ocular symptoms was 13.34 ± 12.85 months. Slightly more than half the patients were Malay (56.3%), with Chinese and Indian ethnicities comprising the remaining ethnic distribution. Most patients lived within 20 km of the hospital (67.1%). Mean waiting time for surgery was 26.70 ± 47.94 days. Preoperatively, anti-vascular endothelial growth factor (anti-VEGF) was used in 98 patients: ranibizumab (Lucentis®; Novartis Pharma AG, Basel, Switzerland) was used in 92 eyes (62.0%), and bevacizumab (Avastin®; Novartis Pharma AG, Basel, Switzerland) in 6 eyes (6.1%).

The majority of patients had underlying hypertension (92%) and slightly more than half (53.2%) were also diagnosed to have hyperlipidaemia. Cerebrovascular accident was present in only 9 patients (5.7%), ischaemic heart disease in 16.5% of patients, 20.9% had neuropathy, and 46.2% had renal impairment based on the creatinine level. Only 69 patients (43.7%) complied with their systemic medications. Mean glycosylated haemoglobin (HbA1c) was 7.91%, indicating fair glycaemic control.

More than half cases were phakic (56.3%) prior to vitrectomy, 41.8% were pseudophakic, and the remaining were aphakic (1.9%). The majority of patients (76.6%) had visual acuity of 6/60 or worse prior to surgery. Based on the indications for surgery, the majority of patients with non-resolving VH (74%) had vision of counting fingers or worse. Slightly less than half (48%) of TRD patients had vision of counting fingers or worse.

Within the study period, 86% of patients underwent 23-G vitrectomy and the remaining 14% underwent the 25-G system. Mean duration of surgery was 126.37 ± 53.26 minutes. Almost half the cases (49%) did not receive any endotamponade at the end of the surgery, 24% had silicone oil, and 27% had gas endotamponade. The majority of surgeries (130 eyes, 82.3%) were performed under local anaesthesia and the remaining were done under general anaesthesia. Intraoperative bleeding was the commonest intraoperative complication (58 eyes, 36.7%) followed by iatrogenic break (44 eyes, 27.8%), and 1 eye (0.6%) had suprachoroidal haemorrhage. Forty-seven patients (29.7%) had reoperation for removal of silicon oil (29 eyes,18.4%), cataract surgery (16 eyes, 10.1%), VH and re-detachment (6 eyes, 3.8%) respectively, and other surgeries (3 eyes, 1.9%).

Visual changes

Generally, vision improved in three-quarters of eyes at 6 months postoperatively. Sub-analysis based on indications revealed that patients with VH tended to do slightly better than patients with TRD, with 79% of patients with VH attaining vision of 6/60 or better, whereas 70% of patients in the TRD group had no change in visual acuity. Looking at improved visual acuity level, 29% of patients treated for VH attained 6/12 or better compared to only 14.5% of the TRD patients at 6 months post-surgery. At 12 months the difference became more apparent, with 33% of patients with VH attaining 6/12 or better while only 8.3% of patients with TRD achieving the same result post-surgery.

Generally, surgery for diabetic-related complications benefited the majority of the patients included in our study. Postoperatively, vision improved in 59.4% of patients and was stable in 17%. Vision worsened in slightly less than a quarter of eyes (23.4%), with most patients losing only 1 or 2 lines of Snellen visual acuity.

Among eyes with VH, more than half the patients (68.3%) attained either better or stable vision 12 months post-surgery. Vision worsened for the remaining 31.7% of patients and only 3.4% of patients lost more than 4 lines of vision. In eyes with TRD, 84.9% had either improvement or stable vision at 12 months postoperatively and vision worsened in 14.1%, as shown in Figure 1. The patients who had worsening of vision lost a maximum of two lines.

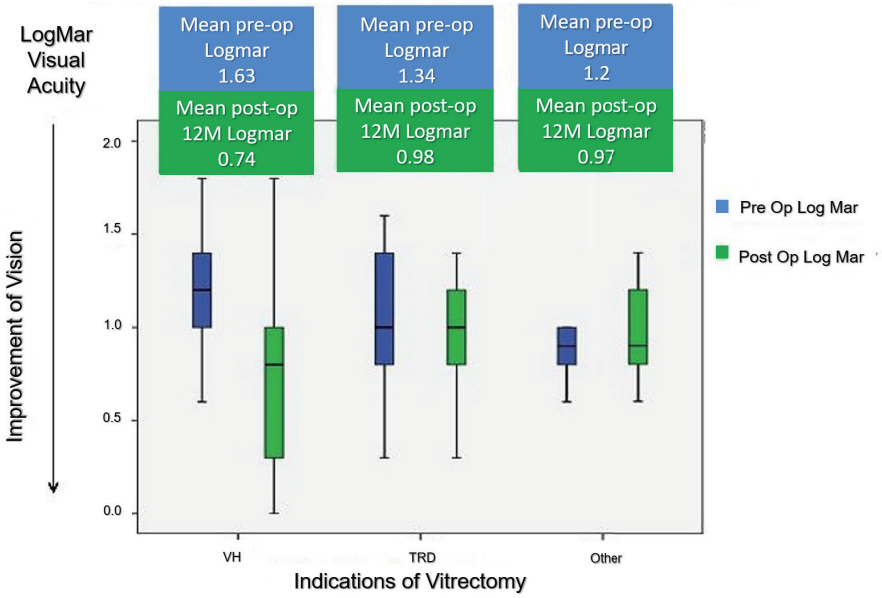

Fig. 1. Box plot describing visual acuity in LogMar before and after surgery for various surgical indications.

Table 2. Univariate analysis for poor visual outcome

Patient factors	Poor visual outcome		12 M
	Yes	No	*p*-value
Ocular factors			
Duration of symptoms (months)	11.57 ± 9.25	12.52 ± 12.51	0.478
Status of lens prior to surgery			
Phakic	44 (63.8)	25 (36.2)	0.550
Pseudophakic	35 (67.3)	17 (32.7)	
Aphakic	2 (100.0)	0 (0)	
Preoperative IOP (mmHg)	14.91 ± 4.04	15.31 ± 4.79	0.370
Preoperative visual acuity (LogMAR)	1.15 ± 0.32	1.03 ± 0.38	0.186
Systemic factors			
Duration of DM	13.96 ± 7.85	14.4 ± 9.43	0.060
Complications of DM			
Stroke	4 (57.1)	3 (42.9)	0.928
Ischaemic heart disease	11 (57.9)	8 (42.1)	0.426
Neuropathy	19 (73.0)	7 (27.0)	0.946
Nephropathy	37 (68.5)	17 (31.5)	0.581
Underlying systemic conditions			
Hypertension	70 (62.5)	42 (37.5)	0.030
Dyslipidaemia	42 (63.6)	24 (36.4)	0.540
Surgical factors			
Duration of surgery (mins)	127.39 ± 61.42	108.79 ± 32.87	< 0.001
Gauge			0.646
23-G	70 (66.7)	35 (33.3)	
25-G	11 (61.1)	7 (38.9)	
Heavy liquid	23 (82.1)	5 (17.9)	0.039
Silicone oil	28 (82.4)	6 (17.6)	0.017
Reoperation	36 (81.8)	8 (18.2)	0.005

DM: diabetes mellitus; IOP: intraocular pressure

Table 3. Multiple logistic analysis for prognostic factor for poor visual outcome at one year

Factors	Odds ratio (95% CI)	*P*-value
Heavy liquid	0.501 (0.161 to 1.559)	0.233
Silicone oil	0.924 (0.246 to 3.468)	0.906
TRD *vs* VH	2.421 (1.056 to 5.552)	0.037
Duration of surgery	0.993 (0.982 to 1.004)	0.185

TRD: tractional retinal detachment; VH: vitreous haemorrhage

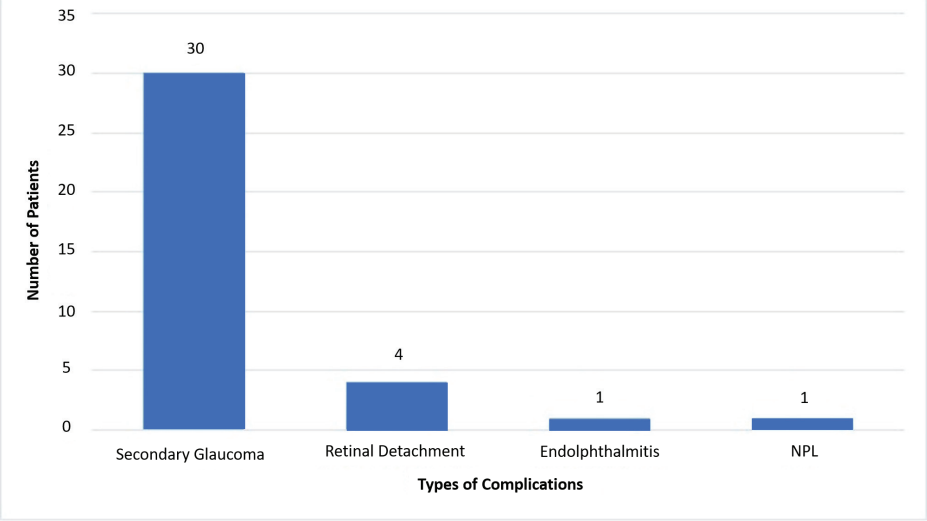

Fig. 2. Bar chart depicting the number of patients developing complications following small-gauge vitrectomy.

Predictive factors for poor vision

Using univariate analysis for poor visual outcomes, duration of surgery was one of the predictors for poor vision (Table 2). Other significant predictors for poor outcomes were the use of heavy liquid, silicone oil, and the need for repeated surgery. However, after multivariate analysis, the only significant factor for poor vision was indication of surgery (Table 3). Patients with TRD had an odds ratio of 2.4 (95% CI: 1.056 to 5.552) of having poor vision compared to patients with VH.

Long-term complications at 12 months postoperative included secondary glaucoma in 30 eyes (24.3%), retinal detachment in 4 eyes (0.03%), endophthalmitis in 1 eye, and neovascular glaucoma in 1 eye that was completely blind with no light perception (Fig. 2). More than 90% of eyes had flat retina at 12 months.

Discussion

Surgery outcomes in diabetic eyes are known to be unpredictable. Various factors contribute to anatomical and functional recovery.[1] Apart from predisposing ocular conditions, underlying medical problems are also pivotal for ocular adaptation and retinal recovery.[2]

The most common indications for surgery in diabetic eye diseases are non-resolving VH and TRD.[3,4] The benefits of vitrectomy in ADED have been described in previous studies mainly using the old cutter system.[5] Despite the significant benefits of surgery among these patients, considerable complications have also been reported.[6] Patient counselling with regards to surgical outcomes may range from saving the eyesight (either to improve or stabilize vision) to delaying blindness. Vitrectomy has helped to deregister 25% of blind patients.[3] Surgical outcomes between populations may also vary due to several factors; outcomes may not always be comparable, especially when patient demographics vary considerably.[1,7] Patients with primary indication of combined tractional and rhegmatogenous retinal detachment (TRD + RRD) appear to have the worse visual prognosis, whereas patients with VH appear to have the best visual prognosis.[8,9]

Most studies reported the visual outcome in a collective manner regardless of the indication of surgery for ADED. Traditionally, ADED studies tend to define a poor visual outcome as 6/60 or worse.[8,9] Considering the improvement in surgical instruments (smaller gauge system), we wished to analyse and report on better levels of visual outcome. Therefore, we defined poor vision as 6/36 or better for the purpose of our analysis.

Small-gauge vitrectomy has been reported to reduce surgical time, reduced patient discomfort, and result in more rapid visual recovery.[6] Evaluation of different sizes of the vitreous cutter in our study failed to exhibit significant association with poor vision or anatomical outcomes post-vitrectomy. A previous report compared the two sizes of small gauge cutter, which were also found to be insignificant.[6] Intraoperative difficulties remained one of the challenges among ADED cases. TRD obviously represents worse preoperative retinal condition, worse perfusion levels, and a more complex surgical scenario. Even then, more than half our patients had improvement of vision post-surgery. TRD patients appeared to have twice the risk for poor vision compared to those with non-resolving VH.

The intraoperative technique using the small-gauge system in ADED during the study period was still at the exploratory stage in our institution (transition from 20-G to small-gauge system). Scissors were still largely utilised during membrane dissection and delamination. Hence, surgical time in our study was more or less the same as those reported for the 20-G system.[2] Only later were "non-scissor" delamination and segmentation used more frequently, potentially reducing surgical time for such cases. The chandelier system, bimanual technique, and non-scissor membrane delamination and segmentation were among the latest surgical manoeuvres

popularised by the new system, which slowly gained popularity among retinal surgeons. The known challenges during surgery are thick adhered membrane with underlying retinal detachment, broad attachment of the membrane, thin atrophic retina in long-standing cases, and absence of posterior vitreous detachment (PVD). Yorston *et al.* described the majority of their patients (85%) not having complete PVD and 74% of them still having posterior hyaloid attachment involving the posterior pole and vascular arcades.[2] Unfortunately, due to the retrospective nature of our study, subjective description of intraoperative findings was considered to be highly inaccurate. Hence, we were not able to describe the detail of intraoperative findings in our series.

Using the old vitrectomy system, at least 27% of patients had posterior retinal break, whereas 17% reported to have entry site break.[10] An almost similar incidence was reported in our study (entry site break and posterior tear). We did not analyse in detail the location of tears due to the variability of documentation.

Associated medical conditions play a vital role in the general well-being of diabetic patients. We found that at least 20% of our patients had some form of neuropathy at the point of vitrectomy. Potential under-reporting among our patients was not surprising, as the question of neuropathy was only documented at the time of presentation and was not routinely asked on every visit. A prospective study by Yorston *et al.* in 2008 reported that at least one-third of their patients also had some form of neuropathy.[4] Interestingly, only half their patients were reported to have underlying hypertension, whereas most of our patients in the study (90%) had hypertension. Furthermore, more than half suffered from hyperlipidaemia and renal impairment. Concurrently, only half our patients admitted to compliance to systemic treatment.

Patients in our series did not show significant association between lens status or usage of antiglaucoma medications with poor visual outcome post-vitrectomy. We also did not find any significant relationship between the duration of diabetes and poor visual outcomes. Most of the patients in our series had other diabetic-related complications, such as diabetic nephropathy requiring haemodialysis and foot ulcer. However, none of the diabetic complications were found to be significantly related to the surgical outcome. There was also no significant association with the presence of hypertension, ischaemic heart disease, and dyslipidaemia. The findings were comparable to the study reported by Gupta *et al.*[3]

Endotamponade in vitrectomy is used to promote retinal reattachment.[11] In this study, although univariate analysis showed a significant association between the use of tamponade and visual outcome post-vitrectomy, multivariate analysis did not support the differences. Yorston *et al.* reported that in 174 vitrectomies, air was used in 7.5%, sulfur hexafluoride (SF6) in 24.1%, octafluoropropane (C3F8) in 10.3%, and silicone oil in 6.9%.[4] Our study found a tendency to use silicone oil more than gas. The possible reasons for the higher usage of silicone oil in our population is likely due to the more severe form of retinal changes or that surgery was performed in a precious eye requiring immediate visual recovery. It was not uncommon for

patients in our study to present late with involvement of the fellow eye.[12] Such cases require early visual rehabilitation.

The use of preoperative anti-VEGF also did not show significant relationship with poor vision after surgery in our patients. The majority of our patients had intravitreal anti-VEGF prior to the surgery. During the period of this study, more ranibizumab than bevacizumab was used in our centre. Before the availability of anti-VEGF, the incidence of recurrent VH post-vitrectomy could be as high as 80%.[14] Our rate of postoperative VH was only 10%. Not only the use of anti-VEGF, but also probably better surgical technique with the use of the small-gauge cutter may have improved the overall rate of postoperative bleeding.

Only one of our patients developed rubeosis iridis and, subsequently, neovascular glaucoma. Other studies have reported the incidence to be as high as 15%.[13] We believe this could be largely attributed to the use of anti-VEGF prior to surgery in our study. At the same time, the small-gauge system potentially causes less postoperative inflammation.[14]

Almost one-fifth of our vitrectomised eyes developed glaucoma at any point postoperatively for various reasons. The majority of cases were managed conservatively with antiglaucoma medications, while a very small percentage resulted in surgical intervention. Similarly, other studies have reported an average of 15–20% of patients developing glaucoma after uncomplicated vitrectomy,[15] and rates were higher in eyes that had undergone cataract extraction (15.0%) compared to phakic eyes (1.4%).[16]

The main limitation of this study is its retrospective design, which is susceptible to bias and relying largely on the accuracy of data entry in the case notes. Despite the limitation of retrospective design, our sample size was large enough to report the findings in our population to show non-inferiority of small-gauge vitrectomy compared to the traditional 20-G system in terms of success in surgical attachment. The demographic findings suggested that we are still dealing with severe forms of ADED (based on the acuity and the need to use silicone oil as endotamponade). The distinguishing features among our population are the higher prevalence of concurrent medical problems such as hypertension and hyperlipidaemia. Even then, the risk of poor visual outcome was not related to the underlying medical problem but rather to the severity of the ocular disease itself.

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Original article

Verification of 3D-printed universal smartphone retinal imaging adapter against conventional fundus camera imaging for diabetic retinopathy screening

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Abstract

Introduction: Screening for diabetic retinopathy (DR) is critical in preventing visual loss. However, current tools are expensive, bulky and sensitive, thus limiting screening coverage, especially in developing areas such as the interior of Borneo. Smartphone-assisted devices may provide an alternative and this study seeks to determine the level of agreement between a smartphone retinal imaging adapter (SRIA) against conventional ones.
Materials and methods: This was a cross-sectional study with Institutional Review Board approval from the Medical Ethics Board of University of Malaya Medical Centre. A total of 284 eyes from 142 patients included underwent retinal imaging using a conventional fundus camera and the SRIA. The images were graded according to Early Treatment of Diabetic Retinopathy Study (ETDRS) classification. Agreement between both modalities was calculated using Cohen's Kappa statistics.
Results: The Kappa agreement between SRIA and conventional fundus imaging in grading individual ETDRS stages stood at 0.648 ($p < 0.001$), achieving up to 0.752 ($p < 0.001$) when differentiating between no DR, non-proliferative DR, and proliferative DR.
Conclusion: DR grading SRIA and conventional fundus camera imaging were comparable. SRIA can be useful in eye screenings but still needs improvement.

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Keywords: diabetic retinopathy, fundus camera, smartphone retinal imaging

Pengesahan pengesanan retinopati diabetes menggunakan adaptor perakam imej retina 3D pada telefon pintar universal berbanding dengan pengimejan kamera fundus secara konvensional

Abstrak

Pendahuluan: Pemeriksaan retinopati diabetes (DR) sangat penting untuk mencegah kehilangan penglihatan dan kebutaan. Walau bagaimanapun, alat yang disedia ada sekarang adalah mahal, bersaiz besar dan sensitif, sehingga membatasi liputan penyaringan, terutama di kawasan yang sedang membangun, seperti pedalaman Borneo. Alat peranti yang dibantu telefon pintar mungkin memberikan alternative. Kajian ini bertujuan untuk menentukan tahap persetujuan imej antara adaptor perakam imej retina 3D pada telefon pintar universal (SRIA) berbanding pengimejan kamera fundus secara konvensional.
Bahan dan kaedah: Ini adalah kajian keratan rentas yang mendapat kelulusan panel kajian institusi dari panel etika perubatan Pusat Perubatan Universiti Malaya. Sebanyak 284 mata dari 142 pesakit diabetes telah menjalani pengimejan retina menggunakan kamera fundus konvensional dan SRIA. Imej telah dinilai mengikut klasifikasi Kajian Rawatan Awal Diabetik Retinopati (ETDRS). Persetujuan antara kedua-dua kaedah pengimejan dihitung menggunakan statistik Kappa Cohen.
Keputusan: Persetujuan Kappa dalam pengimejan retina menggunakan SRIA dan kamera fundus konvensional dalam menilai tahap ETDRS individu terlibat berada pada tahap 0.648 ($p < 0.001$), sehingga 0.752 ($p < 0.001$) bagi mengesan ketiadaan DR, DR tidak proliferatif, dan DR proliferatif.
Kesimpulan: Penggredan imej DR di antara kaedah SRIA dan kamera fundus konvensional adalah setanding. SRIA berpotensi sebagai peralatan bagi pengesanan penyakit mata tetapi masih perlu menjalani penambahbaikan lagi.

Kata kunci: kamera fundus, pengimejan retina telefon pintar, retinopati diabetes

Introduction

Screening and detection of diabetic retinopathy (DR) is a vital first step to enable early intervention and arrest progression of the blinding complication of diabetes mellitus. In many countries, screening of DR is performed using fundus photography by trained technicians, following which images are read by ophthalmologists who then plan subsequent actions. The gold standard initially employed was the 7-field Early Treatment of Diabetic Retinopathy (ETDRS) fundus photography; however, this was time-consuming, tedious and uncomfortable for many patients. Several studies compared the use of 1-field, 2-field and 3-field fundus photography against the 7-field ETDRS fundus photography.[1-9] As the methods with fewer photographs were found to be a good compromise with reasonable sensitivity and patient comfort, 2- or 3-field fundus photography are now commonly used for screening.[4,10] However, although quick and non-invasive, the equipment needed is still expensive, bulky, sensitive, and confined mainly to larger centres. As a result, there is still a barrier to recommended eye examinations where large numbers of diabetic patients default their follow-up appointments in view of geographical difficulty and cost of attending screening centres.

We believe there is a need for a device that is low cost, ultra-portable, and highly adaptable so that screening may be brought to the community. Several groups have introduced different designs of portable fundus cameras with considerable results; however, these devices are still relatively expensive and are largely fragile.[11,12] In the ubiquitous smartphone era, other groups have tested ways for easing the screening of DR using smartphones.[13,14] The use of smartphones and condensing lenses for fundus photography has been described by Haddock *et al.*,[14] Dyaberi *et al.*,[15] and Russo *et al.*[16] Rajalakshmi *et al.* applied their devices for DR screening and found favourable results.[17] However, their devices were still commercially produced and relatively costly. 3D-printed lens adapter designs have now been introduced,[13,18] and have the advantages of being relatively low cost and ultra-portable. In this study, we sought to validate one of these 3D-printed lens adapters as described by Hong *et al.*[19] for detecting and grading DR.

Materials and methods

This was an observational, cross-sectional study. It adhered to the Declaration of Helsinki and Good Clinical Practice guidelines. Institutional Review Board approval was obtained from the Medical Ethics Board of the University Malaya Medical Centre (UMMC). Informed consent was taken from each patient prior to being recruited into the study.

Male and female, type 1 and type 2 diabetes mellitus patients undergoing eye screening at the Ophthalmology clinic of the UMMC eye clinic were approached.

The inclusion criteria were: between 18 and 90 years old, any stage of diabetic retinopathy from no DR to proliferative diabetic retinopathy (PDR), and physically and cognitively fit to undergo both smartphone retinal imaging adapter (SRIA) and conventional fundus camera imaging. The exclusion criteria were: history of ocular morbidities (corneal disorders, macular disorders, glaucoma and intraocular inflammation), contraindication to mydriatic agents, poorly dilating pupils (less than 6 mm), and media opacities (corneal scars, dense cataracts, dense asteroid hyalosis, etc.) precluding fundus examination. All patients underwent a complete eye examination with slit-lamp biomicroscopy. This was followed by fundus photography using the SRIA which attached a 20 D objective lens to an iPhone 6 smartphone (with built-in 8-megapixel camera) and a conventional fundus camera (Topcon TRC-50DX - Type IA; Tokyo, Japan).

The SRIA was made using 3D-printed parts. The parts were made from acrylonitrile butadiene styrene of approximately three layers per mm and 1 mm minimum wall thickness. Nuts and bolts to hold the various pieces in place were sourced from a local hardware shop. Design specifications of the tool were selected from stereolithography files provided open source by Hong[18] and printing was done at a local 3D printing shop. The cost of producing the device depended on the weight (per gram) and type of material used. The approximate cost of 3D printing our SRIA was 25 USD. As for the optics, a 20 D condensing lens (Volk Optical Inc.; Mentor, Ohio, USA) was attached to the SRIA. The combined assembly was then attached to the iPhone 6 smartphone that had a built-in 8-megapixel iSight camera with 1.5 µ pixel size and continuous flash capacity. The device would utilise the flash of the smartphone for co-axial illumination of the retina. It had a 40° field of view and 33 mm working distance. The resolution of the image would depend on the make of the smartphone. The device was fitted onto the smartphone, as shown in Figure 1. The native camera application which has auto-focus and continuous illumination capabilities was utilised. The touch screen interface of the smartphone controlled all image-acquiring work.

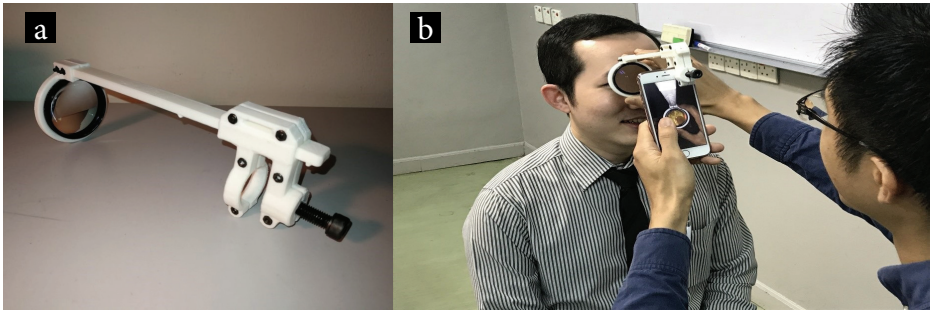

Fig. 1. (*a*) SRIA before attachment to mobile phone. (*b*) Using the SRIA for fundus photography.

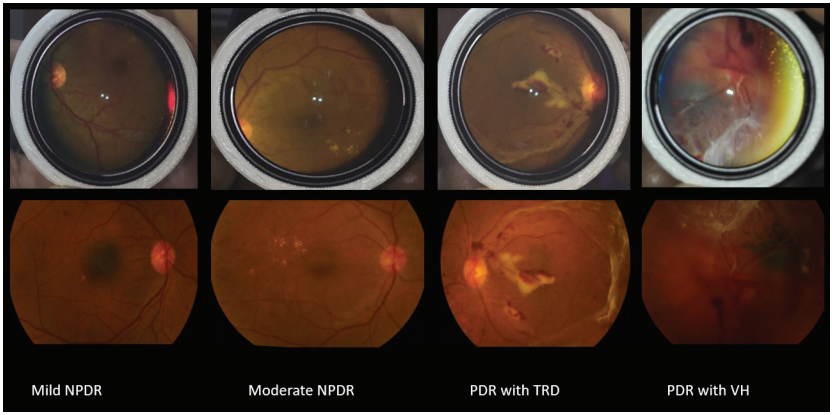

Fig. 2. Sample images from the SRIA (*top*) and corresponding images from the conventional fundus camera (*bottom*).

Subjects were seated comfortably to undergo both imaging modalities after their dilated slit-lamp examination. One researcher (YKG) conducted smartphone retinal imaging while trained technicians performed conventional fundus imaging. The average time taken for each patient was 10 minutes (5 minutes for SRIA and 5 minutes for conventional fundus imaging). Sample images from both imaging modalities are shown in Figure 2. Fundus images were recorded on the fundus camera and the iPhone 6. After the data (image) collection stage was complete, all images were downloaded into a common folder and randomized in their order. One grader (YKG) who was blinded to the patients' clinical details graded them according to the EDTRS classification.

Before the actual study, inter-operator reliability between two graders (an ophthalmology trainee (YKG) and a consultant ophthalmologist with more than five years of experience (AS) was analysed using Cohen's Kappa statistics to determine the reliability of a single grader in evaluating the images from both cameras in this study. There was a substantial amount of agreement shown in the results, with a Kappa value of 0.748 (95% CI: 0.606 to 0.877, $p < 0.001$) for DR and 0.960 (95% CI: 0.863 to 1.000, $p < 0.001$) for clinically significant macula oedema (CSME).

A sample size calculation was performed before the start of the study. In a test for agreement between the two modalities using the Kappa statistic, a sample size of 86 subjects would achieve 80.0% power to detect a true Kappa value of 0.60 in a test of H_0: Kappa = 0.78 *vs.* H_1: Kappa ≠ 0.78 when there are six categories with frequencies equal to 0.48, 0.25, 0.14,0.08, 0.04, and 0.01. This power calculation was based on a significance level of 0.05.

Statistical analysis was done using SPSS version 24.0. The verification of the SRIA using the Topcon conventional fundus camera as the standard was done applying Cohen's Kappa agreement statistics. Agreement was assessed for detecting DR as

well as differentiating and grading DR severity. The level of agreement was based on that suggested by Landis and Koch.[20] Sensitivity and specificity for the SRIA in detecting DR were also determined.

Results

A total of 284 eyes from 142 diabetic patients were enrolled into this study, which ran between June and December 2017. Three images were ungradable with the SRIA while six images were ungradable with the Topcon fundus camera because of cataracts and small pupils. The total percentage of non-proliferative diabetic retinopathy (NPDR) detected was 53.4% with the conventional fundus camera and 53.7% with the SRIA. Proliferative diabetic retinopathy (PDR) was detected in 57 cases (19.5%) with the conventional fundus camera and 51 cases (18.1%) with the SRIA. CSME was detected in 59 (20.8%) cases with the SRIA while 74 (26.1%) cases were detected using the conventional fundus camera. The agreement between the two cameras for CSME was 0.590 (95% CI: 0.470 to 0.701, $p < 0.001$).

Table 1 reveals the DR severity according to each grade of DR. Kappa agreement between the SRIA and Topcon conventional fundus camera in detecting individual DR stages was 0.648 (95% CI: 0.584 to 0.713, $p < 0.001$). Table 2 lists DR after clustering categories into no DR and mild NPDR, moderate and severe NPDR, and PDR. Kappa agreement between SRIA and Topcon conventional fundus camera after this clustering stood at 0.710 (95% CI: 0.634 to 0.776, $p < 0.001$). Table 3 categorises the severity into no DR, any NPDR, and PDR. The rate of agreement between the SRIA and Topcon conventional fundus camera for this clustering was 0.752 (95% CI: 0.654 to 0.834, $p < 0$ .001). In general, our data showed that agreement improved when there was less sub-classification of DR grades. Finally, Table 4 lists the sensitivity and specificity of the SRIA according to the same grades of DR as in Table 3.

Discussion

In this study, we compared the grading of DR between SRIA and conventional fundus camera images. We found a substantial agreement when DR was classified into the various ETDRS stages. The measure of agreement increased when DR grades were clustered into no DR and mild NPDR, moderate and severe NPDR, and PDR. The best agreement was obtained when differentiating between no DR, NPDR, and PDR.

In a study reported by Russo *et al.* using their D-eye device and comparing it with dilated slit lamp retinal examination, they showed a substantial agreement with a Kappa value of 0.78.[16] Another study by Rajalakshmi *et al.* showed a Kappa value of up to 0.90 for detecting any DR using their 'fundus on phone' camera and comparing it with mydriatic seven-field digital retinal colour photography.[17] Our

Table 1. Severity grading from SRIA and conventional fundus camera imaging for each grade of ETDRS retinopathy classification

		Conventional fundus camera						
	***n* (%)**	**No DR**	**Mild NPDR**	**Moderate NPDR**	**Severe NPDR**	**PDR**	**Ungradable**	**Total**
SRIA	**No DR**	*57* (85.1%)	*12* (20.3%)	*5* (5.9%)	*0* (0.0%)	*0* (0.0%)	*2* (33.3%)	*76* (26.8%)
	Mild NPDR	*8* (11.9%)	*31* (52.5%)	*13* (15.3%)	*0* (0.0%)	*0* (0.0%)	*1* (16.7%)	*53* (18.7%)
	Moderate NPDR	*1* (1.5%)	*15* (25.4%)	*64* (75.3%)	*2* (20%)	*3* (5.3%)	*1* (16.7%)	*86* (30.3%)
	Severe NPDR	*0* (0.0%)	*0* (0.0%)	*2* (2.4%)	*6* (60%)	*7* (12.3%)	*0* (0.0%)	*15* (5.3%)
	PDR	*0* (0.0%)	*1* (1.7%)	*1* (1.2%)	*2* (20%)	*47* (82.5%)	*0* (0.0%)	*51* (18.0%)
	Ungradable	*1* (1.5%)	*0* (0.0%)	*0* (0.0%)	*0* (0.0%)	*0* (0.0%)	*2* (33.3%)	*3* (1.1%)
	Total	*67* (100.0%)	*59* (100.0%)	*85* (100.0%)	*10* (100.0%)	*57* (100.0%)	*6* (100.0%)	*284* (100.0%)

DR: diabetic retinopathy; ETDRS: Early Treatment of Diabetic Retinopathy Study; NPDR: non-proliferative diabetic retinopathy; PDR: proliferative diabetic retinopathy; SRIA: smartphone retinal imaging adapter

Kappa agreement between the SRIA and Topcon conventional fundus camera for each DR was **0.648** (95% CI: 0.584 to 0.713, $p < 0.001$).

Table 2. Severity grading from SRIA and conventional fundus camera imaging when clustered into no DR to mild NPDR, moderate to severe NPDR, PDR, and ungradable groups

		Conventional fundus camera				
	n (%)	**No DR and mild NPDR**	**Moderate NPDR and severe NPDR**	**PDR**	**Ungradable**	**Total**
SRIA	**No DR to mild NPDR**	*108* (85.7%)	*18* (18.9%)	*0* (0.0%)	*3* (50.0%)	*129* (45.4%)
	Moderate to severe NPDR	*16* (12.7%)	*74* (77.9%)	*10* (17.5%)	*1* (16.7%)	*101* (35.6%)
	PDR	*1* (0.8%)	*3* (3.2%)	*47* (82.5%)	*0* (0.0%)	*51* (18.0%)
	Ungradable	*1* (0.8%)	*0* (0.0%)	*0* (0.0%)	*2* (33.3%)	*3* (1.1%)
	Total	*126* (100.0%)	*95* (100.0%)	*57* (100.0%)	*6* (100.0%)	*284* (100.0%)

DR: diabetic retinopathy; NPDR: non-proliferative diabetic retinopathy; PDR: proliferative diabetic retinopathy; SRIA: smartphone retinal imaging adapter

Kappa agreement between SRIA and Topcon conventional fundus camera was **0.710** (95%: CI: 0.634 to 0.776, $p < 0.001$)

Table 3. Severity grading from SRIA and conventional fundus camera imaging when categorised into no DR, NPDR, PDR, and ungradable groups

		Conventional fundus camera				
	***n* (%)**	**No DR**	**NPDR**	**PDR**	**Ungradable**	**Total**
SRIA	**No DR**	*57* (85.1%)	*17* (11.0%)	*0* (0.0%)	*2* (33.3%)	*76* (26.8%)
	NPDR	*9* (13.4%)	*133* (86.4%)	*10* (17.5%)	*2* (33.3%)	*154* (54.2%)
	PDR	*0* (0.0%)	*4* (2.6%)	*47* (82.5%)	*0* (0.0%)	*51* (18.0%)
	Ungradable	*1* (1.5%)	*0* (0.0%)	*0* (0.0%)	*2* (33.3%)	*3* (1.1%)
	Total	*67* (100.0%)	*154* (100.0%)	*57* (100.0%)	*6* (100.0%)	*284* (100.0%)

DR: diabetic retinopathy; NPDR: non-proliferative diabetic retinopathy; PDR: proliferative diabetic retinopathy; SRIA: smartphone retinal imaging adapter

Kappa agreement between the SRIA and Topcon conventional fundus camera was **0.752** (95% CI: 0.654 to 0.834, $p < 0.001$).

Table 4. Sensitivity and specificity when using the SRIA

DR status	Sensitivity (95% CI), %	Specificity (95% CI), %	Kappa agreement (95% CI)	P-value
Any DR	91.9 (87.4–95.2)	86.4 (75.7–93.6)	0.752 (0.654–0.834)	< 0.001
NPDR	86.4 (79.9–91.4)	84.6 (76.9–90.4)	0.708 (0.617–0.789)	< 0.001
PDR	82.5 (70.1–91.3)	98.2 (95.4–99.5)	0.839 (0.753–0.917)	< 0.001
CSME	61.1 (48.9–72.4)	93.8 (89.7–96.7)	0.590 (0.470–0.701)	< 0.001

CSME: clinically significant macular oedema; DR: diabetic retinopathy; NPDR: non-proliferative diabetic retinopathy; PDR: proliferative diabetic retinopathy; SRIA: smartphone retinal imaging adapter
Kappa agreement between the SRIA and conventional fundus camera for CSME was **0.590** (95% CI: 0.470 to 0.701, $p < 0.001$).

study of the SRIA displayed an agreement of 0.75 for detecting either no DR, NPDR, or PDR. Kappa agreement for detecting CSME in the same studies by Russo *et al.* and Rajalakshmi *et al.* were similar at 0.79, while our study had a lower agreement of 0.59. One possible reason as to why our study performed worse than Russo *et al.* and Rajalakshmi *et al.* in this aspect is the lack of optical magnification in our device. For example, Russo *et al.* had a significantly higher magnification (similar to that of direct ophthalmoscopy) while using the video mode to compensate for the narrow 20° field of view. Rajalakshmi *et al.* had a 12x optical magnification built into their imaging system. However, the advantage of our SRIA device is that it is self-assembled and therefore considerably much lower in cost.

The SRIA did comparatively well in sensitivity and specificity in detecting any DR (91.9% and 86.4%). It showed especially high sensitivity and specificity in detecting PDR (82.5% and 98.2%) cases, which are usually sight-threatening. In comparison, it was slightly lower than the "fundus on phone" validation study done by Rajalakshmi *et al.*[17] which reported sensitivity and specificity values of 92.7% and 98.4%, respectively, in detecting any DR. Apart from having higher optical magnification, their study utilised annular illumination, which provides better image quality and thus better results. Our study relied on the native flashlight of the smartphone, which was neither annular nor sufficiently co-axial. Further development of the current device could incorporate the mentioned features for improvement in detection of DR.

The SRIA produced fewer hazy images than the conventional fundus camera; hence, the SRIA was able to grade images that would otherwise be ungradable on the conventional fundus camera. This was possibly due to better light penetration with the SRIA, similar to how fundus images are better under indirect biomicroscopy compared to slit-lamp biomicroscopy.

In general, images derived from the SRIA have substantial agreement with those from conventional fundus imaging. We believe that it is a viable alternative for screening in rural areas where fundus cameras are not readily accessible. At the moment, it can be used as a portable tool to determine the urgency of referrals to ophthalmologists. For example, no DR and mild NPDR patients can be seen again after 6–12 months, moderate NPDR or severe NPDR patients will demand an earlier consult, and PDR findings would require urgent/ immediate attention for appropriate management.

The safety profile of the iPhone's native LED flashlight using a 20 D condensing lens to illuminate fundi has been investigated and described previously.[21,22] The iPhone 6 used in this study had a weighted retinal irradiance of 1.4 mW/cm^2 (504 times below the thermal limit), weighted foveal irradiance of 1.61 mW/cm^2 (438 times below the thermal hazard level), and weighted retinal radiant exposure of 56.26 mJ/cm^2 (177 times below the photochemical limit).[21] Hence, the retinal exposure from the iPhone 6 was within the safety limits for ophthalmic instruments set by the International Organization for Standardization (ISO15004-2.2), which

are at least one order of magnitude below the actual retinal damage threshold.[21] Patients were also comfortable with the overall experience of undergoing fundus photography. Additionally, patient education on DR was easier after showing them their respective fundus images for a better understanding of their eye health. For the user, the overall experience was satisfying, and it was relatively quick to get satisfactory image acquisition after overcoming the initial learning curve. Acquisition time significantly reduced after the initial ten patients.

Several technical limitations were encountered during the course of this study. Both imaging systems were highly dependent on good lighting. We noticed that in patients with cataracts, reduced light entering the eye resulted in dark or blurry, and subsequently ungradable images. This may be a disadvantage in rural communities where there may be higher incidences of cataracts. Consequently, real-world results may vary from that of this study. Additionally, the flash unit on the iPhone 6 is not completely co-axial, which resulted in some images being dark, and also distracts the patient due to reflection and glare. A device with proper co-axial lighting may provide much brighter images and reduce the amount of reflection and glare. Finally, a more focused beam of light similar to indirect ophthalmoscopes may also enhance the resolution and overall quality of the images taken.

Conclusion

There was substantial agreement in grading DR severity between SRIA and conventional fundus camera imaging. The agreement between the two modalities was best when used to differentiate between no DR, NPDR, and PDR. Smartphone retinal imaging may be a relatively low-cost, ultra-portable, and comparable way of screening for DR in the community.

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Original article

Retinal nerve fibre layer thickness measured by spectral domain optical coherence tomography amongst early primary open-angle glaucoma patients at Hospital Melaka

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Abstract

Introduction: Glaucoma is second only to cataract as a cause of blindness worldwide and Asians account for almost half the cases. Retinal nerve fibre layer (RNFL) assessment is an important objective method for diagnosis and monitoring of glaucoma as it develops earlier than the development of visual field defects.
Purpose: To estimate the proportion of primary open-angle glaucoma (POAG) patients with normal RNFL thickness (RNFLT) amongst early POAG patients who were under follow-up at the Ophthalmology Department, Hospital Melaka (Melaka, Malaysia).
Study design: Observational cross-sectional study.
Materials and methods: Consecutive sampling of 64 POAG patients who were diagnosed as early POAG as defined by the Glaucoma Staging System 2 (GSS 2) into stage 1 and 2 on Octopus visual field test were recruited in this study. Data collected included demographic data, refraction, slit-lamp examination, intraocular pressure (IOP), gonioscopy, peripapillary retinal nerve fibre layer thickness (RNFLT)

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measured by spectral-domain optical coherence tomography (SD-OCT), and fundus photography.
Results: Among 64 eyes, 57.8% were found to have normal and 42.2% to have abnormal RNFLT classification. There was no difference in terms of age, gender or ethnicity between those with normal and abnormal RNFLT. Mean IOP at presentation, mean duration of POAG, and mean spherical dioptres were compared between the two groups. Only mean spherical dioptres showed a significant difference between the two groups, $p < 0.001$. An increase of spherical dioptres also had a moderate positive correlation with RNFLT in most optic disc quadrants except the nasal, temporal, superonasal, and inferonasal quadrants.
Conclusion: OCT cannot be used as a diagnostic tool alone, especially in early glaucoma, as it showed a normal RNFLT in almost half the patients. RNFLT in early POAG had significant correlation with spherical dioptres in most quadrants.

Keywords: early primary open-angle glaucoma, optical coherence tomography, retinal nerve fibre layer thickness

Pengukuran ketebalan lapisan serat saraf retina menggunakan tomografi koheren optik domain spektrum di kalangan pesakit glaukoma sudut terbuka primer peringkat awal di Hospital Melaka

Abstrak

Pendahuluan: Glaukoma berada ditempat kedua selepas katarak sebagai penyebab kebutaan di seluruh dunia dan orang Asia menyumbang hampir separuh daripada kes ini. Penilaian ketebalan lapisan serat saraf retina (RNFLT) adalah kaedah objektif yang penting untuk diagnosa dan pemantauan glaukoma kerana perubahan ini berlaku lebih awal daripada pembentukan kecacatan medan penglihatan.
Tujuan: Untuk menganggarkan peratusan pesakit glaukoma sudut terbuka primer (POAG) peringkat awal dengan ketebalan RNFL normal di kalangan pesakit POAG di Jabatan Oftalmologi, Hospital Melaka (Melaka, Malaysia).
Reka bentuk kajian: Kajian pemerhatian keratan rentas.
Bahan dan kaedah: Persampelan berturut-turut telah dilakukan ke atas pesakit POAG. Seramai 64 pesakit yang didiagnosa sebagai POAG peringkat awal berdasarkan kepada skor ke atas ujian medan penglihatan Octopus menggunakan Glaucoma Staging System 2 (GSS 2) pada tahap 1 dan 2 telah direkrutkan dalam kajian ini. Data yang dikumpulkan termasuk data demografi, refraksi, pemeriksaan

lampu slit, tekanan intraokular (IOP), gonioskopi, ketebalan lapisan serat saraf retina peripapillary (RNFLT) yang diukur dengan tomografi koheren optik-domain (SD-OCT), dan fotografi fundus.
Hasil: Di antara 64 mata yang terlibat, 57.8% didapati mempunyai RNFLT normal dan 42.2% yang tidak normal. Tiada perbezaan dari segi umur, jantina atau etnik antara mereka yang mempunyai RNFLT normal dan tidak normal. Min IOP pada temujanji pertama, jangka masa purata POAG, dan min diopter sfera dibandingkan antara kedua-dua kumpulan. Hanya diopter sfera yang menunjukkan perbezaan yang signifikan antara kedua-dua kumpulan, $p < 0.001$. Peningkatan diopter sfera juga mempunyai korelasi positif sederhana dengan RNFLT pada kebanyakan kuadran cakera optik kecuali kuadran nasal, temporal, superonasal, dan inferonasal.
Kesimpulan: OCT sahaja tidak dapat digunakan sebagai alat diagnostik, terutama pada glaukoma peringkat awal. Ini adalah kerana RNFLT adalah normal pada hampir separuh pesakit yang terlibat. RNFLT pada peringkat awal POAG mempunyai hubungan yang signifikan dengan diopter sfera di kebanyakan kuadran.

Kata kunci: glaukoma sudut terbuka primer peringkat awal, ketebalan lapisan serat saraf retina, tomografi koheren optik

Introduction

Glaucoma is a neurodegenerative disease caused by progressive retinal ganglion cell (RGC) loss associated with characteristic structural changes in the optic nerve head and retinal nerve fibre layer (RNFL). The neural insult can result in functional loss and decrease in vision-related quality of life.

The prevalence of glaucoma in the world is increasing. Glaucoma is second only to cataract as a cause of blindness worldwide and Asians account for almost half the cases.[1] It was estimated that in 2010, 60.5 million people had glaucoma worldwide, which will increase to 79.6 million by 2020. Of this number, 74% will have open angle glaucoma (OAG) and 4.5 million people will suffer bilateral blindness.[1] The probability of patients becoming blind from newly diagnosed and treated ocular hypertension or OAG at 20-years follow-up was estimated to be 27% in one eye and 9% in both eyes.[2]

In two population-based studies in Singapore, Foster *et al.* and Shen *et al.* reported that the prevalence of glaucoma among the Chinese [3] and Malay [4] populations was 3.2% and 3.4%, respectively, in those aged between 40 and 80 years old. Most of them were diagnosed with primary open-angle glaucoma (POAG). Data from our National Eye Survey in 1996 showed that the prevalence of blindness in Malaysia was 0.29%, with glaucoma contributing to 1.8% of blindness. Other major causes of blindness were cataract (39.1%), retinal disease (24.5%), uncorrected refractive error (4.1%), and corneal disease (3.4%).[5]

In view of the increasing number of adult and elderly patients potentially diagnosed with glaucoma in the coming years, improved and aggressive diagnostic approaches, detection of progression, and estimation of deterioration in disease rates are essential in order to evaluate the risk of functional impairment and establish treatment strategies.

As RNFL defects do not occur in normal eyes, they have a high diagnostic importance to differentiate between normal eyes and eyes with optic nerve damage. RNFL defects are not pathognomonic for glaucomatous optic neuropathy, as they can be found in several other disorders, such as tumours of the pituitary gland, optic disc drusen, diabetic retinopathy, and retinochoroidal scars.

In glaucoma, morphologic changes of the optic disc closely correlate with characteristic patterns of visual loss. Using standard visual field techniques, structural alterations seem to appear before the development of visual field defects.[6–16] There is also evidence that RNFL loss can be observed before visual field loss. In fact, experimental studies have shown that as many as 25% to 50% of RGCs are lost before the decrease in standard automated perimetry (SAP) threshold sensitivity values exceed normal variability and reach statistical significance.[14,17-19] Thus, RNFL assessment has emerged as an important objective method for diagnosis and monitoring of glaucoma as it develops much earlier than the development of functional loss from field defects.

Optical coherence tomography (OCT) offers a good and objective method for RNFL evaluation. A new generation of spectral-domain OCT (SD-OCT) with a markedly enhanced spatial resolution has been introduced in clinical practice and provides excellent reproducibility of peripapillary RFNL thickness (RNFLT) measurement. Bowd *et al.* reported statistically significant quantitative differences in RNFLT between ocular hypertension and normal subjects.[20] Wu *et al.* reported the sensitivity and specificity of SD-OCT in detecting wedge RNFL defects to be 92% and 96%, respectively.[21]

In this study, we aimed to estimate the proportion of early POAG patients with normal RNFLT measured with SD-OCT (OCT Spectralis, Heidelberg; Heildeberg, Germany) in Hospital Melaka.

Materials and methods

Consecutive sampling of 64 patients diagnosed as early POAG and fulfilling the inclusion criteria in the Ophthalmology Clinic in Hospital Melaka were identified. Only one eye from each patient was included. When both eyes were eligible, random sampling by flipping coin was used to determine which eye to include. The sample size was calculated using Epi Info™ software version 7.1.3.10, 2014. Fifty patients were required to achieve 5% precision to estimate the proportion of POAG patients with normal RNFL thickness, which is roughly estimated to be

approximately 3.4% according to a study by Shen *et al.*[4]

The inclusion criteria were patients aged ≥ 40 years old, diagnosed with early POAG, defined as stage 1 or 2 according to Enhanced Glaucoma Staging System (GSS 2) based on mean defect (MD) and loss variance (LV) values. At the time of diagnosis, these patients must have fulfilled the following criteria: characteristic glaucomatous visual field defects which were reproducible in at least two consecutive visits; glaucomatous optic neuropathy such as notching, wedge RNFL defect, splinter haemorrhage, peripapillary beta zone, and vertical cup-disc-ratio (CDR) of 0.7 or more; asymmetrical CDR of 0.2 difference in both eyes; violation of the Inferior, Superior, Nasal, Temporal (ISNT) rule; open angle (Shaffer classification ≥ 3); and intraocular pressure (IOP) > 21 mmHg. Other inclusion criteria included spherical refractive error between -5.00 to +5.00 dioptres (D) to ensure the limits were within the Spectralis OCT normative database range of -5.00 to + 7.00 D, good SD-OCT signal strength (> 15), and clear media for fundus photography. The optic disc photography assessment was done by the principal investigator and confirmed by a consultant ophthalmologist.

The exclusion criteria included: concomitant retinal comorbidities *e.g.* diabetic retinopathy, retinal vein occlusion; systemic diseases known to affect the RNFLT, *e.g.* demyelinating disease and pituitary lesions; previous intraocular surgery except for uncomplicated cataract surgery; secondary causes of glaucoma including pseudoexfoliation, pigment dispersion glaucoma, iridocyclitis, and trauma; patients who had had retinal laser procedures including panretinal photocoagulation; and any other causes of optic neuropathy.

RNFLT measurement was conducted by two different operators with at least 2-years' experience in operating the equipment. For each patient, 16 frames were acquired and averaged using the Spectralis OCT (Heidelberg Eye Explorer version 1.8.6.0 and software version 5.7.5.0). The Spectralis OCT provides an Automatic Real-Time (ART) function that utilizes TruTrack™ image-alignment software, *i.e.* an eye-tracking system. With ART activated, multiple frames of the same scanning location were performed during the scanning process and images were averaged for speckle noise reduction. The software calculated the average RNFLT for the overall global, four quadrants (superior, inferior, nasal, and temporal), and four additional sectors (*i.e.* superotemporal, superonasal, inferonasal, and inferotemporal). A signal strength of less than 15 (deemed weak by the manufacturer) was excluded from the analysis. Normal OCT was defined as RNFLT OCT classification showing "within normal limit", while abnormal OCT was defined as RNFLT OCT classification showing "borderline" RNFLT or "outside normal limit".

Automated visual field tests were performed using Octopus 900 perimetry (Haag Streit International, Switzerland). The MD and LV values were plotted on a GSS 2 diagram for glaucoma staging. Only glaucoma stage 1 and 2 (early glaucoma) were enrolled in this study.

Ethical approval was obtained from the Universiti Kebangsaan Malaysia Research

and Ethics Committee. This study adhered to the tenets of the Declaration of Helsinki and Malaysian Guidelines for Good Clinical Practice. A signed written informed consent was obtained from all patients prior to enrolment.

Results

Demographic characteristics

A total of 92 adults diagnosed with early POAG were screened in this study. Of these, 28 were excluded due to poor fundus photograph image (n = 20), pre-existing retinopathy, *e.g.* diabetic retinopathy (n = 7), and branch retinal vein occlusion (n = 1). A total of 64 patients were finally included in this study. Only one eye of each subject which fulfilled the inclusion criteria was chosen for analysis.

The male-to-female ratio was 1.5:1. There were 27 (42%) Malays, 30 (47%) Chinese, and 7 (11%) Indians. The mean age was 64.3 ± 9.2 years, with the majority of the patients being in the 60–79 age group.

Among 64 eyes, 57.81% was found to have normal OCT and 42.19% to have abnormal OCT classification. There was no difference in terms of age, gender, or ethnicity between those with normal and abnormal OCT grading (Table 1).

Table 1. Demographic characteristics among normal and abnormal OCT groups

Variables	**Normal OCT** ***n*** **= 37 (57.81%)**	**Abnormal OCT** ***n*** **= 27 (42.19%)**	***p*-value**
Gender **Male, *n* (%)** **Female, *n* (%)**	23 (35.9) 14 (21.9)	15 (23.3) 12 (18.8)	0.60¶
Ethnicity **Malay, *n* (%)** **Chinese, *n*(%)** **Indian, *n* (%)**	15 (23.4) 20 (31.3) 2 (3.1)	12 (18.8) 10 (15.6) 5 (7.8)	0.17*
Age group, years, *n* (%) **40–49** **50–59** **60–69** **70–79** **80–89**	3 (4.7) 8 (12.5) 12 (18.8) 13 (20.3) 1 (1.6)	2 (3.1) 5 (7.8) 15 (23.4) 3 (4.7) 2 (3.1)	0.14*
Mean age, years ± SD	64.5 ± 9.7	64.0 ± 8.8	0.83†

Normal: normal OCT classification; abnormal: borderline or defect OCT classification; OCT: optical coherence tomography; SD: standard deviation
¶Chi-square; *Fisher's exact test; †Independent t-test

Ocular characteristics among normal and abnormal OCT grading

Table 2 shows the ocular characteristics of eyes graded as normal or abnormal (borderline and below normal values) on OCT. The mean RNFLT in eyes graded as normal was thicker (96.97 ± 7.54 µm) than those graded as abnormal (77.52 ± 9.06 µm, $p < 0.01$).

Although the mean IOP at presentation was higher in the abnormal group (29.2 ± 5.1 mmHg) compared to the normal RNFLT group (27.8 ± 3.0 mmHg), this was not statistically significant ($p = 0.18$, Table 2).

The mean duration of POAG also appeared to be longer in the abnormal group (25.3 ± 15.0 months) compared to the normal group (23.7 ± 12.4 months), although this again failed to reach statistical significance ($p = 0.65$). The majority of patients had a spherical equivalent between 0.00 and +1.00 DS, with mean spherical dioptres of 1.1 ± 1.3 DS and -0.08 ± 1.7 DS in both the normal and abnormal OCT groups, respectively, $p < 0.001$.

Table 2. Ocular characteristics among normal and abnormal OCT groups

Variables	**Normal OCT *n* = 37**	**Abnormal OCT *n* = 27**	***p*-value**
Mean RNFLT, µm ± SD	96.97 ± 7.54	77.52 ± 9.06	< 0.01†
Mean IOP at presentation, mmHg ± SD	27.8 ± 3.0	29.2 ± 5.1	0.18¶
Mean duration of POAG, month ± SD	23.7 ± 12.4	25.3 ± 15.0	0.65†
Spherical dioptre group, DS, *n* (%) **-3.00 to -2.01** **-2.00 to -1.01** **-1.00 to -0.01** **0.00 to +1.00** **+1.01 to +2.00** **+2.01 to +3.00**	 3 (8.1) 1 (2.7) 6 (16.2) 16 (43.2) 9 (24.3) 2 (5.4)	 5 (18.5) 5 (18.5) 2 (7.4) 7 (25.9) 6 (22.2) 2 (7.4)	0.17*
Refractive group, *n* (%) **Hyperopia, *n* = 42 (65.6)** **Myopia, *n* = 22 (34.4)**	 27 (73.0) 10 (27.0)	 15 (55.6) 12 (44.4)	0.15¶
Mean spherical dioptres, DS ± SD	1.14 ± 1.30	-0.77 ± 1.59	< 0.01†
Laterality, *n* (%) **Right** **Left**	 21 (32.8) 16 (25)	 13 (20.3) 14 (21.8)	0.50¶

OCT: ocular coherence tomography; RNFLT: retinal nerve fibre layer thickness
¶Chi-square; †Independent t-test; *Fisher's exact test

Table 3. Correlation between different quadrants of RNFLT and study variables

RNFLT quadrant	Age		IOP at presentation		Duration of POAG		Spherical dioptric power	
	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value	Correlation Coefficient	*p*-value	Correlation coefficient	*p*-value
G	-0.013	0.92	-0.045	0.71	-0.005	-0.97	0.40	0.01
N	0.023	0.86	0.053	0.85	0.067	0.65	0.08	0.54
T	0.074	0.58	0.275	0.03	0.134	0.31	0.09	0.46
S	-0.001	0.99	-0.205	0.09	-0.072	0.58	0.30	0.02
I	-0.075	0.53	-0.109	0.34	-0.111	0.36	0.45	< 0.01
TS	-0.003	0.98	-0.213	0.08	-0.062	0.62	0.36	< 0.01
NS	-0.028	0.84	-0.204	0.11	0.031	0.82	0.11	0.40
TI	-0.113	0.33	-0.030	0.79	-0.149	0.20	0.48	< 0.01
NI	-0.013	0.92	-0.191	0.13	0.017	0.90	0.24	0.05

G: global; I: inferior; IOP: intraocular pressure; N: nasal; NI: inferonasal; NS: superonasal; POAG: primary open-angle glaucoma; S: superior; RNFLT: retinal nerve fibre layer thickness; T: temporal; TI: inferotemporal; TS: superotemporal
P-values in grey are statistically significant.

Factors associated with normal and abnormal OCT classification

We analysed which of the study variables were associated with RNFL thinning in each quadrant (Table 3). In most quadrants, except the nasal and temporal, an increase in age was associated with RNFL thinning; however, this was not statistically significant ($p > 0.05$). The duration of POAG showed an association with RNFL thinning in the majority of quadrants (global, superior, inferior, superotemporal, inferotemporal, and inferonasal); however, it again failed to meet statistical significance. IOP at presentation showed a statistically significant positive weak correlation at the temporal quadrant ($p = 0.03$) and the spherical dioptric power showed significant positive moderate correlation in all except the nasal and temporal quadrants.

Optic disc characteristics among eyes with normal OCT classifications

Among 37 eyes which were classified as normal OCT, 31 eyes had hard signs of glaucoma such as a notching, peripapillary beta zone, wedge RNFL defect, and/or violation of the ISNT rule (Table 4). The remaining six eyes had variable glaucomatous signs, with one eye showing baring of circumlinear vessel, one showing intrapapillary arterioles narrowing, one with nasalisation of optic disc vessels, and three with bayonetting of the optic disc vessels.

Table 4. RNFLT OCT classification in correlation with the presence of hard glaucomatous signs

Hard glaucomatous signs	**RNFLT OCT classification**		***p*-value**
	Normal *n* = 37	**Abnormal *n* = 27**	
Present, *n* (%)	31 (48.4)	23 (36.0)	0.75*
Absent, *n* (%)	6 (9.3)	4 (6.3)	

OCT: ocular coherence tomography; RNFLT: retinal never fibre layer thickness
*Fisher's exact test

Table 5. Distribution of notching according to quadrants and respective RNFLT OCT grading

Notching	**RNFLT OCT grading**		
Location, *n* (%)	**Normal**	**Borderline**	**Defect**
TS, *n* = 4 (100%)	2 (50.0)	0 (0)	2 (50.0)
NS, *n* = 1 (100%)	1 (100)	0 (0)	0 (0)
TI, *n* = 9 (100%)	2 (22.2)	1 (11.1)	6 (66.7)
TOTAL, *n* = 14 (100%)	5 (35.7)	1 (7.1)	8 (57.2)

NS: superonasal quadrant; OCT: ocular coherence tomography; RNFLT: retinal never fibre layer thickness; TI: inferotemporal quadrant; TS: superotemporal quadrant

Nine (64.3%) eyes with notching had corresponding RNFL thinning (borderline/defect of RNFLT) in the same quadrant. Five (35.7%) eyes had a notch but no corresponding abnormal OCT in the same quadrant (Table 5).

Association between peripapillary beta zone and its respective RNFL OCT grading

Of 64 eyes, 3 (4.7%) eyes had peripapillary beta zone observed in their optic disc stereoscopic photograph, of which only 1 (33.3%) eye had a corresponding RNFL defect. Two peripapillary beta zones were seen in superotemporal quadrants and one peripapillary beta zone was observed in the inferior quadrant.

Association between wedge RNFL defects and its respective RNFL OCT grading

Out of 64 sample eyes, 27 wedge RNFL defects were observed in their optic disc stereoscopic photography. Eleven wedge RNFL defects were seen in the superotemporal and inferotemporal quadrants, four in the superonasal quadrant, and one in the nasal quadrant. Six of 11 (54.5%) and 8 of 11 (72.7%) defects seen in the superotemporal and inferotemporal quadrants, respectively, were associated with corresponding RNFL thinning on OCT, whereas none of the wedge defects seen in the superonasal and nasal quadrants showed RNFL thinning on OCT. Similar to notching, wedge RNFL defects caused significant RNFL thinning in 14 of 27 (51.9%) eyes (Table 6).

Table 6. Distribution of wedge RNFL defects according to quadrants and respective OCT RNFLT grading

Location of wedge RNFL defect *n* = 27	**RNFLT OCT grading**		
Location, *n*	**Normal**	**Borderline**	**Defect**
TS, *n* = 11 (%)	5 (45.5)	0 (0)	6 (54.5)
NS, *n* = 4 (%)	4 (100)	0 (0)	0 (0)
TI, *n* = 11 (%)	3 (27.3)	3 (27.3)	5 (45.4)
N, *n* = 1 (%)	1 (100)	0 (0)	0 (0)
Total, *n* = 27 (%)	13 (48.1)	3 (11.1)	11 (40.8)

N: nasal quadrant; NS: superonasal quadrant; OCT: ocular coherence tomography; RNFLT: retinal never fibre layer thickness; TI: inferotemporal quadrant; TS: superotemporal quadrant

Table 7. ISNT rule in correlation with RNFLT OCT classification

ISNT Rule	Normal OCT *n* = 37	Abnormal OCT *n* = 27	*p*-value
Obey, *n* = 22 (34.38%)	10 (45.45%)	12 (54.55%)	0.15#
Disobey, *n* = 42 (65.62%)	27 (64.29%)	15 (34.71%)	

OCT: ocular coherence tomography; RNFLT: retinal never fibre layer thickness
#Pearson correlation

ISNT rule and RNFL OCT classification

Table 7 shows that violation of the ISNT rule is not associated with RNFL thinning ($p = 0.152$). Among 64 eyes, 22 (34.38%) eyes did not violate the ISNT rule, of which 45.45% had normal OCT and 54.55% had abnormal OCT, whereas 42 eyes (65.62%) violated the ISNT rule, of which 64.29% had normal OCT and 34.71% had abnormal OCT.

Discussion

This study recruited a total of 64 early POAG patients with one eye per patient taken as sample. The OCT findings were normal in 57.8% and abnormal in 42.2% of the patients. This is in keeping with previous findings by Rao *et al.,* who reported the sensitivity of SD-OCT in detecting average RNFL thinning in early glaucoma patients was 37.4% at a fixed 95% specificity.[22] Of note, the Spectralis OCT uses its own normative database, which is based on the Caucasian population. Many studies have found variations in RNFLT among races and ethnicities. Budenz *et al.* reported that the Hispanic and Asian ethnicities had a significantly thicker mean RNFL compared to those of European origin.[23] Alasil *et al.* also reported that the mean RNFLT measured by SD-OCT in Caucasians was significantly lower (96 ± 9.2 µm) than those of Hispanic (102.9 ± 11 µm) or Asian descent (100.7 ± 8.5 µm).[24] This may likely explain why 57.81% of early POAG patients were classified as normal by the Spectralis OCT in our study.

In this study, patients were divided into those with normal and abnormal RNFLT (borderline and below normal values). In both groups, the mean age was comparable, with the majority of patients falling between 60–69 years of age. There was no significant difference in gender or ethnicity between the groups. In two population-based studies done in Singapore, POAG was found to be the predominant form in more than 40% of Malay and Chinese patients.[3,4] Although the mean IOP at presentation was higher and the duration of POAG was longer in

the abnormal than in the normal OCT group in our study, we found there was no statistical significance for these variables.

POAG is a disease involving progressive optic neuropathy. Despite treatment, there will be gradual progression of the disease even when the modifiable risk factor, which is IOP, is well controlled. Thus, the longer the duration of POAG, the more neuropathy is expected to progress, which could explain our findings. Given the present study included only early-stage POAG, there was not much difference in POAG duration between both groups.

We found a significant difference between spherical dioptres in both groups as well. The majority of eyes in both groups were between 0.00 and +1.00 in spherical dioptres. However, in the abnormal OCT group, the mean spherical equivalent was leaning towards myopia. This finding is in agreement with previous studies that found RNFLT is thinner in myopic eyes.[25–26]

Among all variables, RNFLT in the global, temporal, superior, inferior, superotemporal, and inferotemporal quadrants showed significant correlation with the study variables. We found that an increase in spherical dioptres was moderately correlated with an increase in RNFL in most quadrants except the nasal, temporal, superonasal, and inferonasal. The significance of myopia and RNFLT has been reported in many studies.[23,25–27]. Budenz *et al.* found that RNFLT was related significantly to both axial length and refractive error.[23] The Blue Mountains Eye Study showed that glaucoma was present in 4.2% of eyes with low myopia and 4.4% of eyes with moderate-to-high myopia compared to 1.5% of eyes without myopia [29]. This study confirmed a strong relationship between myopia and glaucoma, consistent with our findings.

We also found a weak positive correlation between IOP at presentation and RNFLT in the temporal quadrant. The OCT readings in this study were taken after the patients were initiated on IOP-lowering medications and the IOP was well controlled. We postulate that higher IOP at presentation was associated with thicker RNFL in the temporal quadrant because, generally, patients with higher IOP are likely to be treated more aggressively than those with lower IOP at presentation. This will affect, in general terms, the progression of glaucoma and further RNFL thinning. Hence, after a period of time, those with high IOP at presentation had less glaucoma progression and showed relatively "thicker" RNFL than those with lower IOP at presentation.

Correlation between quadrants and study variables also found that RNFLT is correlated with increasing age in the majority of quadrants except the nasal and temporal. However, this correlation failed to reach statistical significance. This was probably due to the fact that the study had a small sample and was not well distributed among age groups, as we used consecutive sampling. However, this is consistent with a previous study on the effects of aging and RNFL thinning.[24] RNFLT does not show a significant decrease with aging in the nasal and temporal quadrants among the normal population.[23]

Even in the presence of glaucomatous hard signs such as notching and wedge

RNFL defects on optic disc photographs, we found that the Spectralis OCT did not classify all these cases as abnormal OCT in their respective quadrants in early POAG. Fourteen eyes were observed to have notching, of which the majority (nine eyes) was classified as abnormal OCT of its respective quadrant, while the remaining five were normal. Twenty-seven wedge RNFL defect areas were seen, and 14 were classified as abnormal. Previous studies have shown the sensitivity of OCT to detect wedge RNFL defects to be between 80% to 92%, with a specificity between 92% and 94%.[20,30] In this study, we used red-free optic disc photography instead of blue-reflectance RNFL photography by confocal scanning laser ophthalmoscopy, which has been proven to be a better way to visualize RNFL thinning.[31,32] Precise visualization of the RNFL from red-free photography also requires a skilled imager, good pupil dilation, relatively clear media, and high-contrast view, which makes examination difficult in patients with cataract and pigmented fundi.

Although we reached a sample size large enough to achieve the targeted power of the study, the number of eyes with glaucomatous features in each cell was small and this reduced meaningful associations. Increasing the sample size would help identify significant associations between individual hard signs of glaucomatous disc changes and RNFLT.

Conclusion

We conclude that OCT should not be the only tool relied upon to diagnose glaucoma, especially in the early stages. This is supported by the fact that, in our study, more than half of early POAG patients had normal RNFL thickness, possibly attributable to ethnic differences when using normative values from a Caucasian population as reference. Other diagnostic tools such as the Humphrey Visual Field Analyzer and clinical optic disc assessment should be employed as well.

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Brief report

Our experience with emergency ophthalmic surgery at Hospital Kuala Lumpur during the COVID-19 pandemic

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Abstract

As Malaysia called to arms its front liners for the COVID-19 pandemic, Hospital Kuala Lumpur was converted into a hybrid hospital to handle both COVID-19 and non-COVID-19 patients. There was a reprioritization of services affecting all hospital units, including ophthalmology. We illustrate the challenges faced with two ophthalmic emergency cases that presented during this trying period: a case of left eye posterior globe rupture sustained through a motor vehicle accident and another case of right eye bleb leakage 3 weeks post-trabeculectomy.

This report highlights the various perioperative challenges faced by the ophthalmology team in managing these cases. Amongst them were logistic and technical challenges, which included the wait for COVID-19 test results, ophthalmic services scattered between three buildings, and the initial lack of guidelines. Disruption to our emergency ophthalmic workflow required adaptation and improvisation.

As we transition to resume "normal" ophthalmic services, healthcare centres will undergo frequent remodelling in their usual work processes to ensure that high standards of care are upheld whilst protecting healthcare workers.

Keywords: COVID-19, emergency ophthalmic surgery, healthcare management, pandemic

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Pengalaman pembedahan kecemasan oftalmik di Hospital Kuala Lumpur semasa pandemik COVID-19

Abstrak

Ketika Malaysia mempersiapkan barisan hadapannya untuk menghadapi pandemik COVID-19, Hospital Kuala Lumpur berubah menjadi hospital hibrid bagi merawat pesakit COVID-19 dan bukan COVID-19. Penyusunan semula perkhidmatan yang melibatkan semua unit termasuk Oftalmologi dibuat untuk memenuhi keperluan kepentingan perkhidmatan yang mendesak. Di sini kami menggambarkan cabaran yang dihadapi semasa tempoh yang sukar ini dengan dua kes kecemasan oftalmik: kes kecederaan perforasi bola mata kiri berikutan kenderaan bermotor dan kes kebocoran bola mata kanan yang berlaku 3 minggu selepas pembedahan trabekulektomi.

Laporan ini menyoroti pelbagai cabaran perioperatif yang dihadapi oleh pasukan oftalmologi dalam meguruskan kes-kes ini. Antaranya ialah cabaran logistik dan teknikal, termasuk penantian keputusan ujian COVID-19, perkhidmatan oftalmik yang tersebar melibatkan tiga bangunan berasingan, serta kekurangan garis panduan pada peringkat awal. Perubahan aliran kerja disebabkan oleh cabaran-cabaran ini memerlukan adaptasi dan improvisasi.

Dalam peralihan untuk menyambung semula perkhidmatan oftalmik dengan norma baru, pusat dan institusi kesihatan perlu melakukan perubahan dalam proses carakerja untuk memastikan piawaian penjagaan yang tinggi dipatuhi, dan dalam masa yang sama melindungi kakitangan kesihatan.

Kata kunci: COVID-19, pandemik, pembedahan oftalmik kecemasan, pengurusan penjagaan kesihatan

Introduction

The coronavirus disease 2019 (COVID-19) pandemic emerged from a highly infectious, newly discovered strain of single-stranded RNA coronavirus.[1] The outbreak was first documented in Wuhan, China in December 2019.[1] Malaysia recorded its first case of COVID-19 on January 25, 2020.[2]

To flatten the COVID-19 curve, Malaysia enacted a Movement Control Order (MCO) beginning March 18, 2020. During phases 1 to 4 of MCO, elective ophthalmologic procedures were placed on hold. A series of recommendations regarding ophthalmic practice was released to guide ophthalmologists globally on the

provision of ocular care during these unprecedented times.[3,4]

During the COVID-19 pandemic, Hospital Kuala Lumpur (HKL) became a hybrid hospital, handling both COVID-19 and non-COVID-19 patients. As HKL reorganized its resources to tackle the pandemic, ophthalmology services had to adapt to significant changes.

This report illustrates our experience caring for two patients requiring emergency ophthalmic surgery during the peak of COVID-19 in Malaysia.

Case 1

A 48-year-old man presented to HKL after his motorcycle skidded at 4 pm, April 24, 2020. After initial management at the emergency department, he was admitted at midnight with left eye posterior globe rupture and right shoulder soft tissue injuries.

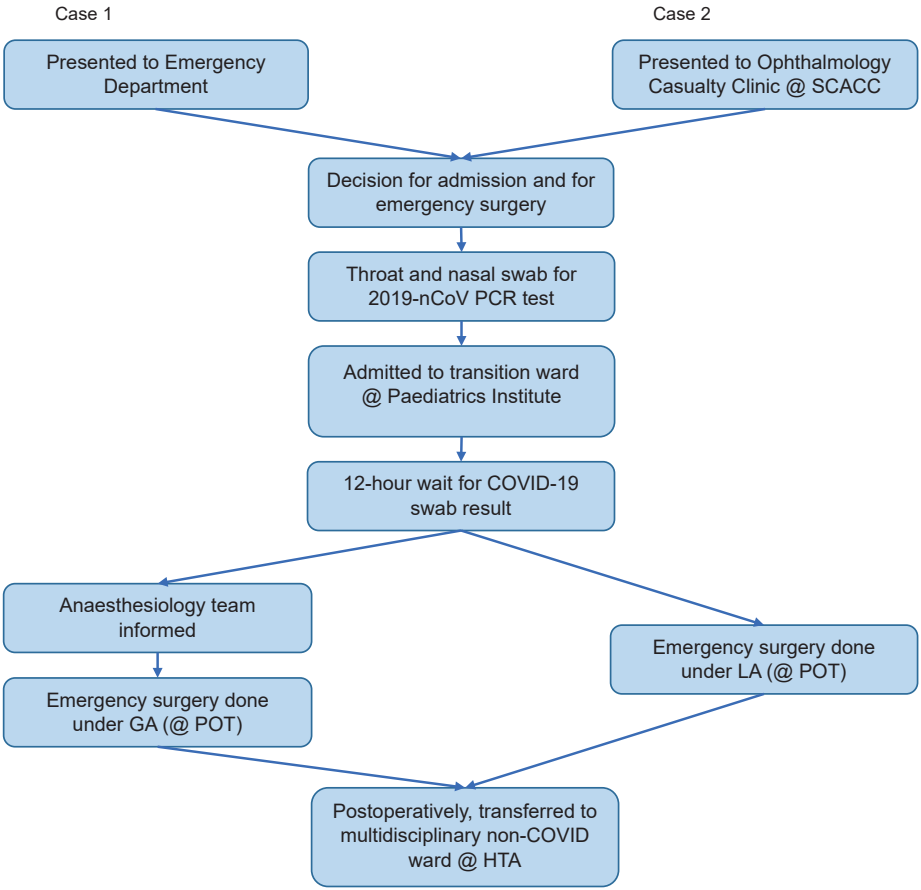
COVID-19 risk stratification, which consisted of temperature measurement and exposure screening questionnaires, deemed the patient low-risk. The patient had to undergo mandatory throat and nasal swabs for 2019-nCoV PCR which was taken at 12.15 am. These measures determined the level of personal protective equipment (PPE) required. During the wait, the patient was placed in the multidisciplinary transition ward and wore a three-ply surgical mask. The on-call pathologist was contacted to expedite testing, shortening the turnover time of verbal reporting from 24 to 12 hours. The following day, his result was available at 12 pm and the anaesthesiologist on-call was informed immediately.

Left eye globe rupture repair was subsequently performed under general anaesthesia at 3 pm. The surgery was done in the designated non-COVID-19 operating theatre at the Paediatrics Institute (Paediatric Operating Theatre, POT). Postoperatively, the patient was monitored in the non-COVID multidisciplinary ward at Hospital Tunku Azizah (HTA, previously known as Women and Child's Hospital) (Fig. 1).

Although the visual prognosis was extremely poor for this patient, we were able to attain primary closure of the globe rupture within 24 hours. The patient was subsequently discharged well on postoperative day 3.

Case 2

A 57-year-old man, 3 weeks postoperative for right eye augmented trabeculectomy, attended clinic review on April 29, 2020 and underwent removal of releasable suture. A few hours later, he experienced gushing of fluid from his right eye. He then presented to HKL Ophthalmology Casualty Clinic at 4 pm, April 30, 2020 and was diagnosed with right eye postoperative bleb leakage, requiring resuturing.



GA: general anaesthesia; HKL: Hospital Kuala Lumpur; HTA: Hospital Tunku Azizah; LA: local anaesthesia; POT: Paediatric Operating Theatre; SCACC: Specialist Complex and Ambulatory Care Centre

Fig 1. Summary of both patients' journey in HKL.

The anterior chamber appeared formed but shallow, the bleb was low-lying and diffuse, and the Seidel's test was positive over the limbal area.

The patient was evaluated similarly to case 1. He was admitted and the throat and nasal swabs were performed at 6.30 pm. During the 12-hour wait in the transition ward, a bandage contact lens was placed and topical antibiotics intensified. Although the results were available the following morning at 6 am, the operating theatres were occupied. Resuturing of the right eye bleb leak was subsequent-

ly performed under local anaesthesia at 11 am at POT. Postoperative care was provided at HTA's non-COVID multidisciplinary ward. The patient was discharged well on postoperative day 2 with a well-formed anterior chamber, diffuse bleb and Seidel's negative.

Discussion

HKL, located on 150 acres in the heart of Kuala Lumpur, is the largest public tertiary hospital in Malaysia with 53 departments and units, 83 wards and 2,300 beds.[5]

The Ophthalmology Department of HKL received 56,859 outpatient visits, admitted 6,559 patients, and performed 4,163 eye surgeries in 2019. The 36-bed ophthalmology ward is located in the main hospital block, one floor above the general operating theatre (GOT). The clinic is located in the Specialist Complex and Ambulatory Care Centre (SCACC), approximately 350 metres away (Fig. 2).

To cope with the increasing COVID-19 patient load, HKL repurposed wards and operating theatres to avail 700 inpatient beds. Health services and personnel were redistributed and surgical wards, including ophthalmology, were among those affected. HKL's main block was designated for the care of COVID-19 and severe

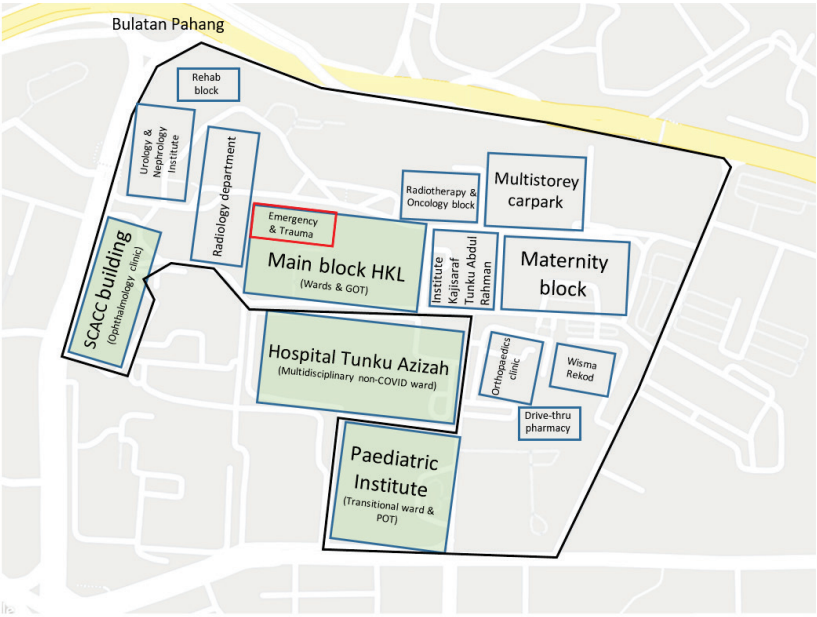


Fig. 2. Illustrated map of HKL.

acute respiratory illness (SARI) patients. The GOT served as an additional intensive care unit, utilizing its ventilators.

The vacant Maternity Block and Paediatrics Institute, whose services were recently transferred to HTA, were reopened to serve as non-COVID and transition wards, respectively. The Ophthalmology Department was allocated a limited number of beds in the multidisciplinary ward at the newly opened HTA.

During the initial phases of COVID-19, generalized recommendations and cautions regarding ophthalmic cases and procedures were released, but standard operating procedures (SOPs) remained lacking. Contributing to the concern was the death of Chinese ophthalmologist Li Wenliang, which revealed possible transmission via conjunctival mucosa.[1] Case reports describing conjunctivitis as a presenting feature of COVID-19 and the need for proximity between ophthalmologists and their patients further amplified the anxiety.[1] A swift remodelling of outpatient and inpatient services was needed to continue delivering high standards of care without jeopardizing healthcare personnel safety.

Globally, emergency services battled with an overwhelming number of COVID-19 patients. Conversely, throughout MCO, the incidence of trauma requiring ophthalmic emergency surgeries drastically reduced at HKL. At the time of writing, there were only 10 ophthalmic emergency admissions during the MCO period, 4 of which were trauma-related, compared to 48 in the corresponding period of 2019.

The two cases illustrated occurred during the height of COVID-19, prior to the availability of SOPs for approaching emergency ophthalmic surgeries. HKL's "ophthalmology service under one roof" was scattered and logistics became an obstacle. Preoperatively, ophthalmology equipment, including the mobile microscope, were transported to POT. All admissions were swabbed for COVID-19 and placed temporarily in the Paediatrics Institute transition wards while awaiting results.

Intraoperatively, experienced surgeons aimed for swiftness and efficiency to minimize exposure time and risk. However, the unfamiliar POT setting posed challenges. When additional equipment was needed, the circulating nurse had to obtain them from a different location, causing delay. There were also conflicts and trade-offs over PPE such as the need for face shields or eye goggles intraoperatively, which may compromise the surgeon's visibility.

Postoperatively, patients received care in the non-COVID multidisciplinary ward at HTA. Fortunately, it was located opposite the Paediatric Ophthalmology ward of HTA. This allowed us access to specialized ophthalmology equipment such as slit lamps and B-scan needed for examinations.

Reflection

Ophthalmology is a field highly dependent on specialized equipment. Location and equipment mobilization have a huge influence on our workflow. With the HKL emergency ophthalmology service stretched across three separate buildings, there was delay associated with equipment availability. We learned to better anticipate and over-prepare for emergency surgeries to reduce delays associated with lacking instruments and supplies.

The delay in surgical intervention resulting from the turnover time of the swab results may negatively impact patient outcomes. As the decision-maker, the attending ophthalmologist must always remain vigilant, balancing urgency and safety. This was demonstrated in the above two cases, in which the risk of complications associated with a delay in surgical intervention was minimized whilst also ensuring the wellbeing of healthcare staff.

In the absence of physical gatherings, virtual platforms are playing an increasingly crucial role in updating ophthalmologists with the latest information. Such channels of communication ensure that our guidelines and SOPs are in sync with the latest knowledge. At the time of writing, the Malaysian guidelines for ophthalmologists were recently released in May 2020 to advise us in these uncertain times.[6]

Conclusion

Our distinct experience in handling emergency ophthalmic surgery was influenced by HKL's layout and its status as a hybrid hospital during the pandemic. COVID-19 posed a multitude of challenges and difficulties to ophthalmologists in delivering care. Our team had to adapt to the restructuring of HKL, optimize the delivery of emergency ophthalmic care across three buildings, as well as overcome the unfamiliar surroundings of the operating theatre and the multidisciplinary ward.

Despite this, excellent teamwork and communication enabled us to make the best out of the situation. We must learn from our COVID-19 experience and be proactive in designing an agile ophthalmology service. As the situation evolves, SOPs and workflows will continue to evolve to accommodate both COVID-19 and non-COVID-19 patients safely. Ophthalmologists should not take for granted the transition to "normal" service. Planning and designing operational flow in wards, clinics, and operating theatres must reflect our acquired knowledge and that of the rest of the world.

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Case report/Case series

Recurrent canalicular granulation tissue following syringing and probing

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Abstract

A 70-year-old woman presented with lower lid swelling in the right eye for a duration of 5 months. There was no associated trauma or surgical intervention to the canaliculi. On examination, there was a soft and diffuse swelling adjacent to the lower punctum. Syringing and probing were done, revealing incomplete blockage of the lacrimal system. After a week of syringing, a growth arising from the lower punctum was noted. Excision was done and histopathological examination revealed granulation tissue with no malignancy seen. At 6 weeks post-excision, the granulation tissue recurred and was treated medically as the patient remained asymptomatic.

Keywords: canalicular, granulation tissue, probing, punctum, syringing

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Kejadian semula tisu granulasi kanalikular selepas prosedur penyiasatan sistem lakrimal dan syringing

Abstrak

Seorang wanita berusia 70 tahun mengalami pembengkakan pada sebelah bawah kelopak mata di sebelah kanan selama 5 bulan. Tiada sejarah trauma atau intervensi pembedahan ke atas kanalikular sebelum ini. Ketika pemeriksaan, terdapat pembengkakan lembut dan mendatar berdekatan dengan bahagian bawah punktum. Berdasarkan syringing dan pemeriksaan yang dilakukan, terdapat penyumbatan separa pada sistem lakrimal. Selepas satu minggu proses syringing, pembengkakan semula timbul dari punktum bawah. Eksisi dilakukan dan pemeriksaan histopatologi menunjukkan tisu granulasi tanpa wujudnya tanda pertumbuhan sel malignan. Selepas 6 minggu eksisi, tisu granulasi berulang lagi dan dirawat secara ubatan kerana pesakit tidak mengalami sebarang simptom.

Kata kunci: kanalikular, penyiasatan sistem lakrimal, punktum, syringing, tisu granulasi

Introduction

Granulation tissue formation of the eye is a common occurrence. As sequelae of any ocular procedure such as strabismus surgery or incision and curettage, the eye develops chronic inflammation. However, granulation tissue in the lower punctum is rare. Classic examples include punctal plug insertion in the treatment of dry eyes or dacryocystorhinostomy silicone tube insertion for nasolacrimal duct obstruction.[1,2] We report a case of recurrent lower punctum granulation tissue after an episode of syringing and probing.

Case report

A 70-year-old Malay woman came to our eye clinic with the complaint of lower lid swelling in the right eye for 5 months. The swelling was confined to the nasal side of the lower lid and was associated with minimal epiphora and clear discharge. Prior to presentation, the swelling had ruptured spontaneously but subsequently recurred. She sought treatment at a primary care setting and was given topical antibiotics. However, the swelling remained the same. She denied any previous trauma, insect

bite, or any surgical intervention to the puncti. Her medical history included hypertension on treatment and bilateral knee osteoarthritis.

Her visual acuity showed OD 6/24, improved to 6/12 with pinhole, and OS 6/36, improved to 6/18 with pinhole. Examination of the right anterior segment revealed a soft and diffuse swelling adjacent to the lower punctum. The surrounding canalicular area appeared minimally erythematous and oedematous. The lower punctum was not obliterated and its ampulla appeared slightly dilated. There was no evidence of meibomitis. The upper punctum was normal in appearance. She also had bilateral immature cataract and right epiretinal membrane. Other examinations were unremarkable.

As chronic canaliculitis with a suspicious canalicular obstruction was suspected, syringing and probing was performed. A 26-G Rycroft cannula attached to a syringe filled with balanced salt solution was used. Syringing of the upper punctum revealed a hard stop with regurgitation. However, there was a soft stop with no regurgitation from the lower punctum. A diagnosis of right incomplete blockage of the lacrimal excretory system was made. Topical dexamethasone and fusidic acid ointment were started, and the patient was advised to apply warm compresses at home.

During her review 1 week later, a soft and pink mass arising from the lower punctum was noted. The mass was excised for diagnostic purposes and histopathological examination revealed inflamed granulation tissue with no malignant cells (Fig. 1).

At 6 weeks post-excision, the granulation tissue of the lower punctum recurred. The oculoplastic team was consulted and the lesion was treated medically with topical dexamethasone, in view of the patient remaining asymptomatic (Fig. 2).

Discussion

Granulation tissue of the canaliculus is commonly associated with procedures involving the puncti, such as silicon plugs and stent insertion.[2-4] In this case, the patient developed it after syringing and probing, which is rare. This procedure is commonly done as an office procedure to find obstructions in the canaliculi. Pre-existing chronic inflammation from canaliculitis and syringing may worsen the inflammation and induce granuloma formation. A mixture of inflammatory cells and hyperplastic lymphoid tissues protrude from the lower punctum, leading to development of the tissue. Inadequate control of inflammation and persistent canaliculitis may lead to recurrence.

Surgical excision is the treatment of choice to remove such granulation tissue. The use of antimetabolites has been reported to reduce the rate of recurrence. Durmus *et al.* reported that mitomycin-C 0.4 mg/ml for 3 minutes over the base of the recurrent granuloma resulted in reduced recurrence.[5] However, in our case the patient did not develop any symptoms such as epiphora or foreign body sensation.

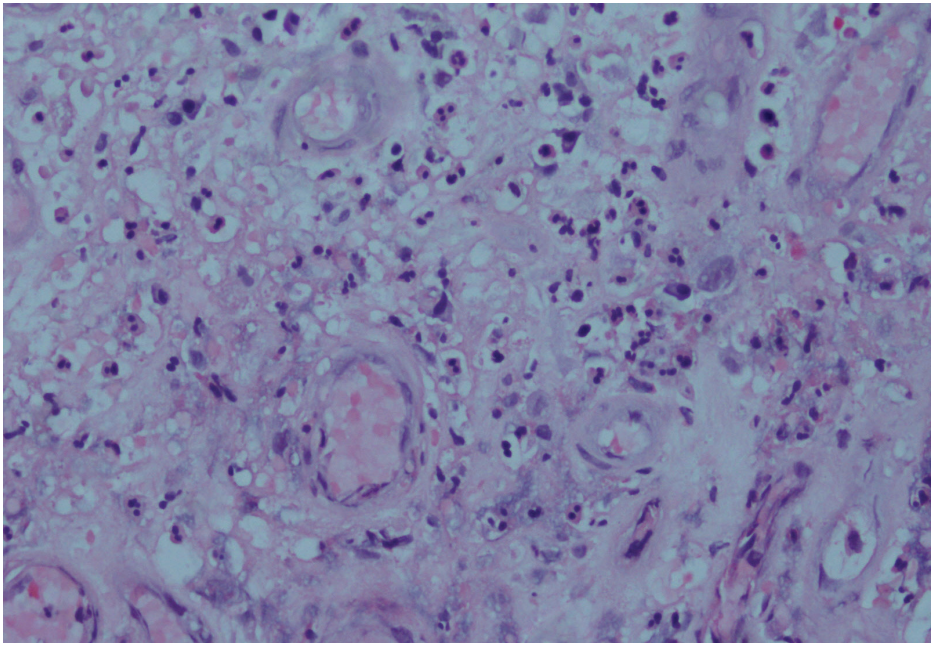

Fig. 1. Histopathological slide showing inflammed granulation tissue with no malignant cells.

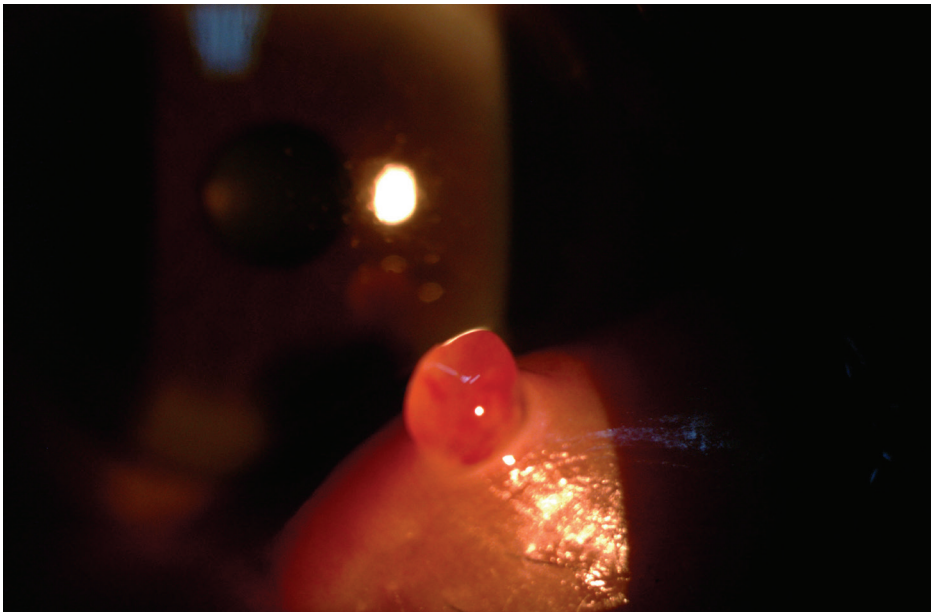

Fig. 2. Recurrence of the lower punctum granuloma.

Clinically, there was no evidence of acute dacryocystitis or ocular surface disease. Hence, the recurrent granulation tissue was treated conservatively.

In summary, the uncommon granulation tissue formation should be informed to patients prior to performing syringing and probing. Topical steroids may be considered after the procedure.

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Case report/Case series

Chemo-adjuvant therapy in recurrent conjunctival intraepithelial neoplasia

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Abstract

A 68-year-old Malay male with no known medical illness presented with progressive growth of right conjunctival mass over a few months. Anterior segment examination of the right eye showed an inferior perilimbal elevated gelatinous conjunctival mass measuring 6 mm vertically x 14 mm horizontally with 360° corneal vascularisation. Excision biopsy and histopathological examination revealed areas of dysplastic cells involving the full epithelial thickness, suggestive of conjunctival intraepithelial neoplasia. The patient defaulted follow-up and presented later with recurrence involving the superior two-thirds of the cornea. Pulsed dosing of topical 5-fluorouracil 1% was initiated 4 times daily for a week with 21-day breaks for a total of 4 cycles. Regression of the lesion was noted after two cycles of 5-fluorouracil.

Keywords: chemo-adjuvant, conjunctival intraepithelial neoplasia, 5-fluorouracil

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Terapi kemo-adjuvan dalam neoplasia intraepitelial konjunktiva yang berulang

Abstrak

Seorang lelaki Melayu berusia 68 tahun tanpa sebarang penyakit kronik menunjukkan pertumbuhan progresif jisim konjuntiva kanan selama beberapa bulan ini. Pemeriksaan klinikal segmen anterior mata kanan menunjukkan ketumbuhan bergelatin pada bahagian bawah perilimbal konjunktiva berukuran 6 mm (menegak) x 14 mm (mendatar) dengan pertumbuhan salurdarah yang memenuhi 360° kornea. Pemeriksaan histopatologi pada biopsi secara eksisi menunjukkan kawasan sel displastik yang melibatkan semua lapisan ketebalan epitelia yang terarah kepada neoplasia intraepitelium konjunktiva. Pesakit gagal hadir rawatan susulan menyebabkan penyakit berulang dan merebak kepada dua pertiga kornea. Rawatan secara topikal 5-fluorouracil 1% secara berkala diberi secara 4 kali sehari selama seminggu diikuti oleh rehat selama 21 hari diberikan sebanyak 4 kitaran. Regresi ketumbuhan diperhatikan selepas dua kitaran rawatan ini.

Kata kunci: kemo-adjuvan, neoplasia intraepithelial konjunktiva, 5-fluorouracil

Introduction

Conjunctival intraepithelial neoplasia (CIN) is a non-invasive lesion in which the conjunctival basement membrane remains intact and the underlying *substantia propria* spared. It commonly occurs over the bulbar conjunctiva in the interpalpebral zone with frequent involvement of the adjacent corneal epithelium. Clinically, it is difficult to distinguish between CIN and squamous cell carcinoma, which invades the epithelial basement membrane and *substantia propria*.

The treatment for CIN involves surgical excision with adjuvant alcohol and cryotherapy. Chemo-adjuvant and chemotherapeutic agents such as 5-fluorouracil (5-FU), mitomycin-C (MMC), and interferon alpha-2b (IFN) have shown promising results in the treatment of conjunctival premalignant lesions.[1,2,3] Here, we report the role and effectiveness of delayed 5-FU treatment in a non-compliant CIN patient.

Case report

A 68-year-old Malay male with no known medical illness presented with progressive growth of conjunctival mass in the right eye over a few months. The best-corrected

visual acuity was 3/60 in the right eye and 6/9 in the left eye. There was no relative afferent pupillary defect. Anterior segment examination of the right eye showed an inferior perilimbal elevated conjunctival mass measuring 6 mm vertically x 14 mm horizontally, with extensive corneal involvement of 360° vascularisation (Fig. 1). Left eye examination was unremarkable. There was no palpable preauricular, submandibular, or cervical lymphadenopathy. The patient underwent excision biopsy with non-touch technique and histological examination revealed areas with dysplastic cells involving the full epithelial thickness, suggestive of CIN (Figs. 2 and 3). He was planned for chemo-adjuvant therapy of topical 5-FU. However, the patient defaulted treatment and presented later with a recurrent lesion involving the superior two-thirds of the cornea with extensive corneal vascularisation (Fig. 4). The patient was then recommenced on 5-FU 1% 4 times daily for a week for 4 cycles with a resting time of 21 days between the cycles. The conjunctival growth responded to treatment, shrinking by 2 clock hours and became less vascular (Fig. 5). His vision improved to 6/9.

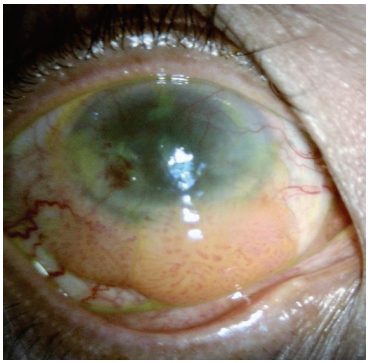

Fig. 1. Anterior segment examination of the right eye showed an inferior perilimbal elevated conjunctival mass measuring 6 mm vertically x 14 mm horizontally, with a gelatinous surface.

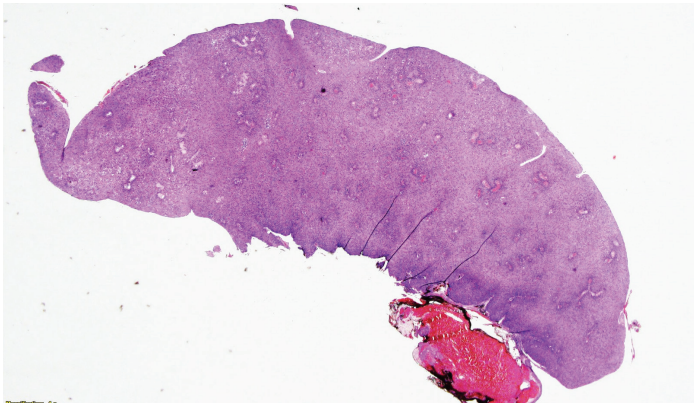

Fig. 2. The slide showing full thickness of dysplastic cells (carcinoma *in situ*). H&E: x20 magnification

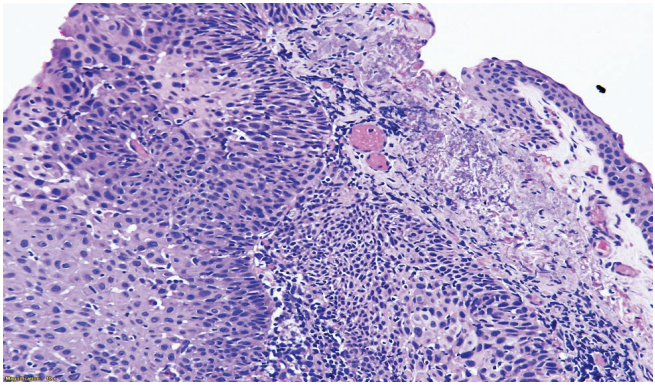

Fig. 3. The dysplastic epithelium on the left (asterisk) showed increased cellularity and loss of normal maturation sequence. The slides showed intact basement membrane with an area of normal conjunctival epithelium (arrow). H&E: x100 magnification

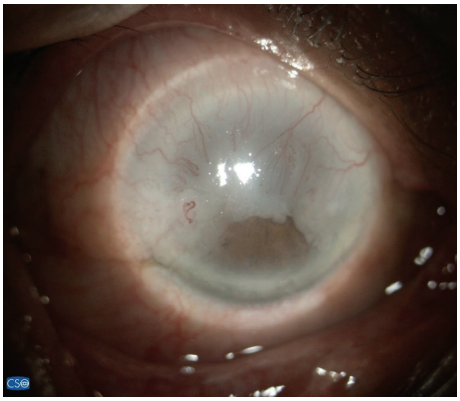

Fig. 4. The recurrence of the conjunctival lesion involving the superior two-thirds of cornea, covering the visual axis with extensive corneal vascularisation.

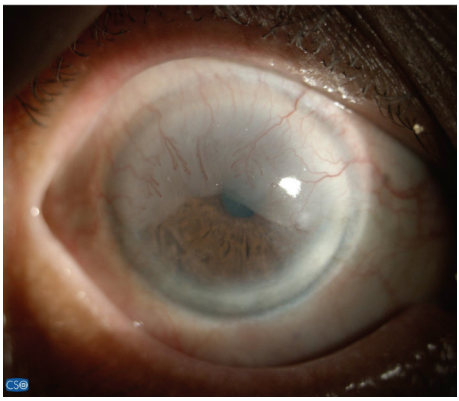

Fig. 5. After two cycles of 5-FU therapy. The conjunctival lesion was reduced in size by two clock hours with less vascularity.

Discussion

CIN, including carcinoma *in situ*, are uncommon clinical entities. The exact aetiology of CIN is unknown with multifactorial possible contributing factors. The known risk factors include older age, fair pigmentation, ultraviolet light exposure, exposure to petroleum products, human papillomavirus, and human immunodeficiency virus (HIV).[4] It is difficult to cure, as it exhibits conjunctivalization, which is prone to multiple recurrences,[2] as shown in this case.

Surgical excision can be used for therapeutic and diagnostic purposes. Before the introduction of chemotherapeutic modalities, traditional therapy involved surgical excision with adjunctive cryotherapy or radiation. However, recurrence rates of up to 33% have been reported, even with clear margins evidenced by pathologic results.[1]

As a sole therapy, topical 5-FU is a long-term, safe, and effective treatment modality for preinvasive ocular surface squamous neoplasia and for almost half of invasive ocular surface squamous neoplasia.[3] Thus, it is an option to start 5-FU first in cases of CIN which can only be diagnosed clinically without histopathology confirmation. Topical chemotherapy has proven benefits when compared to traditional surgical excision and cryotherapy. The advantages include reducing the tumour size and eradicating the histological, non-visible nests of tumour cells. Furthermore, it does not cause limbal stem cell deficiency, which is associated with more destructive therapies involving the limbus.[2] Common side effects include conjunctival and corneal inflammation, corneal epithelial defects, and eye irritation.

The standard dosage of topical 5-FU reported is 1% in aqueous solution, 4 times a day over 4 weeks. A few authors used pulsed dosing with topical 1% 5-FU 4 times daily but limiting the dose to 2–4 days in 4–6 cycles, with an interval of 30–45 days without treatment.[2,5] Pulsed dosing regimens have been found to be as effective as continuous dosing regimens, with a reduced side effect profile.[3,5,6]

This case illustrates the reality of delivering medical care in our daily practice, as non-compliance occurs due to various reasons. The decision to restart the chemo-adjuvant was made in light of the histological findings and to prevent further loss of opportunity in treating the lesion.

Conclusion

In view of the high recurrence rate and surgical difficulties in cases with corneal extension, topical 5-FU is advocated as a chemo-adjuvant in the treatment of CIN to prevent local recurrence after excision biopsy with promising results. It should be instituted at the earliest opportunity available and can even be started in default cases.

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Case report/Case series

Tobacco-alcohol optic neuropathy following festive binge drinking

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Abstract

This case report aims to discuss a case of tobacco-alcohol optic neuropathy secondary to alcohol abuse and chronic cigarette smoking in a 43-year-old man. Possible causes including vitamin B12 deficiency, methanol poisoning, and cyanide in tobacco were discussed. Clinical examination and blood investigation supported the diagnosis of vitamin B12 deficiency, possibly precipitated by methanol and cyanide. The patient was treated with vitamin B12 and folinic acid and asked to abstain from smoking and alcohol consumption. His left eye vision had improved to premorbid vision but there no improvement on the right eye. As a conclusion, tobacco-alcohol optic neuropathy is a diagnosis of exclusion and treatment shows variable response.

Keywords: alcohol, methanol, nutritional, tobacco, vitamin B12 deficiency

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Neuropati optik tembakau-alkohol selepas pesta arak

Abstrak

Laporan kes ini bertujuan untuk membincangkan kes neuropati tembakau-alkohol optik akibat penyalahgunaan alkohol dan merokok secara kronik pada seorang lelaki berusia 43 tahun. Laporan kes ini turut membincangkan tentang kemungkinan penyebabnya termasuk kekurangan vitamin B12, keracunan metanol, dan sianida dalam tembakau. Pemeriksaan klinikal dan kajian makmal ke atas darah menyokong diagnosa kekurangan vitamin B12, yang mungkin dimangkinkan lagi oleh metanol dan sianida. Pesakit dirawat dengan vitamin B12 dan asid folinik dan disarankan untuk berhenti merokok dan minum alkohol. Rawatan ini Berjaya memulihkan penglihatan mata kirinya seperti sediakala tetapi tiada peningkatan penglihatan pada mata kanan. Sebagai kesimpulan, diagnosa neuropati optik tembakau-alkohol adalah dibuat secara pengecualian dari kemungkinan penyebab lain. Rawatan juga menunjukkan tindak balas yang pelbagai.

Kata kunci: alkohol, kekurangan vitamin B12, metanol, nutrisi, tembakau

Introduction

Tobacco-alcohol optic neuropathy is caused by toxic exposure and vitamin deficiency. Chronic smokers and drinkers are exposed to toxic substances that can compromise the vascular supply of the optic nerve. Nutritional deficiency acquired after chronic exposure to alcohol and tobacco might aggravate optic neuropathy. It is a disease often diagnosed late, when recovery of vision is not always possible.[1,2] This case presents a patient who was diagnosed early with tobacco-alcohol optic neuropathy after excluding other more common causes of optic neuropathy. Treatment was started but visual improvement was seen only in one eye with no visual improvement in the contralateral eye.

Case report

A 43-year-old man who was an active chronic smoker (40 cigarettes per day for the past 26 years) with no known medical illness presented with sudden onset of bilateral blurring of vision for 1 day. He had been a consuming alcohol regularly for 20 years (5 units per week), with episodes of binge drinking in the last 2 months,

when he drank 10 units of alcohol in each session almost daily. On presentation, visual acuity was counting fingers for the right eye and 6/36 for the left eye. Optic nerve function in both eyes was reduced, with peripheral field loss and right eye central scotoma. Fundus examination showed bilateral pink but swollen optic discs (Fig. 1).

Contrasted computerized tomography of the brain and orbit were unremarkable, without abnormal enhancement. His peripheral blood film revealed mixed normochromic normocytic and macrocytic red cells. Haemoglobin level was 5.9 g/dL. His erythrocyte sedimentation rate was raised (41 mm/hr). Platelet and coagulation profiles were normal. He was initially treated as megaloblastic anaemia. Intramuscular injection of vitamin B was initiated, but there was only minimal visual recovery in the left eye and no improvement in the right eye. His pre-treatment serum vitamin B12 and folate level were later revealed to be normal.

With the advice of abstaining from alcohol and smoking, two weeks later vision in the left eye improved to 6/9, while right eye still showed no improvement. In addition, his optic disc appeared to be less swollen but had turned pale (Fig. 2). Our final diagnosis was bilateral tobacco-alcohol optic neuropathy. Four months later, his vision remained unchanged and the haemoglobin level improved to 9.2 g/dL.

Discussion

Nutritional and toxic optic neuropathies (NTON) represent a group of medical disorders defined by visual disturbances due to optic nerve damage caused by nutritional deficit or toxins. The most common form of NTON is related to the chronic use of alcohol in heavy smokers, known as tobacco-alcohol optic neuropathy.[2]

The mechanism of tobacco-alcohol optic neuropathy remains unclear. However, in animal studies, toxic substances such as methanol show a predilection for the optic nerve. Methanol is an adulterant in illegally produced alcoholic beverages and accumulation of its metabolite, formic acid, can cause the optic disc to become hyperaemic with oedema, followed by optic atrophy, which was seen in this case.[2,3] Other toxic substances chronic smokers and drinkers are exposed to include tobacco, lead, cyanide, and ethanol, which can compromise the vascular supply of the optic nerve and subsequently impair mitochondrial function. Cyanide is present only in small amounts in cigarettes; smoking alone, even in large quantities, rarely causes optic neuropathy. Optic neuropathy normally occurs in malnourished smokers who are also consuming excessive amounts of alcohol.[2,4] Vitamin B12 and folate deficiency acquired from food deprivation after chronic exposure to alcohol and tobacco might trigger or worsen optic neuropathy.[1,2]

Tobacco-alcohol optic neuropathy is a diagnosis of exclusion and a detailed history and ocular examination including colour vision, visual field test, and investigations for serum B12 and folate levels are essential for diagnosis. Neuroimag-

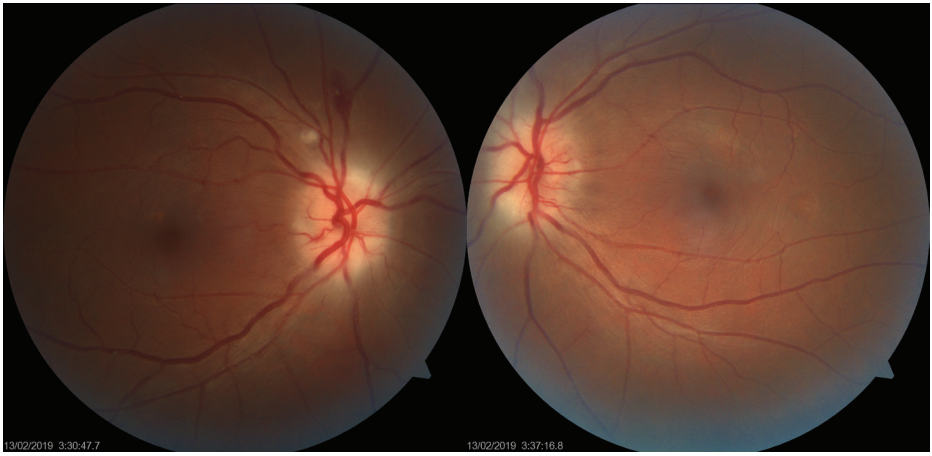

Fig. 1. Fundus images of the right eye (*left*) and left eye (*right*) taken on initial presentation showing bilateral swollen optic discs..

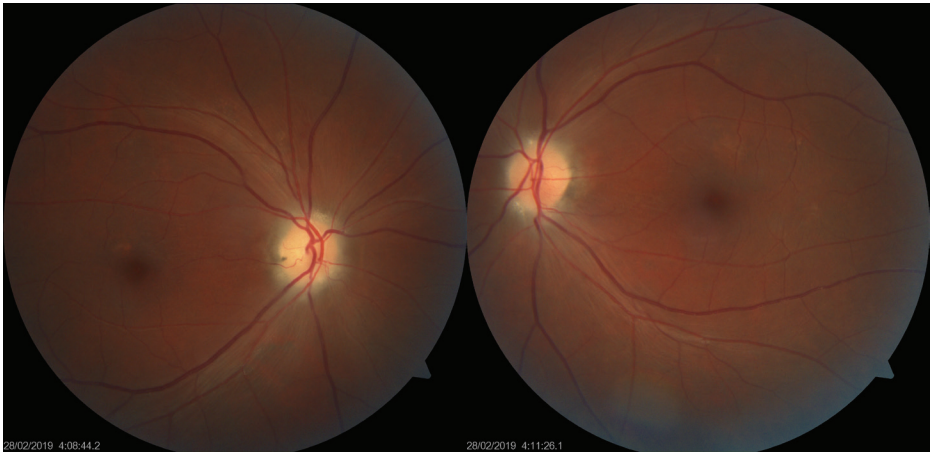

Fig. 2. Fundus images of the right eye (*left*) and left eye (*right*) taken 2 weeks after treatment showing less swollen but pale optic discs.

ing is usually normal but is indicated to rule out a space-occupying lesion causing papilloedema and compressive neuropathy.[1] With relation to this case, both eyes showed reduced optic nerve function and the right eye showed a central scotoma, which is a feature of tobacco-alcohol optic neuropathy. Neuroimaging was normal and blood film showed mixed normocytic and macrocytic anaemia with normal vitamin B12 and folate levels.

Vitamin B12 and folate levels are late, relatively insensitive, and unspecific biomarkers of deficiency.5 Even with normal levels of vitamin B12 and folate,

deficiency is still possible.[5] Increased serum formate levels is a sensitive and specific way to diagnose methanol poisoning, but it was not performed in this patient due to lack of resources.[6] Blood gas will show metabolic acidosis in cases of methanol poisoning but was not done in this case.

The initial treatment of tobacco-optic neuropathy is based on the suspected toxic agent or nutritional deficiency, coupled with abstaining from tobacco and alcohol. Treatment of vitamin B12 deficiency involves administrating intramuscular cyanocobalamin. The patient was given intramuscular cyanocobalamin 1 mg daily for 1 week and then weekly for 10 weeks with full blood count monitoring. For cases of methanol poisoning, treatment includes administration of alcohol dehydrogenase inhibitor (fomeprizole or ethanol) and folinic acid supplementation, which prevent formation of its toxic metabolite and accelerate the metabolism of formic acid, respectively.[3] Alcohol dehydrogenase inhibitor was not given to this patient as he was not showing symptoms of significant acidaemia; however, he was supplemented with folinic acid. Treatment for cyanide poisoning involves administration of parenteral hydroxycobalamin, which chelates cyanide to form cyanocobalamin.[2] The patient was given intramuscular cyanocobalaminn to treat the vitamin B12 deficiency; he did, however, show signs of improvement possibly because of hydroxycobalamin content as high as 30% were found in a vial of cyanocobalamin due to manufacture impurity and action of photolysis.[4]

Tobacco-alcohol optic neuropathy has a variable prognosis and depends on the toxic agent involved, degree of exposure, and visual acuity at presentation.[2] In a retrospective case series describing visual outcomes of 37 patients, 62% of patients had complete recovery, 14% had partial recovery, 14% had complete blindness, and 10% had initial partial recovery followed by deterioration and complete blindness.[7] In this case, the visual recovery was variable for each eye of the same patient despite treatment.

Conclusion

Tobacco-alcohol optic neuropathy is an important cause of optic neuropathy and a diagnosis of exclusion. In presence of a bilateral optic disc swelling with suggestive history and normal imaging of the brain, patients should be initiated with vitamin B12 supplements, folinic acid, and advised to abstain from the likely source of the toxic substance.

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Case report/Case series

Mommy, why can't I see clearly?

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Abstract

Ectopia lentis or crystalline lens subluxation is one of the major criteria to diagnose Marfan syndrome. It may vary from mild lens subluxation to lens dislocation. Herewith is a case report of a 4-year-old autistic boy who had never been diagnosed with Marfan syndrome. He presented to the clinic after his parents noticed he had difficulty focusing on near objects. His bilateral best-corrected visual acuity was 6/60. On examination, there was bilateral lens subluxation superotemporally and lens equator blocking his visual axis. He was sent to the paediatric team and further Marfan workout showed dilated aortic root. He was then diagnosed with Marfan syndrome. He underwent bilateral lens aspiration, anterior vitrectomy, and iris-claw lens implantation. His postoperative bilateral visual acuity on day 1 was 6/30 and his best-corrected visual acuity 3 months after surgery was 6/9 for both eyes. In conclusion, ophthalmologists play an important role in diagnosing and managing Marfan syndrome. Early diagnosis is important to help preserve vision and improve quality of life.

Keywords: ectopia lentis, iris-claw intraocular lens, Marfan syndrome

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Emak, mengapa saya tidak dapat melihat dengan jelas?

Abstrak

Ectopia lentis atau subluksasi kanta adalah salah satu kriteria utama untuk diagnosa sindrom Marfan. Spektrum perubahan pada kanta termasuk subluksasi kanta yang ringan sehingga berlakunya dislokasi kanta. Berikut adalah laporan kes seorang kanak-kanak lelaki autisme berusia 4 tahun yang tidak pernah diketahui mengidap sindrom Marfan. Dia hadir ke klinik setelah ibu bapanya menyedari bahawa dia sukar menumpukan perhatian pada objek berhampiran. Kedua- dua matanya mempunyai ketajaman penglihatan yang terbaik 6/60. Pemeriksaan klinikal menunjukkan subluksasi kanta ke arah superotemporal dan ekuator kanta menghalang paksi penglihatan pada kedua-dua belah matanya. Dia dirujuk kepada pakar pediatrik dan penyiasatan selanjutnya menunjukkan dilatasi pangkal aorta. Berdasarkan bukti ini, diagnosa sindrom Marfan telah dibuat. Pembedahan aspirasi kanta, vitrekomi anterior, dan implantasi kanta iris telah dijalankan ke atas kedua-dua belah mata. Ketajaman penglihatan kedua-dua belah mata mula pulih kepada 6/30 pada hari pertama pasca pembedahan dan terus meningkat kepada 6/9 selepas 3 bulan pasca pembedahan. Kesimpulannya, pakar oftalmologi memainkan peranan penting dalam pengesanan dan perawatan sindrom Marfan. Diagnosis awal adalah penting untuk membantu memelihara penglihatan dan meningkatkan kualiti hidup.

Kata kunci: *ectopia lentis*, kanta intraokular iris, sindrom Marfan

Introduction

Marfan syndrome (MS) is an autosomal dominant genetic connective tissue disorder due to mutations in the fibrillin-1 gene.[1] Fibrillin defects lead to zonular defects, causing subluxated or dislocated lens. Other ocular features of MS are increased axial length, astigmatism, flat cornea, glaucoma, microspherophakia, peripheral retinal degenerations, and retinal detachment.[2]

Early surgical intervention is highly recommended in paediatric patients when there is lens subluxation or dislocation causing visual impairment to ensure early visual rehabilitation and prevent amblyopia.[3]

Case report

A 4-year old autistic boy presented to us after his parents noticed he had difficulty focusing on near objects. At presentation, both eyes had subluxated lens causing significant visual impairment. He was born full term with normal antenatal history. There was no history of squint or headtilt. We report this case due to its clinical significance, given this has been the youngest patient with undiagnosed MS reported to date in Malaysia. Early surgical intervention was done to prevent amblyopia. This is also to ensure he has clear vision to undergo Early Intervention Programme for Autism Spectrum Disorder.[4]

On examination, best-corrected visual acuity (BCVA) in both eyes was 6/60. Both lenses were found to be subluxated superotemporally and the equators were bisecting the visual axis (Fig. 1). The cornea, anterior chamber (AC), intraocular pressure, and fundus were normal. The right eye axial length was 29.61 mm and the

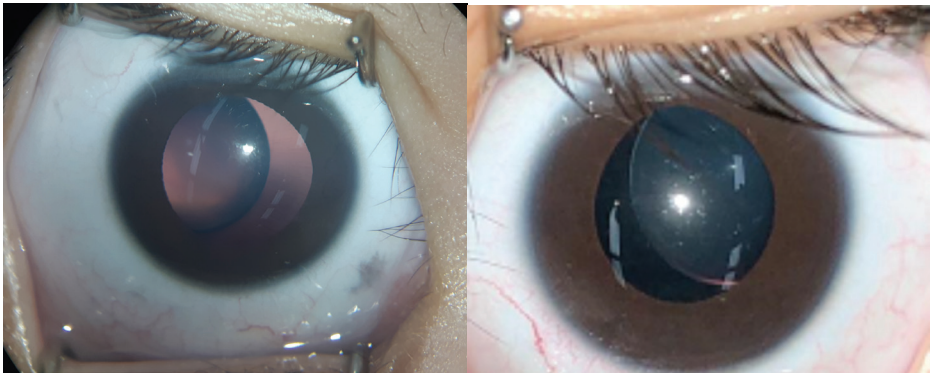

Fig. 1. Right eye (left) and left eye (right) showing both lens subluxated superotemporally.

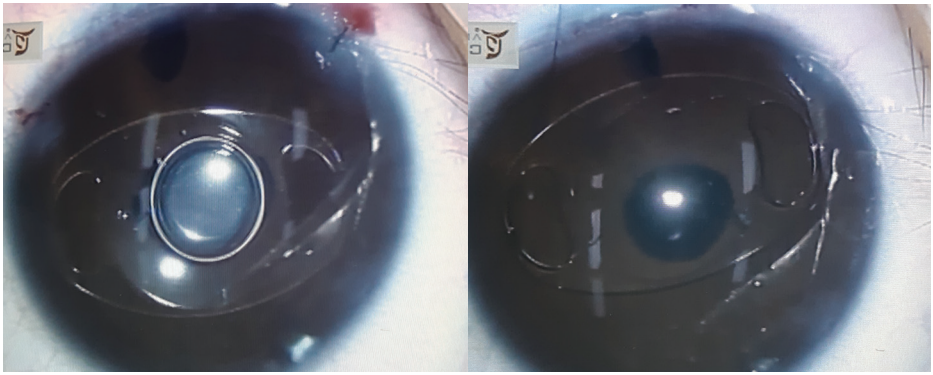

Fig. 2. Right eye (left) and left eye (right) after iris-claw IOL implantation.

left eye axial length was 29.02 mm. Taken together, the findings upon examination arose suspicion of MS. He was referred to a paediatrician for further MS workout. The paediatric team found the aortic root was significant dilated and the diagnosis of MS was confirmed.

He underwent bilateral lens aspiration, anterior vitrectomy, and iris-claw AC intraocular lens (IOL) implantation under general anaesthesia (Fig. 2). The surgical technique was modified to accomodate the subluxated lens. Capsular hooks were used to stabilise the lens centrally for the surgery and an iris-claw Artisan OPHTEC IOL (Groningen, Netherlands) (Table 1) was inserted for visual rehabilitation.

The surgical steps were as follows. Two paracenteses were made at the 2 and 4 o'clock position. The AC was filled with viscoelastic. A scleral tunnel was made superiorly. Continuous curvilinear capsulotomy was performed, and two capsular hooks were used to centralise the lens via the paracenteses. The lens was noted to be microspherophakic. Lens aspiration was done by automated irrigation and aspiration. This was followed by capsular removal and automated anterior vitrectomy. The remaining capsule was removed, as positioning the IOL in this case was not considered safe. An adult Artisan aphakia IOL was used given that the patient's white-to-white diameter was 12 mm. IOL power was +6.0 D and +7.0 D for the right and left eye, respectively. The IOL was implanted after the pupil was pharmacologically miosed and the haptics were enclaved at the 3 and 9 o'clock position. An enclavation needle was used to enclave the haptic via a newly made paracentesis at 11 o'clock for the temporal haptic and via the pre-existing paracentesis at 2 o'clock for the nasal haptic. Peripheral iridectomy was made at 12 o'clock. The scleral tunnel was sutured with nylon 10-0 after viscoelastic removal. Intracameral cefuroxime (1 mg) was given, followed by subconjunctival dexamethasone at the end of the procedure. A similar procedure was done for the left eye. Topical Maxitrol by Alcon (Puurs, Belgium) every 2 hours was started 4 hours after surgery and was gradually tapered down over 2 months. The patient was discharged well 1 day after

Table 1. Dimensions of the Artisan aphakia IOL model 205.

	**Optic**	5.0 mm, biconvex
	Body	5.4 mm
	Overall diameter	8.5 mm

Table 2. Pre- and postoperative BCVA

	Right eye	Left eye
Preoperative BCVA	6/60	6/60
Preoperative refraction	+5.00	+6.00
Postoperative BCVA	6/9	6/9
Postoperative refraction	+0.50/-1.25 x 75	+1.50/-1.75 x 95

BCVA: best-corrected visual acuity

the surgery.

One month post-surgery, examination under anaesthesia revealed a significant amount of astigmatism, therefore all sutures were removed. Eventually, the patient had good postoperative visual acuity and his BCVA and refraction pre- and post-surgery are shown in Table 2. There were no postoperative complications.

Discussion

Almost 50% of patients are diagnosed with Marfan syndrome primarily as part of the evaluation for ophthalmic complaints.[5] *Ectopia lentis* is the most predominant ocular complication of MS.[6] It is also one of the major criteria in diagnosing MS.[7] Subluxation is usually toward the superotemporal direction, but the lens may also dislocate anteriorly, causing pupillary block glaucoma, as well as posteriorly into the vitreous.

Lens extraction with IOL implantation is the best choice for early visual rehabilitation, especially among the paediatric population. Romano *et al.* suggested early surgical intervention in children with subluxated lens, as 50% of their patients developed functional amblyopia despite good conservative management.[3] They noticed amblyopia was worse when the lens was covering the visual axis and the lens edge was 1.3 mm from the centre of the pupil (range of 0.3 to 2.3 mm) or bisecting the visual axis. Kanigowska *et al.* reported that 90% of their patients had marked improvement in vision after lensectomy and IOL implantation.[8]

Anterior chamber IOLs, posterior chamber IOLs with capsular tension ring (CTR), and scleral-fixated IOLs can be implanted, but with longer duration of surgery, higher risk of corneal endothelial cell loss, glaucoma, dislocated IOL and CTR, and retinal detachment.

The Artisan IOL (iris claw) is one of the best options and a good alternative for

inadequate capsular support as it has a good visual outcome, shorter duration of surgery, and lower incidence of intra- and postoperative complications than other types of IOL. It was designed to avoid direct contact with the iris (except at the clamping site), which reduces the risk of iris trauma and inflammation.

Sarioglu *et al.* reported a case where they implanted double Artisan IOL (anterior and posterior) and three years follow up showed preserved corneal endothelial cells, normal intraocular pressure and good visual outcome.[9] Lifshitz *et al.* successfully implanted the Artisan IOL in four paediatric eyes with good visual outcome and without any complications.[10]

Another main advantage of the Artisan IOL is it can be unclipped from the iris with a simple, relatively atraumatic motion and exchanged for a new IOL of appropriate power. It offers a less traumatic IOL exchange procedure as the child grows and refraction changes.

Thus, for this patient, we successfully performed early lens extraction to prevent amblyopia and allow early visual rehabilitation. We chose the Artisan IOL due to its advantages, as outlined above.

Conclusion

Ophthalmologists play an important role in diagnosing MS. Early surgical intervention is highly recommended in paediatric patients with lens dislocation and subluxation to prevent amblyopia.

The Artisan IOL is a safe and effective means for early visual rehabilitation with less complications compared to other IOLs. It is also technically much easier to replace if IOL exchange is needed due to changes in the patient's refraction.

Acknowledgements

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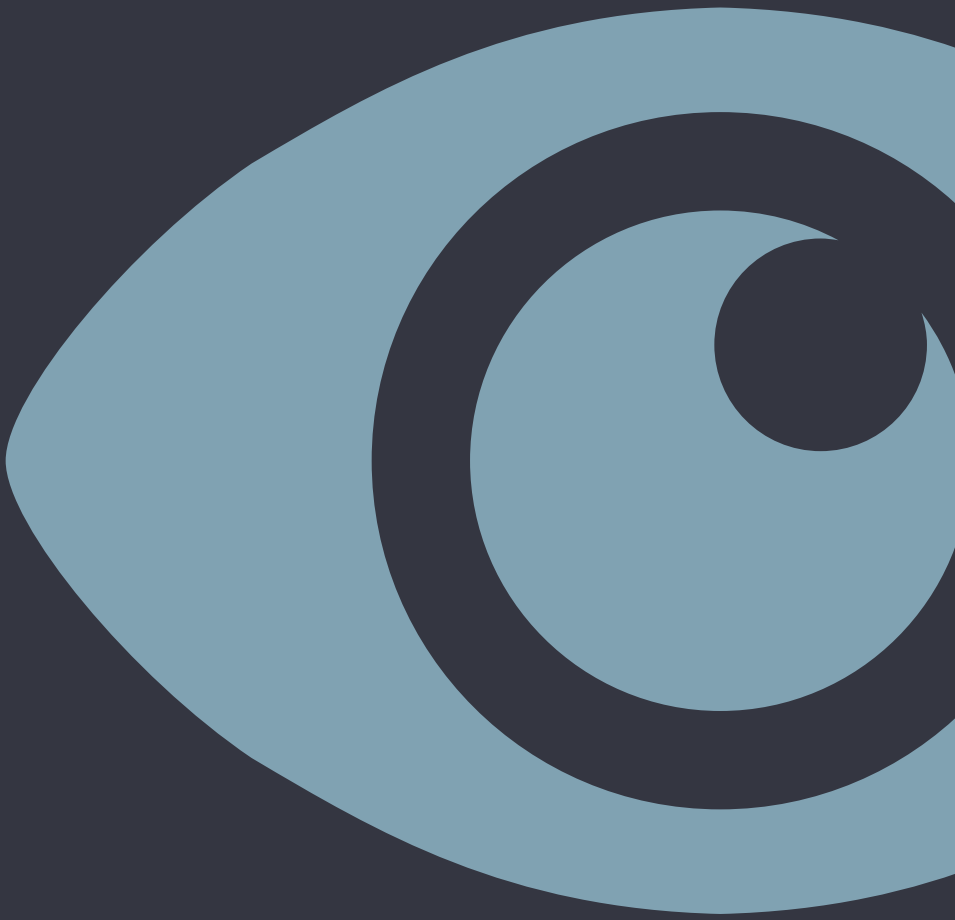

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