Malaysian Journal of Ophthalmology

© Malaysian Journal of Ophthalmology 2019; 3:170-180
Original article

Efficacy of selective laser trabeculoplasty in primary open-angle glaucoma: HKL experience, one-year results

Lim Chuan Chun[1], Jelinar Mohamed Noor[2], Norlina Mohd Ramli[1], Ch'ng Tun Wang[2], Gan Eng Hui[2]

[1]Department of Ophthalmology, University Of Malaya, Kuala Lumpur, Malaysia; [2]Department Of Ophthalmology, Hospital Kuala Lumpur, Ministry Of Health, Malaysia

Abstract

Introduction: Selective laser trabeculoplasty (SLT) has been demonstrated to lower intraocular pressure (IOP) and reduce the number of topical medications used in patients with primary open-angle glaucoma (POAG).
Purpose: The purpose of our study was to investigate the sustainability and efficacy of SLT in treating POAG at one year following laser. To our knowledge, this is one of the first studies to be published based on local data in Malaysia.
Study design: This was a retrospective study conducted in a specialist eye clinic, Hospital Kuala Lumpur, from July 2017 until January 2019. Data was collected from the medical notes of the patients.
Materials and methods: The study recruited cases of POAG patients who were using topical antiglaucoma medications. Inclusion criteria were patients with unilateral or bilateral POAG aged 50 years and above. Exclusion criteria were secondary open-angle glaucoma and all forms of angle-closure glaucoma. Patients who had undergone trabeculectomy or glaucoma drainage devices were excluded in our study. A single session of 360° SLT using a Q-switched Nd:YAG laser with an initial energy of 0.8 mJ was performed. IOP and number of antiglaucoma medications were recorded at prestudy, 1 week, 1 month, 3 months, 6 months, and 12 months.
Results: In 17 eyes, mean prestudy IOP was 19.3 ± 3.3 mmHg while on 2.18 ± 0.7 eye drops. At 12 months after SLT, mean IOP was 13.3 ± 3.5 mmHg while on 1.88 ±

Correspondence: Dr. Lim Chuan Chun
E-mail: chuanchun87@gmail.com

0.9 IOP-lowering eye drops. This represented a 31% reduction of IOP compared to prestudy levels. However, the reduction of number of medications was not statistically significant.
Conclusion: A single session of 360° SLT treatment for POAG patients is able to lower IOP by 31% at one year following laser. SLT is a safe and effective procedure for reducing IOP. It may be used as adjuvant therapy, especially in noncompliant patients; patients who have difficulty applying topical eye drops or who are intolerant to topical medication.

Keywords: intraocular pressure (IOP), primary open-angle glaucoma (POAG), selective laser trabeculoplasty (SLT)

Keberkesanan laser trabeculoplasti khusus dalam glaukoma sudut terbuka utama: pengalaman satu tahun HKL

Abstrak

Pengenalan: Laser trabeculoplasty khusus (SLT) telah menunjukkan penurunan tekanan intraokular (IOP) dan pengurangan bilangan ubat-ubatan topikal yang digunakan pada pesakit dengan glaukoma sudut terbuka utama (POAG).
Tujuan: Tujuan kajian kami adalah untuk mengkaji kemampanan dan keberkesanan SLT dalam merawat POAG dalam satu tahun laser berikut. Dalam pengetahuan kami,kajian ini adalah kajian pertama yang diterbitkan berdasarkan data tempatan di Malaysia.
Reka bentuk kajian: Ini adalah kajian retrospektif yang dijalankan di klinik mata pakar, Hospital Kuala Lumpur, dari Julai 2017 hingga Januari 2019. Data dikumpul dari rekod perubatan pesakit.
Bahan dan kaedah: Kajian ini merekrut kes-kes pesakit POAG yang menggunakan ubat titis antiglaukoma. Kriteria inklusi adalah pesakit dengan POAG sebelah atau dua belah mata dan berusia 50 tahun ke atas. Kriteria pengecualian adalah glaukoma terbuka sudut sekunder dan semua bentuk glaukoma sudut tertutup. Pesakit yang telah menjalani trabeculektomi atau peralatan saliran glaukoma tidak termasuk dalam kajian kami. Sesi tunggal 360° SLT menggunakan Q-switched Nd: YAG laser dengan tenaga awal 0.8 mJ dilakukan. IOP dan bilangan ubat antiglaukoma dicatat pada prakajian, 1 minggu, 1 bulan, 3 bulan, 6 bulan, dan 12 bulan.
Keputusan: Dalam 17 mata, min IOP prestudy adalah 19.3 ± 3.3 mmHg manakala min bilangan botol ubatan titis ialah 2.18 ± 0.7. Pada 12 bulan selepas SLT, Min IOP adalah 13.3 ± 3.5 mmHg manakala paras bilangan ubat titis mata ialah 1.8 ± 0.9.

Ini menunjukkan pengurangan IOP sebanyak 31% berbanding tahap prakajian. Walau bagaimanapun, pengurangan bilangan ubat tidak signifikan secara statistik. *Kesimpulan:* Satu sesi rawatan 360T SLT untuk pesakit POAG dapat mengurangkan IOP sebanyak 31% pada satu tahun selepas laser. SLT adalah prosedur yang selamat dan berkesan untuk mengurangkan IOP. Ia boleh digunakan sebagai terapi tambahan, terutama pada pesakit yang tidak patuhsetia kepada ubatan; pesakit yang mengalami kesukaran menggunakan titisan mata topikal atau yang tidak bertoleransi terhadap ubat topikal.

Kata kunci: tekanan intraokular (IOP), glaukoma sudut terbuka utama (POAG), trabeculoplasty laser terpilih (SLT)

Introduction

Lowering intraocular pressure (IOP) is the mainstay of glaucoma treatment in an attempt to halt the characteristic progressive optic neuropathy and prevent irreversible visual field loss. This goal can be achieved either by medical, laser, or surgical modalities.

The glaucoma laser trial demonstrated that laser trabeculoplasty plays a vital role in glaucoma treatment. The trial proved that initial treatment with argon laser trabeculoplasty (ALT) was at least as efficacious as initial treatment with topical IOP-lowering medication.[1] Selective laser trabeculoplasty (SLT) was approved by the FDA in 2001. It uses a frequency-doubled, Q-switched, 532 nm Nd:YAG laser that is able to deliver a short pulse of 3 ns duration which limits the conversion of energy to heat. The IOP-lowering effect of SLT is mediated through an increase in outflow facility. Transmission electron microscopy has demonstrated that SLT selectively targets pigmented trabecular meshwork cells, results in fracturing of melanin granules and rupturing of lysosomal membranes in the pigmented cells, but spares adjacent tissue from collateral thermal damage.[2]

The efficacy of SLT in patients with primary open-angle glaucoma (POAG) has been demonstrated in various studies. In terms of IOP-lowering effect, SLT is at least comparable to that of topical medications. SLT is a viable treatment option when considering potential local and systemic adverse effects as well as compliance issues associated with long-term topical medication use.[3] The purpose of our study was to investigate the sustainability and efficacy of SLT in treating POAG at one year following laser. To our knowledge, this is one of the first studies to be published based on local data in Malaysia.

Materials and methods

We conducted this retrospective study in the ophthalmology clinic at Hospital Kuala Lumpur from July 2017 until January 2019. This study adhered to the tenets of the Declaration of Helsinki. The authors declared no financial or conflicting interest.

Inclusion criteria were patients with unilateral or bilateral POAG aged 50 years and above. Most of them were intolerant to the local side effects of topical medications, showing conjunctival hyperaemia and allergic reaction to the eye drops. The IOP of all subjects was less than 25 mmHg on topical IOP-lowering agents. All the participants were not listed for any intraocular surgery for at least one year after SLT treatment in order to reduce bias and to observe the IOP trend.

Exclusion criteria were secondary open-angle glaucoma and all forms of angle-closure glaucoma. Patients who had undergone trabeculectomy or glaucoma drainage devices were excluded in our study.

Data was collected from the medical notes of the patients. The prestudy IOP on IOP-lowering medications and the number of IOP-lowering medications were recorded prior to study enrolment. Fixed-combination eye drops were counted as two types of IOP-lowering medications.

Informed consent was taken prior to SLT treatment. The procedures were carried out by two glaucoma specialists in our clinic. We followed the laser treatment protocol as mentioned in Clinical Practical Guidelines of Management of Glaucoma (Malaysia) and Asia Pacific Glaucoma Guidelines (Third edition). We prepared the patients with topical amethocaine local anaesthesia. All patients received a single session of 360° SLT using a Q-switched Nd:YAG laser with an initial energy of 0.8 mJ. The power was titrated up or down until bubble formation was just visible. Both eyes were treated in the same laser session for those with bilateral disease. In all treated eyes, all subjects were given topical prednisolone forte, four times a day for one week.

Subjects returned for follow up at 1 week, 1 month, 3 months, 6 months, and 12 months after SLT treatment. All the subjects were reviewed by glaucoma specialists in our clinic. Antiglaucoma medications were resumed and titrated based on clinical response to achieve target IOP for each individual. The primary outcome included IOP at the following time intervals: 1 week, 1 month, 3 months, 6 months, and 12 months after SLT. Goldmann applanation tonometry was used to measure IOP. The secondary outcome included the number of IOP-lowering medications used at 1 week, 1 months, 3 months, 6 months, and 12 months after SLT.

Definition of success

Complete success of SLT treatment was defined as an IOP reduction of more than 20% at one year after SLT compared to prestudy without any additional IOP -lowering medications.

Statistics

SPSS software version 20 was used for all analyses. Paired sample t-test was used to analyse the primary and secondary outcomes of the study, namely, IOP at prestudy, 1 week, 1 month, 3 months, 6 months, and 12 months after SLT and number of IOP-lowering medications at prestudy, 1 week, 1 month, 3 months, 6 months, and 12 months after SLT, respectively.

A Kaplan-Meier survival curve was used to represent the need for additional topical IOP-lowering medications or the need of performing glaucoma surgery during the study period. All means were expressed as mean ± standard deviation. Statistical significance was defined as a P value less than 0.05.

Results

A total 17 eyes of 10 subjects were recruited for our study. The mean age of the subjects was 69 ± 9.4 years, with 9 male and 1 female subjects. There were 8 right eyes and 9 left eyes (Table 1). The mean pre-study IOP was 19.3 ± 3.3 mmHg while on 2.18 ± 0.7 antiglaucoma eye drops (Table 2, Table 3, Fig. 1, and Fig. 2).

Subjects returned for follow-up on 1 week, 1 month, 3 months, 6 months, and 12 months after SLT. When using the pre-study IOP for comparison, there was significant IOP reduction at all-time intervals at 1 week, 1 month, 3 months, 6 months and 12 months following SLT ($P<0.05$) (Table 2). However, there was no significant difference in the number of IOP lowering eye drops at pre-study as compared to 1 week, 1 month, 3 months, 6 months, and 12 months following SLT ($P > 0.05$)(Table 3).

At 12 months after SLT, the mean IOP was 13.3 ± 3.5 mmHg while on 1.88 ± 0.9 IOP-lowering eye drops (Table 2, Table 3, Fig. 1, and Fig. 2). This represented a 31% reduction IOP as compared to pre-study levels. There was no significant reduction in the number of IOP-lowering eye drops as compared to pre-study levels. At 1 year, complete success was achieved in 58.8% of eyes (Table 4).

During the study period, the mean survival rate of SLT was 76.5% at 1 year after the procedure (Fig. 3). Based on the Kaplan-Meier survival curve, early intervention was carried out for the subjects who did not respond well to SLT treatment in the first three months. Three eyes required additional of topical antiglaucoma medications and one eye of a subject underwent minimally invasive glaucoma surgery, as SLT failed to achieve target IOP. For those subjects who responded well in the first three months, there was no further intervention needed from three months until one year.

Table 1. Demographics of subjects in SLT

		Number
N = 10		
Mean Age (In years)		69 ± 9.4
Age range		48-77
Race		
	Malay	5
	Chinese	4
	Indian	1
Sex		
	Male	9
	Female	1
Laterality		
	Unilateral	3
	Bilateral	7
	Right eye	8
	Left eye	9

Table 2. Mean IOP before and after SLT

	Pre-study (n = 17)	1 week (n = 17)	1 month (n = 17)	3 months (n = 16)	6 months (n = 16)	12 months (n = 16)
Mean IOP (mmHg)	19.3 ± 3.3	16.1 ± 3.7	14.8 ± 2.6	15.1 ± 3.8	14.5 ± 2.6	13.3 ± 3.5
P value		0.003	0.001	0.001	0.001	0.001

Table 3. Mean number of IOP lowering medications before and after SLT

	Pre-study (n = 17)	1 week (n = 17)	1 month (n = 17)	3 months (n = 16)	6 months (n = 16)	12 months (n = 16)
Mean number of antiglaucoma eyedrops	2.18 ± 0.7	2.24 ± 0.6	2.18 ± 0.7	2.12 ± 0.6	1.88 ± 0.9	1.88 ± 0.9
P-value		0.58	1.00	1.00	0.26	0.26

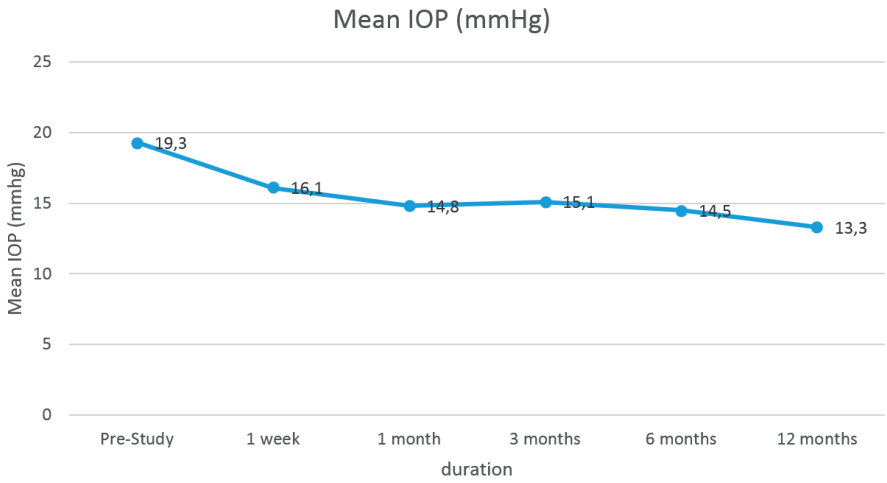

Fig. 1. Changes in mean IOP before and after SLT.

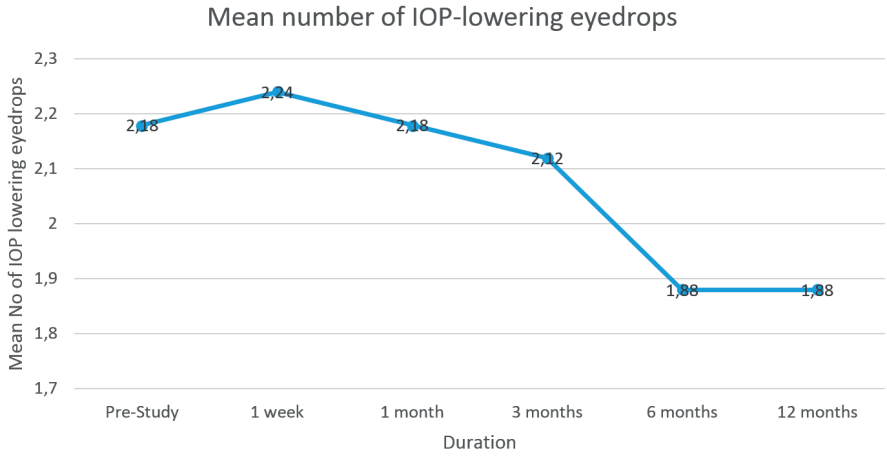

Fig. 2. Changes in mean number of IOP-lowering medications before and after SLT.

Table 4. Comparison of IOP at pre-study and at one year. Mean survival rate and overall success rate

n	IOP at pre-study	IOP at one year	IOP change	IOP change in %	Additional antiglaucoma medications during study period	Success
1	14	18	4	29	No	No
2	20	14	-6	-30	No	Yes
3	18	10	-8	-44	No	Yes
4	18	10	-8	-44	No	Yes
5	19	14	-5	-26	No	Yes
6	18	10	-8	-44	No	Yes
7	11	14	3	27	No	No
8	22	22	0	0	No	No
9	24	14	-10	-42	No	Yes
10	18	12	-6	-33	No	Yes
11	23	16	-7	-30	Yes	No
12	24	16	-8	-33	No	Yes
13	20	11	-9	-45	No	Yes
14	22	10	-12	-54	No	Yes
15	19	10	-9	-47	Yes	No
16	20	11	-9	-45	Yes	No
17	18	*	*	*	*	No
Mean survival rate					13/17 (76.5%)	
Overall success rate						10/17 (58.8%)

* Patient underwent minimally invasive glaucoma surgery implantation at three months after SLT.

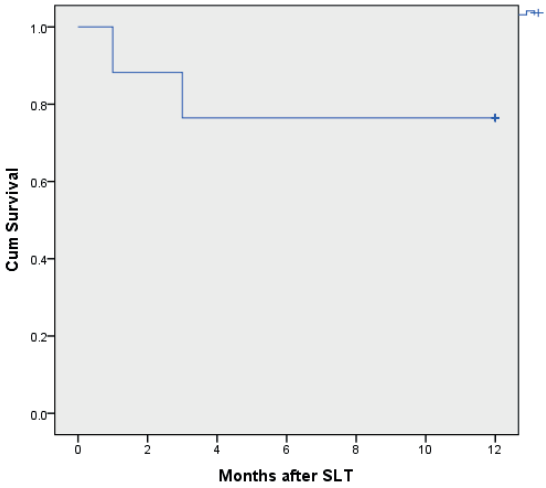

Fig. 3. Kaplan-Meier survival curve following SLT, where mortality = need of additional topical IOP-lowering medications or need of doing glaucoma surgery during the study period.

Discussion

The mainstay of glaucoma therapy involves lowering IOP in order to reduce the rate of glaucoma progression. Eye drops are traditionally the first line of therapy. However, topical agents and its preservatives can produce local and systemic adverse effects.[4] Patients must also tolerate repeat application of drugs and ongoing medical costs.[5] These problems may reduce compliance and adherence to medications.

SLT has been shown to be effective as primary or adjuvant therapy for open-angle glaucoma. Realini demonstrated an immediate and sustained reduction in IOP after SLT therapy in open-angle glaucoma patients that were washed out from all topical medications. Mean IOP reductions ranged from 7.3 to 8.3 mmHg (34.1–38.9%) through 1 year of follow-up.[6] Hence, SLT may be preferred as the first-line therapy or as an alternative treatment when glaucoma patients suffer local adverse effects as well as compliance issues associated with the use of long-term topical IOP-lowering agents.[3]

Based on our study, there was a significant reduction of IOP at 1 week following SLT, followed by a gradual decline in IOP and a plateau from 1 month to 12 months (Table 2, Fig. 1). These findings suggested that the effectiveness of SLT was quite consistent and lasted for up to 12 months after laser. Our study demonstrated that, at 12 months, treated eyes achieved a 31% reduction in IOP as compared to prestudy levels. Most studies define successful SLT treatment as a reduction > 20% in IOP from baseline levels. Our findings were consistent with several studies which

reported more than a 20 % reduction of IOP compared to baseline.[7-10]

Nevertheless, there was no significant difference between the number of medications used before SLT and at 12 months after SLT (P > 0.05)(Table 3, Fig. 2). Our findings were inconsistent with other studies which demonstrated that the number of glaucoma medications were reduced after SLT.[11,12] In our study, mean IOP at 12 months had achieved the target IOP in clinical practice. Hence, the number of medications was maintained.

SLT has been found ineffective in patients who are treated with prostaglandin analogue therapy before SLT,[13] showing a decreased IOP-lowering response following SLT. The diminished effect of SLT on these patients is probably due to fact that both SLT and prostaglandin analogues share common mechanisms of action in decreasing IOP. However, we did not observe this phenomenon in our study. All of our subjects were treated with prostaglandin analogues before SLT and were able to achieve an IOP reduction of 31% at 1 year.

SLT has been shown to be effective in normal-tension glaucoma (NTG), pseudoexfoliation glaucoma (PXFG), and pigmentary glaucoma. SLT produced favourable clinical outcomes in patients with NTG. At 2 years follow-up, there was an 11.5% reduction in IOP and 41.1% reduction in glaucoma medication usage compared with pre-study levels.[14,15] On the other hand, patients with pseudoexfoliation glaucoma who were treated with SLT treatment achieved an IOP reduction comparable to POAG patients at one year follow-up.[16] We did not include other subtypes of open-angle glaucoma in our study to reduce bias.

Our study had limitations. It would have been ideal to avoid using any IOP-lowering medications during the study period in order to observe the IOP-lowering effect of SLT alone. However, patients could have achieved a suboptimal IOP during the study period, putting them at risk of disease progression. We were also limited by heterogeneity of the eyes studied in terms of glaucoma severity. In addition, the timing of IOP measurement was not standardized; thus, diurnal variations of IOP may have influenced the study outcome. For this reason, 24-hour IOP monitoring in future studies would enlighten us on the circadian efficacy of SLT. In addition, a larger sample size and a longer study period would reduce bias and help us better understand the long term effects of SLT.

In conclusion, our study found that a single session of 360° SLT treatment for POAG patients was able to lower IOP by 31% at 1 year following laser. We found no significant adverse effects, pointing toward SLT being a safe and effective procedure for IOP reduction.

Acknowledgements

We would like to thank the Director General of Health Malaysia for his permission to publish article.

References

1. The Glaucoma Laser Trial (GLT) and Glaucoma Laser Trial Follow-up Study. Am J Ophthalmol. 1995;120(6):718-731.
2. Latina MA, Park C. Selective targeting of trabecular meshwork cells: in vitro studies of pulsed and CW laser interactions. Exp Eye Res. 1995;60(4):359–371.
3. Kadasi LM, Wagdi S, Miller KV. Selective laser trabeculoplasty as primary treatment for open-angle glaucoma. R I Med J. 2016;99(6):22–25
4. Baudouin C. Detrimental effect of preservatives in eyedrops: implications for the treatment of glaucoma. Acta Ophthalmol. 2008;86(7):716–26.
5. Li X, Wang W, Zhang X. Meta-analysis of selective laser trabeculoplasty versus topical medication in the treatment of open-angle glaucoma. BMC Ophthalmol. 2015;15:107.
6. Realini T. Selective laser trabeculoplasty for the management of open-angle glaucoma in St. Lucia. JAMA Ophthalmol. 2013;131(3):321–327.
7. Lai JS, Chua JK, Tham CC, Lam DS. Five-year follow up of selective laser trabeculoplasty in Chinese eyes. Clin Experiment Ophthalmol. 2004;32(4):368–372.
8. Nagar M, Ogunyomade A, O'Brart DP, Howes F, Marshall J. A randomised, prospective study comparing selective laser trabeculoplasty with latanoprost for the control of intraocular pressure in ocular hypertension and open angle glaucoma. Br J Ophthalmol. 2005;89(11):1413–1417.
9. Nagar M, Luhishi E, Shah N. Intraocular pressure control and fluctuation: the effect of treatment with selective laser trabeculoplasty. Br J Ophthalmol.2009;93(4):497–501.
10. Bovell AM, Damji KF, Hodge WG, Rock WJ, Buhrmann RR, Pan YI. Long term effects on the lowering of intraocular pressure: selective laser or argon laser trabeculoplasty? Can J Ophthalmol. 2011;46:408–413.
11. Francis BA, Ianchulev T, Schofield JK, Minckler DS. Selective laser trabeculoplasty as a replacement for medical therapy in open-angle glaucoma. Am J Ophthalmol. 2005;140(3):524–525.
12. Klamann MK, Maier AK, Gonnermann J, Ruokonen PC. Adverse effects and short-term results after selective laser trabeculoplasty (SLT). J Glaucoma. 2014;23(2):105–108.
13. Alvarado JA, Iguchi R, Juster R, Chen JA, Shifera AS, From The Bedside to the Bench and Back Again: Predicting and improving the outcome of SLT glaucoma therapy. Trans Am Ophthalmol Soc. 2009;107:167-18114.
14. Lee JW, Ho WL, Chan JC, Lai JS. Efficacy of selective laser trabeculoplasty for normal tension glaucoma: 1 year results. BMC Ophthalmol. 2015;15:1.
15. Lee JW, Shum JJ, Chan JC, Lai JS. Two-year clinical results after selective laser trabeculoplasty for normal tension glaucoma. Medicine (Baltimore). 2015;94(24):e984.
16. Miraftabi A, Nilforushan N, Nassiri N, Nouri-Mahdavi K. Selective laser trabeculoplasty in patients with pseudoexfoliative glaucoma vs primary open angle glaucoma: a one-year comparative study. Int J Ophthalmol. 2016;9(3):406–410.