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Literature Review

Clinical Outcomes of Laser Peripheral Iridotomy in Eyes with Primary Angle Closure Suspect and Primary Angle Closure

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ABSTRAK

Pendahuluan: *Glaukoma primer sudut tertutup merupakan penyebab buta ke dua mata secara permanen. Laser iridektomi perifer merupakan tindakan pencegahan standar pada seseorang yang mempunyai factor predisposisi kelompok sudut tertutup, yang diawali dengan tersangka primer sudut tertutup menuju ke primer sudut tertutup dan berakhir ke glaukoma primer sudut tertutup. Tinjauan pustaka ini menilai hasil laser iridektomi perifer (LIP) pada tekanan intraokular, kedalam bilik mata depan dan luasnya lebar sudut bilik mata depan.*

Metode: *Jurnal dicari melalui komputer yang diunduh dari data dasar MEDLINE di website Pubmed. Kriteria inklusi adalah semua pasien yang mempunyai mata tersangka primer sudut tertutup dan primer sudut tertutup dilakukan laser iridektomi perifer. Jurnal tidak dinilai apabila LIP dilakukan pada glaukoma primer sudut tertutup. Hasil akhir yang dinilai adalah tekanan intraokular (TIO), kedalaman bilik mata depan dan luas dangkalnya sudut bilik mata depan.*

Hasil: *Terdapat 8 jurnal yang akan di nilai. Empat jurnal mengevaluasi pasien tersangka primer sudut tertutup dan 1 jurnal menilai pasien primer sudut tertutup yang dilakukan LIP. Dinilai pula 3 jurnal yang membandingkan antara pasien tersangka primer sudut tertutup dengan pasien primer sudut tertutup paska LIP. Hasil yang didapat adalah setelah dilakukan tindakan LIP, sebagian besar terjadinya turunnya TIO, 5 jurnal melaporkan adanya bilik mata depan yang lebih dalam dan 4 jurnal memperlihatkan bertambah luas sudut bilik mata depan.*

Kesimpulan: *LIP dapat digunakan sebagai profilaksis menghambat perkembangan sudut bilik mata depan menjadi tertutup.*

Kata kunci: *Laser iriedktomi perifer tersangka primer sudut tertutup, primer sudut tertutup, glaucoma primer sudut tertutup.*

ABSTRACT

Background: *Primary angle closure glaucoma (PACG) is a leading cause of bilateral blindness worldwide. Laser peripheral iridotomy (LPI) has been proposed as the standard prophylactic option for patients with the risk of developing the spectrum of disease, from primary angle closure suspect (PACS) to primary angle closure (PAC) then to PACG. We aim to evaluate the effect of LPI on intraocular pressure (IOP), anterior chamber depth (ACD) and angle width, as prophylactic management in PACS and PAC.*

Methods: *Literature search was conducted from MEDLINE database using Pubmed search engine. Inclusion criteria were all studies (interventional and observational) that reported outcomes of LPI on PACS and/or PAC eyes. Exclusion criteria were outcomes of LPI on PACG eyes.*

Results: *There were 8 studies included in this literature review; 4 studies evaluated patients with PACS, 1 study evaluated patients with PAC, while 3 studies had compared between PACS and PAC. Following LPI, majority of the studies showed a decrease of IOP when compared to baseline. While, 5 studies evaluated changes of central ACD and majority of those studies indicated deepening of ACD. Four studies had assessed the angle width changes after LPI that revealed advancement of angle width.*

Conclusion: *The results of this literature review showed that LPI in PACS and PAC eyes showed decrease of IOP within a specified period, the deepening of central ACD and increase of angle width.*

Keywords: *Primary angle closure suspect, primary angle closure, laser peripheral iridotomy*

Primary angle closure glaucoma is a part of chronic primary angle closure (CPAC) spectrum disease. It was divided into 3 groups: primary angle closure suspect (PACS), primary angle closure (PAC) and PACG.[2] The natural course of Primary angle closure suspect eye could be stable or progressing into PAC and development into PACG. In a population-based study of PACS, the 5-year incidence of PAC was 22%, as reported by Thomas et al.[3] This study also reported 28.5% of the PAC subjects had progressed into PACG.

In Asian populations, the prevalence of PACS has been reported to be 1.4-10.1%, while PAC has lower prevalence ranging from 1.4 to 3.1%.[4] Descriptive study by Faiqoh[5] in RSCM Kirana between 2001-2010 also showed similar result in PAC and PACS prevalence which were 47/3203 (1.5%), and 16/3203 (0.5%) respectively.

Treatment of the CPAC spectrum is directed toward 2 goals: eliminating the angle closure component and control any remaining IOP elevation.[6] Laser peripheral iridotomy (LPI) has been proposed as the standard prophylactic option for patients with the risk of developing spectrum of disease, from PACS to PAC and to PACG.[4]

There is no clear evidence demonstrating LPI in preventing acute angle closure or preventing the development of chronic angle closure glaucoma in asymptomatic eyes with narrow angles. A hospital-based study on the course of PACS subjects after LPI revealed that 28% progressed into PAC. Decreasing anterior chamber angle (ACA) was the predictive factor for the progression of PACS to PAC.[7] Moreover, a study on angle closure glaucoma suspects by Wilensky et al[8] reported that 25 (19.5%) patients progressed to angle closure glaucoma after 2.7 years follow-up. This literature review was conducted to summarize the outcomes of LPI that include IOP, ACD and changes of angle width, as prophylactic management for primary angle closure suspect and primary angle closure, in order to prevent the development towards PACG.

MATERIAL AND METHODS

Literature search was conducted from MEDLINE database using Pubmed search engine for articles by entering keywords: primary angle closure suspect, primary angle closure, laser peripheral iridotomy. Only articles in English were selected. Reference lists from the included studies were also checked for potential relevant articles.

Inclusion criteria were all studies (interventional and observational) that reported outcomes of LPI on PACS and/or PAC eyes. Exclusion criteria were outcomes of LPI on PACG eyes. Restriction for publication date was not performed. Studies were dropped out if the full text article could not be accessed.

All studies were then rated based on level of evidence developed by Oxford Center for Evidence-based Medicine Levels of Evidence (Table 1).

Table 1. Oxford Centre for Evidence-Based Medicine 2011 Level of Evidence: Treatment Benefits

Level	Studies
I	Systematic review of randomized trial or n-of-1 trial
II	Randomized trial or observatonal study with dramatic effect
III	Non-randomized controlled cohort/follow up study
IV	Case-series, case-control studies or historical-ly controlled study
V	Mechanism based reasoning, expert opinion

The extracted information included author, year of publication, level of evidence, number of sample, mean subjects' age, sex distribution, and follow-up time. Outcome of this review were IOP, ACD and angle width changes. Articles and results were presented in table form.

Primary angle closure suspect was defined as eyes with greater than 270° of irido-trabecular contact with normal IOP and absence of peripheral anterior synechiae (PAS), disc abnormality, and visual field defect.[6] Primary angle closure was defined as an eye with greater than 270° of irido-trabecular contact with either elevated IOP and/or PAS with normal disc and visual field examinations.[6] Laser peripheral iridotomy was application of neodymium: yttrium-aluminium-garnet (Nd:YAG) laser to create an opening in the peripheral iris.[6]

Measurement outcomes were IOP as measured by applanation tonometer Goldmann or Tonopen® or non-contact air puff tonometry.[6] Central ACD was the distance from posterior surface of the cornea to the anterior surface of the lens along with the perpendicular bisector of the anterior chamber horizontal diameter, which was

a line with its two endpoints placed on each scleral spur in the horizontal image, as measured using anterior segment optical coherence tomography (AS-OCT), A-scan biometry, ultrasound bio-microscopy or pentacam.[9] Angle width is the angle in degrees between a tangent to the peripheral third of the iris, recorded using Shaffer's grading system, assessed by Goldmann gonioscopy.[10] Grade 0, was a closed angle (0°), grade 1 was a very narrow angle (<10°), grade 2 was moderately narrow (10°-20°), grade 3 was moderately open (25°-34°), and grade 4 was wide open angle (35°-45°).

RESULTS

All the reviewed articles were published between 2007 and 2013. Reviewed studies were categorized in the level of evidence I-V. Based on the study design, only one study was a randomized trial and the others were prospective, case series, and retrospective studies with level of evidence II, III or IV. Age distribution was between 50 years old until 66 years old in all of the studies. Follow-up time varies among studies, ranging from 30 minutes until to 2 years. Total subjects in each article ranged from 15 eyes up to 734 eyes.

The mean of initial IOP was ranged from 15 mmHg to 22 mmHg. Most of the reviewed studies used Goldmann applanation tonometry as gold standard tool for IOP measurement, however study by He M et al[12] and Loon-Lee T et al[14] used Tonopen® and non-contact air puff tonometry. The mean intial of IOP in PAC eyes were higher than PACS eyes. Majority of these studies showed a decrease of IOP following LPI when compared to baseline. However, 3 studies specified different conditions. Study by Jiang Y et al[11] in PACS eyes indicated higher IOP after LPI in 1 hour and 2 weeks follow-up time. Cumba RJ et al[2] also reported in PACS eyes in 6 months after LPI with increased IOP. Study by Loon-Lee T et al[14] showed a rise IOP at 30 minutes post LPI in PAC and PACS eyes.

Study by Cumba RJ et al[2] showed 5 eyes (9.09%) with glaucomatous progression during the course of follow-up; two eyes were PACS eyes (8.0% of 25 PAC eyes), and 10% of 30 PAC eyes. One eye demonstrated visual field progression, 2 eyes showed optic disc progression. The mean duration from initial LPI to progression was 28.9±18.3 months.

Table 2. Characteristics data of reviewed studies

No	Author	Year	Study Design	Level of Evidence	Subject (eyes)	Mean Age (years)	Gender	Diagnosis
1	Jiang Y et al[11]	2012	Prospective, randomized controlled trial	II	734	59.5±5.0	609 women (82.9%) 125 men (17.1%)	PACS
2	Cumba RJ et al[2]	2013	Retrospective case series	IV	25	64.6±12.5	34 women (61.8%)	PACS
					30	64.6±12.5	21 men (38.2%)	PAC
3	He Me et al[12]	2007	Prospective intervention al study	III	72	50.0±14.5	52 women (72.2%) 20 men (27.8%)	PACS
4	Esmaeili A et al[10]	2013	Prospective intervention al case series	IV	48	57.0±8.65	36 women (0.75%) 12 men (0.25%)	PACS
5	Yan-yun C et al[13]	2011	Prospective intervention al study	III	21	60.4±6.38	N/A	PACS
					81	60.1±7.13	N/A	PAC
6	Ramani KK et al[7]	2009	Prospective intervention al study	III	82	52.1±10.0	54 women (65.9%) 28 men (34.1%)	PACS
7	Loon-lee T et al[14]	2013	Retrospective study	III	238	63.9±10.9	124 women (75.6%) 40 men (24.4%)	PACS
					85	64.1±11.1	45 women (78.9%) 12 men (21.1%)	PAC
8	Lei K et al[9]	2009	Prospective intervention study	III	15	66.0±5.7	11 women (73.3%) 4 men (26.7%)	PAC

Table 3. Intraocular pressure changes following LPI

No	Author	Subject (eyes)	Diagnosis	Mean IOP (mmHg)		Follow-up Time
				Pre-LPI	Post-LPI	
1	Jiang Y et al[11] (2012)	734	PACS	15.6±2.7	17.5±4.7	1 hour
					15.6±3.4	2 weeks
2	Cumba RJ et al[2] (2013)	25	PACS	16.0±3.0	16.0±3.4	6 months
					15.3±3.9	12 months
		30	PAC	22.0±5.7	18.6±4.7	6 months
					19.0±5.7	12 months
3	He M et al[12] (2007)	72	PACS	14.4±3.0	11.3	2 weeks
4	Esmaeili A et al[10] (2013)	48	PACS	17.86±4.5	16.91±3.55	1 hour
5	Yan-yun C et al[13] (2011)	21	PACS	16.25±4.82	15.24±2.13	1 year
		81	PAC	22.17±10.03	16.18±2.28	1 year
6	Ramani KK et al[7] (2009)	82	PACS	15.77±4.06	14.85±3.65	1 week
					14.52±3.15	6 months
					15.17±3.39	2 years
7	Lei K et al[9] (2009)	15	PAC	17.8±3.3	15.9±3.1	1 week

Study by Ramani KK et al[7] revealed 15 eyes out of 52 eyes (28.9%) developed into PAC with synechial changes. Five eyes developed within 6 months, 4 eyes developed between 6 months and 1 year, 5 eyes between 1 and 1.5 years, and 1 eye developed in 2 years. None had acute angle closure attacks with symptoms or raised IOP within 2 years. No optic disc neuropathy was noticed up to 2 years of follow-up.

Five studies evaluated changes of central ACD after LPI. Most of studies used A-scan biometry as a measurement tool, while study by Lei K et al[9] used anterior-OCT and Ramani KK et al assessed using both ultrasound biomicroscopy (UBM) and A-scan biometry. Result of majority indicated an advancement of central ACD after LPI. On the other hand, two studies by Jiang Y et al[11] and He M et al[12] showed different result which revealed slightly decreasing of ACD after LPI.

Four studies assessed the angle width changes after LPI. Those studies used variety unit of measurement (Shaffer's grading system and angle degrees) and devices. Study by Cumba RJ et al and He M et al used 4 mirrors gonioscopy lens while Ramani KK et al used UBM. Other 4 studies did not evaluate the angle width changes.[9,13,14]

Study by Cumba RJ et al[2] included 25 PACS eyes, 8 eyes had 10^o angle and 17 eyes had 20^o angle. One month after LPI, 8 eyes showed no deepening of angle width, 13 eyes showed deepening of angle width by 10^o and 4 eyes showed deepening of angle width by 20^o. Cumba RJ et al also evaluated 30 PAC eyes with 5 eyes had 0^o angle, 5 eyes had 10^o angle, 18 eyes had 20^o angle, and 2 eyes had 30^o angle. One month following LPI, 8 eyes showed no deepening of angle width, 16 eyes showed deepening of angle width by 10^o and 6 eyes showed deepening of angle width by 20^o.

Meanwhile, study by He M et al[12] revealed that the Shaffer's grade increased in 50 eyes (72.4%), remained unchanged in 14 eyes (20.3%), and decreased in only 5 eyes (7.2%). Study by Esmaeili A et al[10] exhibited an increased of mean Shaffer's degrees in all quadrants. Study by Ramani KK et al[7] also stated that the quadrant with LPI (superior) and quadrant opposite to LPI (inferior) had an increased mean modified Shaffer's grades.

DISCUSSION

Primary angle closure suspect consist of eyes with anatomically narrow angles potentially predisposing to angle closure. This spectrum of disease could develop into chronic primary angle closure glaucoma. The prevalence of angle-closure glaucoma increases with each decade after 40 years of age.[6] All of the reviewed studies also showed similiar age distribution, between 50 years old until 66 years old.

Primary angle closure has been reported 2 to 4 times more common in women than in men, irrespective of race.[15] The increased prevalence of angle closure in women probably reflects the fact that women have shallower anterior chambers.[6]

Laser peripheral iridotomy is accepted world wide as one of the first-line interventions for acute and chronic PACG as well as the treatment of choice for fellow eyes of a person having an acute angle closure attack.[18,19] The major advantage of LPI is that it is noninvasive and can be performed quickly and safely on an outpatient basis, without the attendant risks of invasive surgery.[19] Moreover, LPI has been recorded to reduce the IOP in persons with PAC, in European and Asian populations.[16] The most common complication after LPI is postoperative IOP elevation, which vary in incidence from 5.7% to 40% after an LPI. These transient pressure elevation occurrs most commonly in the first 3 hours after the laser procedure.[14] This condition appeared in study conducted by Loon-lee T et al[14] which showed an increased of IOP about 1-2 mmHg compared to baseline at 30 minutes after LPI.

The difference in the IOP spikes among studies may result partly from different energy used in creating iridotomy. Higher amounts of laser energy may induce a stronger prostaglandin-mediated inflammatory response, and thus cause more active aqueous production. Moreover, based on the photodisruption mechanism of the Nd:YAG laser, more shots of laser applied in the procedure may release more pigment particles from the iris, which could challenge the aqueous outflow facility and could induce IOP elevation.[11]

Study by Jiang Y et al[11] in 734 PACS eyes showed IOP spike in 72 eyes (9.8%) at 1 hour after LPI. The eyes that demonstrated an IOP spike had significantly shallower anterior chamber and more quadrants of the anterior chamber angle with a Shaffer's grade of 1 or less. The total laser energy used was significantly higher in eyes with IOP spike than those without IOP spike. Furthermore, eyes with an IOP spike after LPI needed significantly more shots of laser to achieve patent iridotomies. The peak of IOP elevation after LPI may not necessarily occur at 1 hour after treatment, and it is not certain that the increasing IOP will occur later the same day or at any point before 2 weeks after LPI. This slight IOP elevation was not of clinical significance and was unlikely to induce any glaucomatous damage. However, in the current study, the mean IOP then became slightly decreased to 15.6±3.4 mmHg at 2 weeks after LPI.

Study by Cumba RJ et al[2] revealed a rise in IOP after 6 months post LPI in PACS eyes. This case series demonstrates that LPI alone does not prevent patients from requiring additional treatment or surgery. Seven (28.0%) PACS eyes required additional glaucoma treatment but 13 (52.0%) required cataract extraction. Twenty four eyes with PAC (80.0%) required additional glaucoma treatment after initial LPI.

None of the study subjects from the reviewed studies developed increased IOP, acute attacks, and symptoms related to angle closure. It is presumed that eventhough LPI could prevent an acute attacks, it did not prevent the progression of glaucoma.[20,21]

An ACD of less than 2.5 mm predisposes patients to primary angle closure, whereas most patients with primary angle closure have an ACD of less than 2.1 mm.[15] This condition was compatible with the subjects in this reviewed studies. Most of the subjects have central ACD approximately les than 2.5 mm.

Table 4. Anterior chamber depth changes following LPI

No	Author	Subject (eyes)	Mean Central ACD (mm)		Follow-up Time
			Pre-LPI	Post-LPI	
1	Jiang Y et al[11] (2012)	734	2.54±0.22	2.49±0.20	1 hour
				N/A	2 weeks
2	Cumba RJ et al[2] (2013)	25	N/A	N/A	N/A
3	He M et al[12] (2007)	72	2.05±0.17	2.04	2 weeks
4	Esmaeili A et al[10] (2013)	48	2.06±0.19	2.08±0.19	1 hour
5	Yan-yun C et al[13] (2011)	21	N/A	N/A	N/A
6	Ramani KK et al[7] (2009)	82	2.43±0.37	2.46±0.31	1 week
				2.52±0.35	6 months
				2.46±0.31	1 year
				2.52±0.33	2 years
7	Loon-lee T et al[14] (2013)	238	N/A	N/A	N/A
8	Lei K et al[9] (2009)	15	1.93±0.22	1.97±0.23	1 week

The changes of central ACD after LPI is uncertain. Peripheral ACD usually increases after LPI, in the absence of extensive PAS, whereas the central depth is unchanged. Ultrasonic biomicroscopy studies also demonstrate the same finding: after iridotomy, the angle opens and markedly reduces the appearance of occludability without deepening the central anterior chamber.[6] Five reviewed studies evaluated the changes of ACD.

The exact mechanism for deepening of the central AC is not clear. Dada et al[22] hyposthesized that the obstructed aqueous might find its way into the vitreous and push the lens forward. Decompression of the aqueous with relief of the pupillary block may thus prevent this abberant aqueous movement, relieve the forward pressure on the lens, and resulted in a deepening of the central anterior chamber.

The difference in measurement methods among reviewed studies may play an important role. The most common method for ACD measurement is A-scan ultrasound biometry, which may result in inaccurate values caused by indentation of the cornea and shallowing of the anterior chamber with the probe tip of the ultrasonography device. Study by Jiang Y et al; He M et al; Ramami KK et al used A-scan ultrasound biometry for ACD measurement. This might influence the measurement result.

Majority of the reviewed studies confirmed that the angle width widens after LPI in most treated eyes. However, since Shaffer's gonioscopic grading was subjective, observer bias cannot be excluded as a possible explanation for this finding. It was believed that the widening of the angle due to an overall displacement of the iris after the LPI. Laser peripheral iridotomy equilibrates the pressure between the anterior and posterior chambers. It eliminates the pressure gradient, flattens the iris then allowing

Table 5. Angle width changes following LPI

No	Author	Subject (eyes)	Diagnosis	Angle Width		Follow-up Time
				Pre-LPI	Post-LPI	
1	Jiang Y et al[11] (2012)	734	PACS	N/A	N/A	N/A
2	Cumba RJ et al[2] (2013)	25	PACS	0° : 0 (0%) 10° : 8 (32%) 20° : 17 (68%) 30° : 0 (0%)	0° : 8 (32%) +10° : 13 (52%) +20° : 4 (16.7%)	1 month
		30	PAC	0° : 5 (16.7%) 10° : 5 (16.7%) 20° : 18 (60%) 30° : 2 (6.7%)	0° : 8 (26.7%) +10° : 16 (53.3%) +20° : 4 (16.7%)	1 month
3	He M et al[12] (2007)	72	PACS	Grade 0: 46 eyes	Grade 0: 10 (21.7%) Grade 1: 11 (23.9%) Grade 2: 6 (13.0%) Grade 3: 12 (26.0%) Grade 4: 7 (15.2%)	2 weeks
				Grade 1: 21 eyes	Grade 0: 4 (19.0%) Grade 1: 4 (19.0%) Grade 2: 3 (14.2%) Grade 3: 8 (38.0%) Grade 4: 2 (9.5%)	2 weeks
				Grade 2: 1 eye	Grade 3: 1 (100%)	2 weeks
4	Esmaeili A et al[10] (2013)	48	PACS	Superior: 1.33±0.47° Inferior: 1.79±0.50° Nasal: 1.50±0.50° Temporal: 1.50±0.50°	Superior: 1.87±0.39° Inferior: 2.35±0.56° Nasal: 1.94±0.24° Temporal: 2.00±0.29°	1 hour
5	Yan-yun C et al[13] (2011)	21	PACS PAC	N/A N/A	N/A N/A	N/A N/A
6	Ramani KK et al[7] (2009)	82	PACS	Superior: 0.99±0.75° Inferior: 0.99±0.78°	Superior: 3.18±0.10° Inferior: 3.15±0.96° Superior: 3.00±1.13° Inferior: 2.91±1.12°	1 year 2 year
7	Loon-lee T et al[14] (2013)	238	N/A	N/A	N/A	N/A
8	Lei K et al[9] (2009)	15	N/A	N/A	N/A	N/A

the peripheral iris to fall backward, resulting in a wider angle configuration.[12]

Study about PACS eyes and PAC eyes by Cumba RJ et al[2] revealed that PACS group did much better in terms of IOP control after LPI. In the current study, 7 eyes (28.0%) developed ocular hypertension, requiring additional medical therapy with 2 out of 25 PACS eyes progressing to glaucomatous damage (8.0%). Similiar result was showed by Peng et al[23] study which 9 of 239 PACS (3.8%) eyes progressed into glaucoma. The combined results of these 2 studies indicate that continued observation was warranted for PACS patients treated with LPI. Patients who undergo LPI for CPAC spectrum may require additional intervention for lowering the IOP.

Study by Ang et al[19] found that LPI in the fellow eyes of Asian patients with acute primary angle closure (APAC) is effective as prophylaxis against the development of acute angle closure in the long term. This study shown 71 fellow eyes of patients with APAC (88.8%) having no subsequent rise in IOP during follow-up, with approximately 4 years of follow-up. However, because a small proportion of fellow eyes did experience a rise in IOP within the first year, close monitoring is still advised in the follow-up of fellow eyes of patients with APAC.

CONCLUSION

Laser peripheral iridotomy in PACS and PAC eyes resulted in the lowering IOP, within a specified period. Most of the reviewed studies showed an increase of peripheral ACD and deepening of angle width, despite of the different tools measurement being used. By controlling IOP and anatomical factor (deep ACD and angle width) of patients with PACS and/or PAC eyes, hopefully this could avoid further progression and glaucomatous damage.

REFERENCES

1. Quigley HA, BA. The number of people with glaucoma worldwide in 2010 and 2020. Br J Ophthalmol 2006;90:262-7.
2. Cumba, R et al. Clinical outcomes of peripheral iridotomy in patients with the spectrum of chronic primary angle closure. ISRN Ophthalmology 2013:1-9.
3. Thomas R, PR, Muliyil J, Kumar RS. Five-year risk of progression of primary angle closure to primary angle closure glaucoma: a population-based study. Acta Ophthalmol Scand 2003;81:480-5.
4. Foster PJ, BR, Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys. Br J Ophthalmol 2002;86:238-42.
5. Faiqoh M, AW. Karakteristik pasien di divisi glaukoma poliklinik mata RSCM tahun 2001-2010. 2011;1-18.
6. Stamper, R, Lieberman, M. & Drake in Primary angle-closure glaucoma. United Kingdom: Mosby Elsevier 2009:188-211.
7. Ramani KK, MB, George RJ, Lingam V. Follow-up of primary angle closure suspects after laser peripheral iridotomy using ultrasound biomicroscopy and A-scan biometry for a period of 2 years. J Glaucoma 2009;18:521-7.
8. Wilensky JT, KP, Frohlichstein D, et al. Follow-up of angle closure suspects. Am J Ophthalmol 1993;115:338-46.
9. Lei K, WN, Wang L, Wang B. Morphological changes of anterior segment after laser peripheral iridotomy in primary angle closure. Eye 2009;23:345-50.
10. Esmaeili, A et al. Assessment of the anterior chamber parameters after laser iridotomy in primary angle closure suspect using pentacam and gonioscopy. Int J Ophthalmol 2013;6:680-4.
11. Jiang Y, CD, Foster PJ, He M, Huang S, Aung T, et al. Immediate changes in intraocular pressure after laser peripheral iridotomy in primary angle-closure suspects. Ophthalmology 2012;119:283-8.
12. He M, FD, Ge J, Huang W, Jin C, Lee PS, et al. Laser peripheral iridotomy in primary angle-closure suspects: biometric and gonioscopic outcomes: the Liwan Eye Study. Ophthalmology 2007;494-500.
13. Yan-yun C, L-p. S, Thomas R, Yuan-bo L, Su-jie F, Xia S, et al. Long-term intraocular pressure fluctuation of primary angle closure disease following laser peripheral iridotomy/iridoplasty. Chin Med J 2011;124:3066-9.
14. Loon-lee T, YJ, Nongpiur ME, Jia-tan W, Aung T, Perera SA. Intraocular pressure spikes after a sequential laser peripheral iridotomy for angle closure. J Glaucoma 2013;00:1-5.
15. American Academy of Ophthalmology, A. A. o. O. G. P. American Academy of Ophthalmology; 2010.
16. He M, FP, Ge J, Huang W, Zheng Y, et al. Prevalence and clinical characteristics of glaucoma in adult chinese: a population based study in Liwan District, Guangzhou. Invest Ophthalmol Vis Sci 2006;47:2782-8.
17. Vijaya L, GR, Arvind H, et al. Prevalence of primary angle-closure disease in an urban south indian population and comparison with a rural population: the Chennai Glaucoma Study. Ophthalmology 2008;115:655-60.
18. Chen MJ, CC, Chou CK, et al. The long-term effect of Nd:YAG laser iridotomy on intraocular pressure in Taiwanese eyes with primary angle-closure glaucoma. J Chin Med Assoc 2008;71:300-4.
19. Ang, L, Aung, T & Chew, P. Acute primary angle closure in an Asian population: long-term outcome of the fellow eye after prophylactic laser peripheral iridotomy. Ophthalmology 2000;107:2092-6.
20. Ritch, R. Assessing the treatment of angle closure. Ophthalmology 2003;110:1867-8.
21. Nolan, W, Foster, P, Devereux, J & al, e. Yag laser iridotomy treatment for primary angle closure in East Asian eyes. Br J Ophthalmol 2000;84:1255-9.
22. Dada, T et al. Comparison of ultrasound biomicroscopic parameters after laser iridotomy in eyes with primary angle closure and primary angle closure glaucoma. Eye 2007;21:956-61.
23. Pheng, P, Nguyen, H, Lin, H, Ngunyen, N & Lin, S. Longterm outcomes of laser iridotomy in Vietnamese patients with primary angle closure. Br J Ophthalmol 2011;95:1207-11.