The Comparison of Success Rate in Each Quadrant of Laser Peripheral Iridotomy in Patients with Primary Angle-closure Disease

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Abstract

Background: To find the proper location of LPI based on the success rate in each location regardless of symptoms.

Material and Methods: A retrospective observational study was performed on 57 patients (aged 37-80 years old). All patients were diagnosed with PAC, PACG, or PACS and needed LPI. *P* values for mean/median data were calculated with the use of the Kruskal Wallis Test, for percentages with the use of Fisher's exact test.

Results: The result shows that the location of PI is statistically related to the success rate ($P < .001$) with the highest success rate of 92.9% at the inferotemporal area, the inferonasal area with 83.3% successful rate, and the least successful area at the superotemporal part with 46.8%. The laser power and the number of shots used in different locations of PI are not statistically significant.

Conclusions: The success rate of LPI is the highest in the inferotemporal area. There was no clinical difference in dysphotopsia of each quadrant. Therefore, the inferotemporal quadrant could be an alternative in the location of placing laser peripheral iridotomy.

Conflict of Interest: The author has no financial interest in this study

Keywords: Laser iridotomy, angle closure, angle closure glaucoma, angle-closure suspect, location of LPI, successful rate of LPI

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Introduction

Glaucoma is a progressive optic neuropathy, which in the early stage, structural changes in the optic nerve head (ONH) and/or retinal nerve fiber layer (RNFL) defect are present, followed by peripheral visual field defect (VFD). In the late stage, the central visual field is involved and is irreversible. Thus, early detection of the disease is very crucial.[1-2]

The risk factors of glaucoma can be divided into elevated intraocular pressure (IOP), which is currently the only modifiable risk factor, and non-modifiable risk or inherent determinants.[3] According to a study in Thailand, the mean and median intraocular pressure in Thai population over 50 years old was 13.3 mmHg.[4] The daily fluctuation is between 6-8 mmHg.

Nowadays, the treatment of glaucoma is based on the pathophysiology of glaucoma which includes typically open-angle glaucoma and angle-closure glaucoma. The initial treatment is mainly topical medications to control IOP within an acceptable range. Laser treatment is also used in both first-line management and refractory cases. Laser peripheral iridotomy (LPI) has been the standard initial treatment for angle-closure disease, including PACG, primary angle closure (PAC), and primary angle closure suspect (PACS). LPI is a procedure in which a full-thickness hole is created in the iris to eliminate pupillary block, the main mechanism of angle closure, by allowing the aqueous humor flow from the posterior to anterior chambers through the full-thickness hole.[5]

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After LPI, patients may experience new visual disturbances commonly including blurring, glares, halos, lines, spots, and shadows.[6] Nowadays, there is still no conclusion to the proper location of LPI as the results in each study are controversial.[7-10] The location of LPI is believed cause the symptoms, especially if not covered by the upper eyelid.[7,8] In one study by Weintraub J, the superior or superotemporal area of LPI is found to cause fewer symptoms,[9] while temporal placement is preferred to superior placement in another by Vanessa et al.[10] In the Zhongshan Angle-Closure Prevention Trial, there is no difference in straylight and visual symptoms in totally covered, partially covered and totally uncovered LPI by the eyelid.[11] This concludes that any location of LPI can be related to the new-onset dysphotopsia symptoms with the preferred location at the temporal area.[7,8,10,11]

This retrospective study was designed to find the most successful location based solely on the success rates at different locations of LPI cases done at Thammasat Eye Center, Thammasat hospital, Thailand.

Methods

This study is a retrospective observational study. All LPI cases from 2018 to June 2021 were collected due to limited accessible data before 2018. The inclusion criteria were any Asian patients with dark-colored iris, older than 18 years old, who were diagnosed with angle closure who needed LPI as reported in table 1. All cases with adequate data that met the inclusion criteria were then collected using the case report form. The case report form must not contain name, surname, HN, address, telephone, Identification number, or any identifiers which can link to research participants. Cases with secondary angle closure, previous LPI in other treatment sessions, previous glaucoma surgery, and loss follow-up to treatment more than 2 weeks will be excluded. Regarding the dysphotopsia and other visual symptoms, there was no significant symptom difference in each group of the patient according to the recorded data. Therefore, the symptoms were not included in this study.

This is a pilot study, thus no sample size was calculated. All the data was then analyzed by SPSS version 23.0 to find the proper locations of LPI. The demographic variables were analyzed using descriptive statistics. In analytic statistics, a *P* value < .05 was taken as statistically significant. Categorical data were analyzed by Chi-square test, unless the expected cell < 5 more than 20% then Fisher Exact test will be used. For other continuous data such as laser power and the number of shots, one-way ANOVA was used unless there is a normal distribution of data, The Kruskal Wallis Test will be used instead.

Results

Fifty-seven patients were included ranging from 37-80 years old, both male and female. The mean age was 62.07 years. Forty-one patients had underlying medical conditions while sixteen have at least dyslipidemia, diabetes mellitus, or hypertension (Table 1).

Table 1: General characteristic of patients (n = 57)

	Values (n = 57)	
	n	**%**
Gender		
Female	33	57.9%
Male	24	42.1%
Age (year)		
< 60	19	33.3%
≥ 60	38	66.7%
Mean ± SD	62.07 ± 8.94	
Median (min - max)	64.00 (37 - 80)	

Table 1: General characteristic of patients (n = 57) (Continue)

	Values (n = 57)	
	n	**%**
Underlying medical conditions		
no	41	71.9%
yes	16	28.1%
DLP	1	1.8%
DM	3	5.3%
HT	4	7.0%
HT DLP	7	12.3%
HT DM DLP	1	1.8%

One hundred treated eyes were studied, including fifty-two left eyes (52.0%) and forty-eight right eyes (48%). Different locations of LPI were observed and classified as four quadrants including 12% inferonasal, 28% inferotemporal, 13% superonasal, and 47% superotemporal. Each patient was diagnosed with either PAC, PACG, or PACS with a different VA. Seventy-seven eyes have an initial IOP exam lower than 21 while twenty-three eyes have a higher or equal IOP to 21.

Table 2: Treatment (n = 100)

	Values (n = 100)	
	n	**%**
Study eye		
Left	52	52.0%
Right	48	48.0%
Location of PI		
inferonasal	12	12.0%
inferotemporal	28	28.0%
superonasal	13	13.0%
superotemporal	47	47.0%
O'clock		
1	7	7.0%
2	22	22.0%
4	14	14.0%
5	10	10.0%
7	7	7.0%
8	9	9.0%
10	24	24.0%
11	7	7.0%
VA		
20/20	19	19.0%
20/30	32	32.0%
20/40	21	21.0%
20/50	8	8.0%

Table 2: Treatment (n = 100) (Continue)

	Values (n = 100)	
	n	**%**
VA		
20/60	4	4.0%
20/70	7	7.0%
20/100	1	1.0%
20/200	2	2.0%
10/200	2	2.0%
5/200	1	1.0%
HM	1	1.0%
PL	2	2.0%
Diagnosis		
PAC	29	29.0%
PACG	46	46.0%
PACS	25	25.0%
IOP initial exam		
≤ 21	77	77.0%
> 21	23	23.0%
Mean ± SD	18.89 ± 9.16	
Median (min - max)	16.00 (80 - 053)	
Cornea (clear)	100	100.0%
Lens (phakic)	100	100.0%
Iris (no NV)	100	100.0%
Fundus		
0.3	7	7.0%
0.4	9	9.0%
0.5	17	17.0%
0.6	23	23.0%
0.7	14	14.0%
0.8	17	17.0%
0.9	13	13.0%
Med		
none	30	30.0%
brimonidine bid	25	25.0%
brimonidine bid, timolol bid	10	10.0%
brimonidine bid, latanoprost hs	2	2.0%
dorzolamide/timolol bid	5	5.0%
dorzolamide/timolol bid, brimonidine bid	2	2.0%
dorzolamide/timolol bid, latanoprost hs, brimonidine bid	9	9.0%
timolol hs	7	7.0%
latanoprost hs	3	3.0%

Table 2: Treatment (n = 100) (Continue)

	Values (n = 100)	
	n	**%**
Med		
latanoprost hs timolol bid	4	4.0%
latanoprost hs, timolol bid, brimonidine bid	2	2.0%
brimonidine/brinzolamide tid, lumigan/timolol od	1	1.0%
IOP post LPI		
≤ 21	94	94.0%
> 21	6	6.0%
Mean ± SD	14.7 ± 5.67	
Median (min - max)	14.0 (9 - 48)	
Follow up duration		
1 week	31	31.0%
2 weeks	20	20.0%
3 weeks	37	37.0%
4 weeks	12	12.0%
Laser power		
1.5	1	1.0%
1.8	1	1.0%
2.0	11	11.0%
2.5	31	31.0%
2.7	2	2.0%
2.8	3	3.0%
3.0	26	26.0%
3.5	14	14.0%
3.6	2	2.0%
4.0	4	4.0%
4.5	5	5.0%
Mean ± SD	2.89 ± 0.64	
Median (min - max)	3.00 (1.5 - 4.5)	
Number of shots		
Mean ± SD	11.09 ± 7.29	
Median (min - max)	10.00 (2 - 35)	
No. of session		
1	67	67.0%
2	31	31.0%
3	2	2.0%
Success (No. of session = 1)		
Yes	67	67.0%
No	33	33.0%

Table 3: Successful rate of LPI at different quadrants using different laser power and number of shots (n = 100)

	Location of PI								
	Inferonasal (n = 12)		Inferotemporal (n = 28)		Superonasal (n = 13)		Superotemporal (n = 47)		*P* value
	n	%	n	%	n	%	n	%	
Success (No. of session = 1)									< .001*
Yes	10	83.3%	26	92.9%	9	69.2%	22	46.8%	
No	2	16.7%	2	7.1%	4	30.8%	25	53.2%	
Laser power									.132
Mean ± SD	3.18 ± 0.73		2.96 ± 0.73		2.99 ± 0.47		2.75 ± 0.59		
Median (min - max)	3.00 (2.0-4.5)		2.85 (1.8-4.5)		3.00 (2.0-3.6)		2.50 (1.5-4.5)		
Number of shots									.342
Mean ± SD	11.92 ± 7.10		10.89 ± 8.59		8.23 ± 5.34		11.79 ± 6.98		
Median (min - max)	12.50 (4.0-20.0)		8.00 (3.0-35.0)		8.00 (2.0-20.0)		10.00 (3.0-30.0)		
Success (IOP initial exam ≤ 21)									.002*
Yes	8	100%	20	90.9%	7	70.0%	19	51.4%	
No	0	0%	2	9.1%	3	30.0%	18	48.6%	
Success (IOP initial exam > 21)									.034*
Yes	2	50.0%	6	100%	2	66.7%	3	30.0%	
No	2	50.0%	0	0%	1	33.3%	7	70.0%	
IOP change (n = 30)**	(n = 3)		(n = 10)		(n = 5)		(n = 12)		-
Decrease	3	100%	9	90.0%	3	60.0%	7	58.3%	
Not change		-	1	10.0%		-	2	16.7%	
Increase		-		-	2	40.0%	3	25.0%	
Mean ± SD	4.33 ± 3.06		2.60 ± 1.96		0.40 ± 2.30		0.83 ± 2.72		-
Median (min - max)	5.0 (1 - 7)		2.0 (0 - 7)		2.0 (-3 - 2)		1.0 (-3 - 6)		

P values for mean/median data were calculated with the use of the Kruskal Wallis Test, for percentages with the use of Fisher's exact test,

* Significant at the 0.05 level

**IOP change = initial IOP- post-LPI IOP in the group with no medication (n = 30)

The location of PI is statistically significant to the success rate ($P < .001$) with the highest success rate of 92.9% at the inferotemporal area, the inferonasal area with 83.3% successful rate, and the least successful area at the superotemporal part with 46.8%. The laser power and the number of shots used in different locations of PI are not statistically significant.

When comparing the mean of laser power used at four different locations of PI (Laser power used in the inferonasal area has the mean of 3.18 ± 0.73 J, Inferotemporal area 2.96 ± 0.73 J, Superonasal area 2.99 ± 0.47 J and Superotemporal area 2.75 ± 0.59 J). The study shows no difference in the mean of laser power with $P = .132$.

When comparing the number of shots used at 4 different locations of PI (Laser power used in the inferonasal area has the mean power of 11.92 ± 7.10 J, Inferotemporal area 10.89 ± 8.59 J, Superonasal area 8.23 ± 5.34 J and Superotemporal 11.79 ± 6.98 J) The study shows no difference in the number of shots with $P = .342$.

In cases with initial IOP ≤ 21, the successful rate with PI at 4 different locations has a *P* value of .002. The highest success rate is 100% in the inferonasal area, 90.9% in the

inferotemporal area, and the lowest rate of 51.4% in superotemporal area.

In cases with initial IOP > 21, the successful rate with PI at 4 different locations has a *P* value of .034. The Inferotemporal area has the highest success rate of 100%, then superonasal 66.7%, inferonasal 50%, and superotemporal 30.0%.

In the group with no medication, thirty eyes were observed. However, the *p*-value was not analyzed as the samples were inadequate. There was a 100% IOP reduction with LPI at the inferonasal area, 90% at the inferotemporal area, 60% at the superonasal area and 58.3% at the superotemporal area. The highest mean reduction of IOP is at the inferonasal area, 5.0 (1-7), while the least reduction is at the superotemporal area with a mean of 1.0 (-3 - 6).

The overall success rate of each location is as follows; 92.9% inferotemporal, 83.3% inferonasal, 69.2% superonasal, and 46.8% superotemporal. (Figure 1)

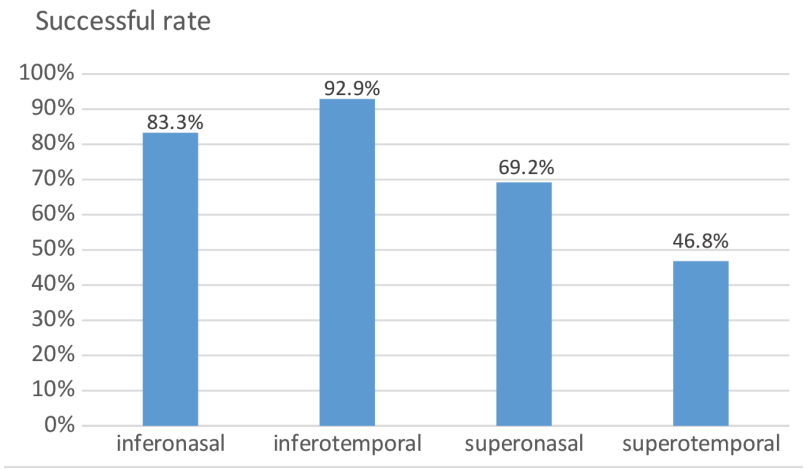

Figure 1: Successful rate at different location of LPI

Table 4: Comparing IOP in each groups of patients with no medication

Diagnosis	n	Initial IOP		Post-LPI IOP		IOP change	
		Mean	SD	Mean	SD	Mean	SD
PAC	12	15.92	2.50	13.83	3.21	2.08	3.42
PACG	4	11.50	3.00	11.25	1.89	0.25	1.26
PACS	14	14.79	1.81	13.00	1.80	1.79	2.12
		P = .041*		*P* = .209		*P* = .262	

P values from the Kruskal Wallis Test, * Significant at the 0.05 level

The IOP change was compared in groups of patients with no medication. The PACG patients have a significant reduction of IOP (*P* = .041) compared to PAC and PACS patients. While PAC and PACS patients rarely have no reduction in IOP. (Table 4)

There is no significant IOP reduction (*P* = .209) and IOP change (*P* = .262) after LPI between the three groups.

Discussion

The best proper location of LPI is still controversial regarding its effect of causing dysphotopsia. The recent study shows no nuance in dysphotopsia in different locations of LPI with preferred location on the temporal area.[7,8,10,11] Therefore, this study aims to find the location with the highest success rate of LPI treatment regardless of symptoms. According to the result,

the location of LPI is significantly related to the success rate. The highest success rate of LPI is at the inferotemporal area with 92.9 percent, while another area has 83.3 percent (inferonasal), 69.2 percent (superonasal), and 46.8 percent (superotemporal) of the success rate. Laser power and the number of shots were not related to the successful rate statistically. Most of the studies did not base their decision on the treatment of LPI on the location but on symptoms and thickness of the area.[6-12] The selection of the location of LPI based on the quadrant may not be applicable to all patients as there are many factors involved. In one recent study, using pretreatment ASOCT scans was superior to ophthalmologists in predicting the success of LPI for PACS eyes.[13] However, ASOCT is only available in medical schools, and some large governmental and private hospitals in Thailand. Therefore, it is not always practical to use ASOCT to find the proper location of LPI. The number of shots and Power used in each location does not affect the success rate which correlates with the previous study.[10] There was no difference in visual symptoms and dysphotopsia in each group of patients according to the recorded data. Therefore, the symptoms were not taken into analysis.

The main limitations of the study was its retrospective design, and a relatively small sample size. In the future studies with a larger sample size could be involved to help determine subgroup analysis. It is also important to appreciate other factors which may affect the decision in the location of LPI treatment such as the thickness of the iris by observation or ASOCT which is more precise.[12] From the study review, there was no previous research on the location of LPI and successful rate.

Conclusion

According to the author's study, the highest success rate of LPI is at the inferotemporal, inferonasal, superonasal, and superotemporal areas respectively. There was no clinical difference in dysphotopsia, and therefore, was not analyzed statistically. The location of LPI can be either fully covered, partially covered, or totally uncovered by the eyelid. The most preferred location due to the highest success rate with no significant clinical difference in visual symptoms is inferotemporal. However, the study is a retrospective study and the sample size is small, a further study with a prospective manner and a larger number is recommended.

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