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## Accommodation Amplitude Before and After Laser-assisted in Situ Keratomileusis (LASIK) in Myopic Patients

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### ABSTRACT

**Introduction:** Laser-assisted in situ keratomileusis (LASIK) is the most common refractive surgery to treat myopia. One of the most common complain after this procedure is blurry near-vision. This study was aimed to evaluate the role of accommodation amplitude (AA) in myopic patients before and after LASIK and its effect to blurry near-vision in myopic patients after LASIK. **Methods:** Patients with myopia who underwent LASIK procedure in Sriwijaya Eye Center Hospital from January to February 2018 studied prospectively. AA was assessed before and after LASIK with 1 day, 1 week and 1 month. Myopia degree, intraocular pressure (IOP), age, gender, ablation and corneal profile were also assessed. **Results:** A total 52 eyes from 32 patients were included. Visual acuity (VA) of all sample were significantly improve in 1 day after LASIK (p 0,001). Mean AA in myopic patients before LASIK 9,25 D and AA 1 day after LASIK were all significantly decrease into 9,00D (p 0,012) which can cause in blurry near- vision after LASIK. In 1 month followed- up, mean AA is significantly improved into 11,00 D (p 0,000) with no complain. Other factor that affect the changing AA were corneal cell density (CD), IOP and AA before LASIK. **Conclusions:** There is significant AA difference in myopic patients before and after LASIK. Blurry near-vision after LASIK is caused by AA adaptation mechanism after LASIK.

### 1. Introduction

Myopia is one of the most common eye refractive disorders. In recent years, incidents based on population-based prevalence studies illustrate an increase in the incidence of myopia.<sup>1</sup> The rate of loss of obstruction due to myopia is expected to increase sevenfold from 2000 to 2050, with myopia being the main cause of permanent blindness worldwide.<sup>2</sup> Myopia is due to the strength of refraction exaggeration that does not match the axial length of his eyeballs.<sup>3</sup>

Increasingly each year, many therapies have been suggested to prevent or slow the progression of myopia. Accommodation is a basic mechanism in the progression of myopia, so optical correction with the use of bifocal or multifocal glasses when doing work at close range has been recommended to reduce the progression of myopia. Recently,

LASIK has become the most commonly performed refraction correction procedure because of its proven stability and effectiveness, but some patients complain of blurred vision and tired eyes when they look closely after LASIK.<sup>4-5</sup>

Accommodation is considered to be associated with the complaint, because LASIK causes a state of emmetropia in patients who were previously myopia, so that the increased accommodation capability needed to look closely is needed. Several methods can be used to measure the amplitude of accommodation, but the ciliary muscle contractions when accommodation is unknown.<sup>6-8</sup>

Several previous studies stated that complaints after LASIK action that often arises is vision that is still blurry and blurred and eyes get tired quickly (asthenopia).<sup>6-8</sup> This needs to be considered

whether the complaint arises due to changes in the ability of accommodation in patients who have done LASIK by measuring the amplitude of accommodation in patients before and after LASIK. The study examined the amplitude of accommodation in patients just before LASIK and 1 week after LASIK.

While there is no mention of differences in the amplitude of accommodation in patients before LASIK and 1 day after LASIK to see whether this action has a significant impact on the ability of patient accommodation.<sup>6-8</sup> Based on this background, researchers want to know the difference in accommodation capability by measuring the amplitude of accommodation before and after LASIK was performed in myopia patients followed by 1 day before and 1 day, 1 week value of differences in the amplitude of accommodation before and after LASIK in myopia patients at Sriwijaya Eye Center Palembang.

## **2. Methods**

This study uses a prospective study method to determine the amplitude comparison of accommodation before and after the LASIK action over a 2-month period at Sriwijaya Eye Center Palembang. This research will be conducted at Sriwijaya Eye Center Palembang. The entire implementation time starts from January to February 2018. The target population is all myopic patients who seek treatment at the Sriwijaya Eye Center from January to February 2018 and affordable population is all eyes of myopia sufferers who performed LASIK at the Sriwijaya Eye Center from January to February 2018. The parameters of the accommodation amplitude before and after LASIK are unknown, so the researchers decided to use the pilot study method and determined a temporary sample size of at least 30 eyes. After the research is done, the results of the sampling will be adjusted to the analysis of the pilot study.

The exclusion criteria were patients with myopia who performed LASIK at the Sriwijaya Eye Center Palembang, aged over 18 years - 40 years, and willing to participate in the research by signing

an informed consent letter. The exclusion criteria were myopia patient with other abnormalities in the cornea, lens, retina, macula and optic nerve, amblyopia, glaucoma, history of eye surgery, long-term use of drugs that can affect the vision, and systemic disorders.

We performed a sharp examination of vision with Snellen chart, then corrected the best sharp vision with the spherical method using a trial lens. Patients with correction of spherical minus lens, cylindrical minus and both. The results of a sharp vision check with Snellen chart were then converted in logmar form.

Ophthalmologic examination with slit lamp and posterior segment examination with direct funduscopy. If the patient has other abnormalities in the anterior and posterior segments, then the patient is excluded. A wavefront, corneal topography and pachimetry analysis are examined to ensure that the patient is eligible for LASIK.

Examination of the accommodation amplitude is done by trial lens, trial frame and jegger card in each eye with the best correction 1 day before surgery at the time of follow-up, accommodation amplitude was checked again 1 day, 1 week and 1 month after LASIK All examination results are recorded and then analyzed as research results.

## **3. Results**

In all, 52 eyes were collected from 32 patients. For all numerical data normality testing is performed using Shapiro Wilk. If the data is normally distributed, then it is presented as an average  $\pm$  standard deviation and using parametric statistical tests (correlation). If the data is not normally distributed then the data is presented in the form of a median (minimum- maximum) and uses a non- parametric statistical test (Wilcoxon). Patients participating in this study were aged between 18-26 years with an average age of 20.06  $\pm$  2.01 years. Most with age <20 years (53.1%). Most of the patients were male, as many as 26 people (81.25%) while women were only 6 people (18.75%).

Of the 32 patients (52 eyes) who participated in

this study, an analysis of 28 right eyes (53.8%) and 24 left eyes (46.2%). The distribution of the degree of myopia for each eye is listed in Table 1. In general, the most common were mild myopia in 31

eyes (59.6%), moderate myopia in 19 eyes (36.5%) and severe myopia in only 2 eyes (3, 8%). There was no difference in the degree of myopia between the right eye and the left eye ( $p = 0.982$ ).

Table 1. Frequency distribution of degrees of myopia in the right and left eye.

|                  |          | Eye         |             | Total       |              |
|------------------|----------|-------------|-------------|-------------|--------------|
|                  |          | OD          | OS          |             |              |
| Degree of myopia | Mild     | 17<br>32.6% | 14<br>26.9% | 31<br>59.6% | (p = 0.982)* |
|                  | Moderate | 10<br>19.2% | 9<br>17.3%  | 19<br>36.5% |              |
|                  | Severe   | 1<br>1.9%   | 1<br>1.9%   | 2<br>3.8%   |              |
| Total            |          | 28<br>53.8% | 24<br>46.2% | 52          |              |

\*Chi-square test

Research subjects with mild myopia found as many as 25 eyes (48.1%) were male and 6 eyes (11.5%) were female. Whereas severe myopia found 2 eyes (3,8) in male research subjects. The

frequency distribution of myopia degrees by gender can be seen in table 2. There was no difference in the degree of myopia with gender in this study ( $p = 0.446$ ).

Table 2. Frequency distribution of myopia degrees by gender

|                  |          | Eye        |             | Total      |              |
|------------------|----------|------------|-------------|------------|--------------|
|                  |          | OD         | OS          |            |              |
| Degree of myopia | Mild     | 25 (48.1%) | 6 (11.5%)   | 31 (59.6%) | (p = 0.446)* |
|                  | Moderate | 13 (25%)   | 6 (11.5%)   | 19 (36.5%) |              |
|                  | Severe   | 2 (3.8%)   | 0           | 2 (3.8%)   |              |
| Total            |          | 40 (76.9%) | 12 (23.1 %) | 52         |              |

\*Anova test

Table 3. Frequency distribution of myopia degrees by age

|                  |          | Age Group   |             |           | Total       |              |
|------------------|----------|-------------|-------------|-----------|-------------|--------------|
|                  |          | <20 y/o     | 20-25 y/o   | > 25 y/o  |             |              |
| Degree of myopia | Mild     | 16<br>30.7% | 15<br>28.8% | 0         | 31<br>59.6% | (p = 0.204)* |
|                  | Moderate | 7<br>13.4%  | 10<br>19.2% | 2<br>3.8% | 19<br>36.5% |              |
|                  | Severe   | 0           | 2<br>3.8%   | 0         | 2<br>3.8%   |              |
| Total            |          | 23<br>44.2% | 27<br>51.9% | 2<br>3.8% | 52          |              |

\*Chi-square test

From table 3, it can be seen that mild myopia mostly occurs in study subjects with age below 25 years, namely 16 eyes (30.7%) while those under

20 years of age and 15 eyes (28.8%) at 20-25 years. From the analysis it was found there was no difference between the degree of myopia and age in

this study (p = 0.204).

In patients, several parameters were measured before LASIK was performed as a condition for the patient's eligibility to do LASIK. Some of the parameters measured include visual acuity, intraocular pressure (IOP), corneal thickness (CT),

corneal cell density (CD) as well as the zone and depth of ablation that will be performed at the time of LASIK to achieve the specified refraction target. Data and the mean of some pre-LASIK parameters on the subject of this study are listed in table 4.

Table 4. Pre-LASIK parameters

| Parameter                    | Amount | Min  | Max   | Mean    | Std.    |
|------------------------------|--------|------|-------|---------|---------|
| Corneal Thickness            | 52     | 490  | 627   | 536.58  | 27,920  |
| Corneal cell density         | 52     | 2073 | 3223  | 2662.15 | 267,021 |
| Ablation zone                | 52     | 5.75 | 6.00  | 59856   | .088886 |
| Depth of ablation            | 52     | 13   | 140   | 54.08   | 29,824  |
| Sharp of vision              | 52     | .18  | 1.52  | 9027    | .41348  |
| Intraocular pressure (IOP)   | 52     | 11   | 21    | 16.42   | 3019    |
| Accommodation amplitude (AA) | 52     | 4.50 | 14.75 | 9.5423  | 2,82928 |

In this study the LASIK procedure only applied 2 ablation zones, most of which were 6 mm ablation zones with 49 eyes (94.2%) and 5.75 mm ablation

zones with only 3 eyes (5.8%). The average accommodation amplitude before LASIK was 9.54 D and the mean visual acuity before LASIK was 0.9.

Table 5. Distribution and relationship of degree of myopia with intraocular pressure and accommodation amplitude

| Parameter | Degree of myopia | Mean      | Std. Deviation | Min  | Max   | P-value * |
|-----------|------------------|-----------|----------------|------|-------|-----------|
| IOP       | Mild             | 16.10     | 3.24           | 11   | 21    | .382      |
|           | Moderate         | 16.68     | 2.68           | 12   | 21    |           |
|           | Severe           | 7:00 p.m. | 0.00           | 19   | 19    |           |
| A A       | Mild             | 9.06      | 2.45           | 5.25 | 12.75 | 0.003     |
|           | Moderate         | 10.84     | 2.79           | 6.25 | 14.75 |           |
|           | Severe           | 4.62      | 0.17           | 4.50 | 4.75  |           |

\* ANOVA test.

Table 5 explains the distribution and relationship of the degree of myopia to intraocular pressure and the amplitude of accommodation in the study subjects prior to LASIK. The mean intraocular pressure in study subjects with mild and moderate myopia ± 16 mmHg, while in severe

myopia it reached 19 mmHg. But from the ANOVA test it was found that there was no significant difference between intraocular pressure and the degree of myopia (p = 0.382).

In the accommodation amplitude of the research subjects before LASIK was obtained the

mean in mild myopia was 9 diopters, moderate myopia was 10.8 diopters and severe myopia was 4.6 diopters. The ANOVA test states that there is a difference in the amplitude of accommodation based on the degree of myopia ( $p = 0.003$ ) before LASIK measures and there is a significant difference in the amplitude of accommodation between the moderate and severe myopia groups ( $p = 0.006$ ).

In this study assessed changes and the sharp relationship of vision, intraocular pressure and the amplitude of accommodation before and after LASIK. Subjects were assessed visual acuity, intraocular pressure and accommodation amplitude before the procedure and 1 day, 1 week, 1 month after the LASIK procedure.

### Sharp changes in vision

Before LASIK, the mean for sharp vision in the study sample was  $0.9 \pm 0.41$ . LASIK's actions significantly cause sharp improvement in vision. One day after the LASIK procedure, the average is

sharp vision rises dramatically to 0.01. Likewise with measurements 1 week and 1 month after LASIK, visual acuity improved with a median value of 0.00 in all study subjects.

In a sharp change of vision, obtained a normal data distribution and data in the form of numerical so that it is analyzed by the correlation method. Significant changes in vision at 1 day, 1 week and 1 month after LASIK were significant ( $p = 0,000$ ). From the correlation analysis, it was concluded that significant changes in vision were significant, it was also found that changes in vision before and after LASIK had a moderate correlation at 1 day and 1 week after LASIK ( $r \Rightarrow 0.4$ ) and a strong correlation at 1 month after the LASIK action ( $r \Rightarrow 0.60$ ).

The sharp improvement pattern of vision can be seen graphically on the figure 1. Visible improvement in vision marked by a decrease in numbers the drastic logmar in 1 day after LASIK and settled for 7 days to 1 month after the LASIK procedure.

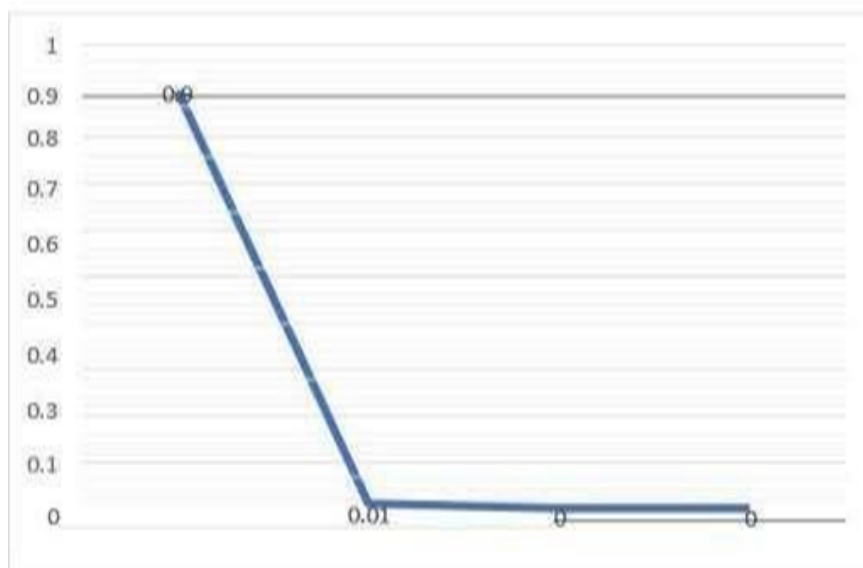


Figure 1. Pattern of sharp changes in vision after LASIK

### Changes in intraocular pressure (IOP)

Before the LASIK procedure, the mean intraocular pressure was  $16.42 \pm 3.0$  mmHg. Intraocular pressure decreases gradually until 1 month after LASIK. Parametric analysis of the Pearson correlation test was carried out and the

changes in intraocular pressure before 1 day, 1 week and 1 month after LASIK were significant ( $p = 0,000$ ). From the correlation test obtained differences in intraocular pressure before 1 day and 1 week after the LASIK action had a strong correlation ( $r > 0.5$ ) and with 1 month after the

LASIK treatment had a moderate correlation ( $r > 0.25$ ).

The pattern of improvement in intraocular pressure graphically can be seen in figure 2. There

is a decrease in intraocular pressure 1 day after LASIK and decreases 1 week and 1 month after LASIK action.

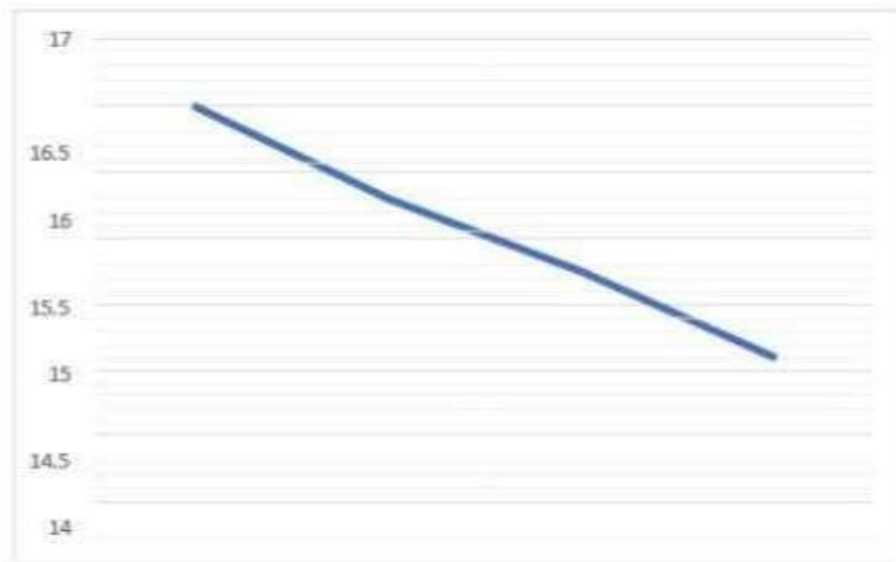


Figure 2. Patterns of changes in intraocular pressure after LASIK

#### Changes in accommodation amplitude

The amplitude of accommodation before LASIK measures obtained a median of 9.25 D with a minimum value of 4.5 D and a maximum of 14.75 D. As shown in table 11, the median of the accommodation amplitude 1 day after the LASIK action decreased to 9.0 D. At 1 week after LASIK measures, accommodation amplitude returned to normal and increased compared to before LASIK at 1 month after LASIK action with a median value of accommodation amplitude 11 D.

At the change in the amplitude of the accommodation, abnormal data distribution was obtained and the data in the form of numerical analysis was performed using the nonparametric Wilcoxon test. It was found that the change in the amplitude of the accommodation 1 day and 1 month after the LASIK action was significant ( $p < 0.05$ ).

To see what factors are correlated with the amplitude of accommodation before LASIK action, multiple linear regression analysis is carried out with the amplitude of accommodation before LASIK is performed as a dependent variable. The results of the analysis show that the relationship between corneal endothelial cell density (CD) and

intraocular pressure (IOP) to the amplitude of accommodation before LASIK can be described by mathematical formulas:

$$Y = 28.62 - 0.003 \text{ CD} - 0.258 \text{ IOP}$$

#### 4. Discussion

Patients participating in this study were aged between 18-26 years with an average age of  $20.06 \pm 2.01$  years, most with age  $< 20$  years (53.1%). The results of previous studies report on research subjects to be carried out by LASIK with varying age ranges. Khan et al reported research subjects with an age range of  $24 \pm 3.41$  years.<sup>28</sup> The age range in the studies of Chan et al  $31.71 \pm 4.86$  years and Mostafa EM with an age range of  $21.8 \pm 5.2$  years.<sup>8,29</sup>

Based on the data obtained in this study, the sex of the subjects of this study was dominated by men as many as 26 people (81.25%) while women were only 6 people (18.75%). Most of the previous studies of the research subjects to be carried out by LASIK were more women. The study by Chan et al reported that more research subjects in women consisted of 24 women and 17 men.<sup>8</sup> Oshika T et al and Villarubia et al also reported the same results.<sup>30,31</sup> However, a study by Yamane N et al

reported that out of 110 patients to be performed by LASIK there were more men, as many as 69 people.<sup>32</sup>

In this study, it was found that myopia sufferers who will do more LASIK actions in men. LASIK corrects myopia by removing a thin layer of tissue in the central cornea and making the center of the cornea flatter to allow the focal point to move closer to the retina, so as to improve sharp vision in myopia patients.<sup>40,41</sup> Various clinical studies have shown that after LASIK, the final sharp vision of myopia patients will progress. LASIK results in rapid visual improvement with minimal pain. After LASIK, myopia patients will achieve sharp vision 20/20 to 20/40.<sup>8,41,42.</sup>

Research by Yamane N et al in 200 eyes with myopia that performed LASIK actions reported that LASIK significantly improved vision.<sup>32</sup> The study by Hanera RG in 24 eyes of 14 study subjects, 1 month after LASIK, the patient achieved satisfactory results.<sup>43</sup> Research by Kim H and Joo C reported 96% in 32 moderate myopia eyes and 94.1% in high myopia eyes achieving sharp vision 20/20 or better after 2 months of LASIK.<sup>44</sup>

In this study, according to previous studies obtained one day after LASIK, the average sharp vision increased dramatically to 0.1. Likewise, measurements 1 week and 1 month after LASIK, sharp vision improved with an average of 0.00 in all study subjects. Intraocular pressure decreased gradually until 1 month after LASIK. Before the LASIK procedure, the mean intraocular pressure was  $16.42 \pm 3.0$  mmHg. After LASIK, a gradual decrease in intraocular pressure was obtained on the first day after LASIK with an average of  $15.83 \pm 2.25$  mmHg, 1 week after LASIK with an average of  $15.25 \pm 2.15$  mmHg and decreased to  $14.62 \pm 2.0$  mmHg 1 month after LASIK. From the analysis obtained a significant difference in intraocular pressure at IOP 1 week and 1 month after LASIK ( $p = 0.003$  and  $p = 0,000$ ).

The decrease in intraocular pressure in this study is probably due to changes in corneal central thickness and corneal curvature due to LASIK procedures that affect when measuring intraocular

pressure.<sup>45</sup> Ehler et al reported that there was a change in intraocular pressure as measured by implantation tonometry of 0.7 mmHg per 10 $\mu$ m of corneal central thickness.<sup>26</sup> The analysis of 13 papers published from 1968 to 1999 concluded that the measurement of pressure intraocular and central corneal thickness are related. There is a 10% change in corneal central thickness without corneal pathology abnormalities can cause changes in intraocular pressure of  $1.1 (\pm 0.6)$  mmHg.<sup>46</sup>

The decrease in intracular pressure in this study is the same as that of Kohlhass et al. In which there was a decrease in intraocular pressure in the study subjects, 101 eyes out of 59 patients after LASIK treatment The study concluded that there was a significant correlation between intraocular pressure and corneal central thickness after LASIK. The subjects of the study found a decrease in intraocular pressure as measured by Goldmann's applied tonometry from  $16.5 \pm 2.1$  mmHg to  $12.9 \pm 1.9$  mmHg.

In this study found a significant change in the amplitude of the accommodation of the first day, first week and first month after LASIK action. Obtained a decrease on the first day post LASIK from before the LASIK action with a median of 9.25 D decreased to 9.0 D, returned to normal at 1 week after LASIK to 10 D and finally experienced an increase of 1 month after the LASIK action with an average accommodation amplitude of 11 D with significant difference ( $p = <0.05$ ).

In a study conducted by Lei liu et al, at 1 week and 1 month after LASIK, the accommodation amplitude decreased significantly compared to the accommodation amplitude before LASIK with correction glasses ( $p <0.05$ ). there was no significant difference between the degree of mild to moderate myopia at 3 months after LASIK ( $P > 0.05$ ).<sup>6</sup> In this study also found no significant difference between changes in the amplitude of accommodation with the degree of myopia.

In the study of Lei Liu et al, out of 50 eyes with various degrees of myopia that performed LASIK, the results of changes in accommodation ability

were not significant after LASIK.<sup>6</sup> Whereas in this study stated that there was a significant difference between the amplitude of accommodation before and after LASIK action ( $p < 0.05$ ) with a strong relationship on the amplitude of accommodation 1 day, 1 week and 1 month after LASIK action ( $r > 0.60$ ). The difference in results when compared with this study can be due to the different accommodation amplitude measurement methods.

In the research of Liu lei et al, the push-u In daily practice, to measure the amplitude of accommodation can be done in various ways and most often used is a subjective examination. Subjective examination consists of push-ups (PU), push-downs (PD) (or also often called push-away), and minus the lens with the spherical method. From various literatures it is explained that the results of the measurement of higher accommodation amplitude are obtained in the push-up method compared to the spherical method. The push-up method is more often chosen and used because it is practical and the examination time required is relatively shorter. But in the literature it is also explained that the advantage of the spherical method is that it can measure the amplitude of accommodation more accurately.<sup>3,4,46</sup>

The difference in the measurement results of the two methods can be estimated beforehand depending on the type of accommodation stimulation performed. In the push-up method, what is done is to reduce the reading target distance, so that the angle to capture images on the retina increases and the stimulation of proximal accommodation increases, inversely proportional to the target reading distance. So that this method can provide results of examination of higher accommodation amplitudes. On examination with the spherical method, there is a reduction in the image of the retina caused by optical refraction on the concave lens. Unlike the push-up method, there is no change in the relative magnification distance.

## 5. Conclusion

There is a change in the amplitude of accommodation in patients with myopia after LASIK action where there is a significant decrease in the amplitude of accommodation on the first day and starts again at 1 week and increases compared to before the LASIK action at 1 month after LASIK.

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