

## **Difference in the anterior chamber angle of the four meridians**

**Lovisa Pettersson<sup>1</sup> and Fredrik Källmark<sup>2</sup>**

### **Abstract**

**Aim:** This present study aims to investigate the changes in the anterior chamber angle width according to four different meridians correlated with the individual strabismus, grade of ametropia, and corneal thickness.

**Method:** Both eyes of 50 healthy subjects were included in the study. The angle width was measured in four meridians (0°, 94°, 180°, 274°) three times in each eye with the Sirius Scheimpflug camera. The specific angles were chosen to represent the nasal, temporal, superior and inferior meridians.

**Result:** The result shows that in a mixed population of different grades of ametropia and strabismus the nasal angle is narrower than the equivalent angle on the temporal side. In the same group no difference in between the inferior and superior angle was found. A significant difference between the group of exophorias and orthophorias was found whereas the subjects with exophoria had a greater difference in between the nasal and temporal angle. No correlation between difference in angle and corneal thickness was found.

---

<sup>1</sup> E-mail: lovisamapettersson@gmail.com

<sup>2</sup> Clinical Neuroscience, Karolinska Institutet, Stockholm, e-mail: fredrik.kallmark@ki.se

**Conclusion:** When examining the chamber depth it is important to take this difference into notice and always examine both the nasal and temporal angle, especially when the patient has exophoria.

**Keywords:** Anterior chamber angle, Scheimpflug, glaucoma

## 1 Introduction

Glaucoma is a disease that causes a major proportion of the amount of irreversible blindness in the world [1, 2]. Glaucoma can be caused by a narrow or closed angle which can increase the intra ocular pressure and the risk of getting glaucomatous optic neuropathy [3, 4].

The prevalence of glaucoma caused by angle-closure ranges in different studies between 0.09% to 0.6% for European people over the age of 40 [5, 6].

Alongside glaucoma, ophthalmologists also evaluate the angle depth prior to pupillary dilation since there is a concern of causing a acute angle closure [7]. To be noted, the risk of acute angle closure in an asian group of subjects has in contrast to this shown to be low [8]. In addition to this studies have shown significant results of increasing pressure after dilation, especially in patients with open-angle glaucoma where elevation of more than 5 mmHg in up to 32% of the subjects [9, 10, 11, 12]. The intra ocular pressure is suggested to be re-checked after dilation to make shore there has not been any increase of the IOP [13].

To investigate the anterior chamber angle there are a several different methods. As a reference standard, gonioscopy is still used, although it was developed in the late 1800's [14, 15].

In clinical practice today Van Herick measurement with a slit lamp is commonly used. The Van Herick method of determining the depth can today be translated in to exact angles degrees [16].

The Van Herick method classifies the angle into five grades considering the angle width, where 0 is considered completely closed while 4 is viewed as wide open. The scale corresponds to an approximate angle where 1 equals  $10^\circ$ , 2 to  $20^\circ$ , 3 to  $20\text{-}35^\circ$  and 4 to  $35\text{-}45^\circ$  [17].

The Scheimpflug camera gives a photo of the anterior eye segment including the cornea and the lens. Its depth of focus reaches from the anterior corneal surface to the posterior lens surface [18]. Scheimpflug photography uses the change in focal plane that occur when the lens is tilted. In a standard camera the focal plane, lens plane and film plane are aligned to accomplish an exact parallel. The Scheimpflug on the other hand tilts the film plane to shift the plane of focus to the intersection point of the planes of the film and lens. This allows the slit lamp image to contain depth [15, 19]

Because of the rotation of the camera the examiner can in a matter of seconds get a black and white film recording of the anterior chamber where exact readings of the angle can be performed with the use of geometry [18, 20]. Using the Scheimpflug camera is a good way to examine the angle of the anterior chamber [21].

Earlier studies have shown that the angle gets narrower with age and that there is no difference of the angle in different quadrants [22]. Another study has shown the result of a change especially in age with an increased narrowing of all quadrants, especially the lateral quadrant [12].

In Asia, a study was performed on glaucoma patients where they found that the inferior angle was the most frequently to be closed [23]. Further, Chen HB et al. [9] showed that there is no correlation between the corneal thickness and the angle.

This present study aimed to investigate the difference in the anterior chamber angle width according to four different meridians correlated with the individual strabismus and grade of the ametropia.

## 2 Material and methods

Both eyes of 58 healthy selected subjects were measured but only 50 of the subjects were included in the study. All subjects were recruited among students from the department of clinical neuroscience, Karolinska Institutet.

The inclusion criteria's were: no ocular disease, no contact lens use during the last 24 hours and no presbyopia (age under 35).

The exclusion criteria were 3 reliable measurements per eye which i.e. includes things such as excessive eye movements.

The subjects were divided in to groups according to the individual strabismus and grade of the ametropia. The range of ametropia according to Logan in 2005, in a group of young British students of similar age as our group, showed a distribution of 50% myopia, 18% hyperopia and 32% emmetropia. The amount of myopic subjects in our study was a total of 43%, emetropic 35% and hyperopic 22% (Table 1). The prevalence of ocular alignment is shown in Table 2.

Table 1: Distribution of ametropia

Ametropia	Range of ametropia	Number of eyes
<b>High myopia</b>	<b>&gt;-3,50</b>	<b>25</b>
<b>Low myopia</b>	<b>-0,75 to -3.25</b>	<b>18</b>
<b>Emetropia</b>	<b>-0,50 to +0.50</b>	<b>35</b>
<b>Low hyperopia</b>	<b>+0.75 to +3.50</b>	<b>17</b>
<b>High hyperopia</b>	<b>&gt; +3.50</b>	<b>5</b>
<b>Astigmatism</b>	<b>&gt;-0,75</b>	<b>23</b>

Table 2: Distribution of ocular alignment

Ocular alignment	Number of subjects
Exotropia	1
Esotropia	2
Exophoria	13
Esophoria	8
Orthophoria	26

The age of the subjects ranged from 19-33 years of age with a mean of 23.87 years. The angle width was measured in 4 meridians (0°, 94°, 180°, 274°) three times per eye with the Sirius Scheimpflug camera (Figure 1). All the measurements were performed by an experienced examiner. The angles were specifically chosen to represent the four meridians; superior, inferior, nasal and temporal. Each eye was measured three times to get an average of each angle (Figure 2). All patients were informed not to wear contact lenses the same day prior to the examination to not interfere with the measurement of corneal thickness.

Different parameters such as corneal thickness, also measured with the Sirius, strabismus and level of ametropia was measured- all to later be correlated with the result of the angular measurements.

The strabismus was examined with the cover test by the same examiner. The level of ametropia was collected from the patient's journals of their last refraction.

Eight subjects were excluded from the study because of several different reasons, 4 because of age, 2 because of contact lenses and 2 because of excessive blinking which made the measurements unreliable.



Figure 1: Sirius Scheimpflug camera

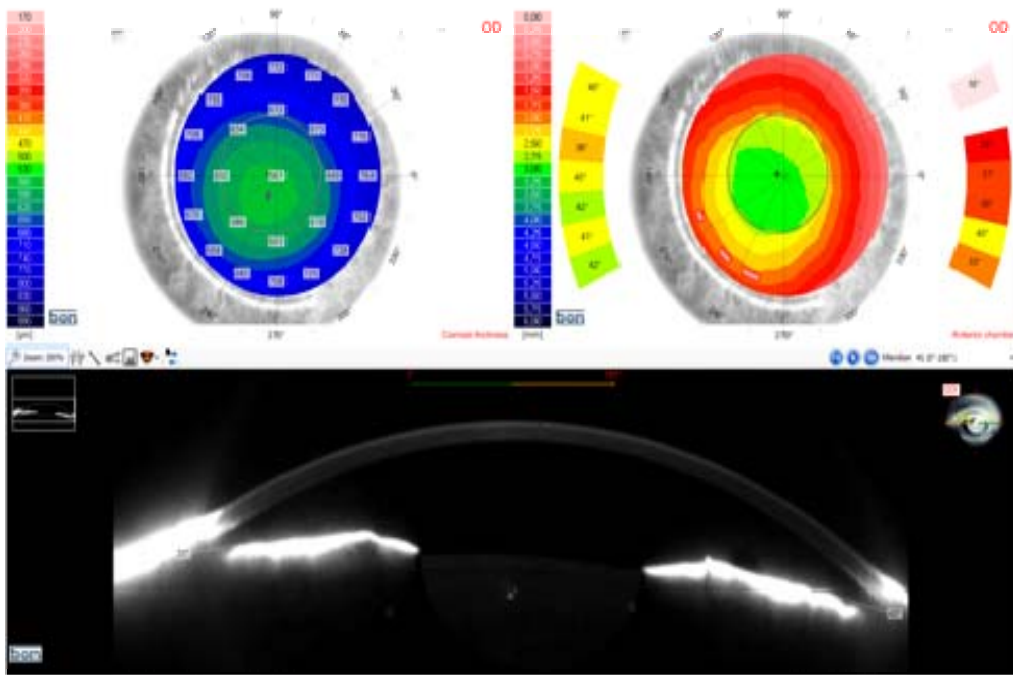


Figure 2: Showing the anterior angle from the Scheimpflug camera showing corneal thickness (top left), angle depth (top right) and exact nasal and temporal angles

### Statistical analysis

All data was analyzed with GraphPad InStat. Wilcoxon matched paired test and Pearson regression was used to evaluate the differences in angle depth and the correlation between difference in angle depth and corneal thickness. Significant p-value of 0.05 was considered in the analyzes.

## 3 Main Results

The results showed that the nasal angle was statically narrower than the temporal angle when all 50 subjects were included ( $p < 0,001$ ). The mean nasal angle was 40.895 with a standard deviation of 6.908 degrees while the temporal 47.531 with a standard deviation of 5.578 degrees (Figure 3)

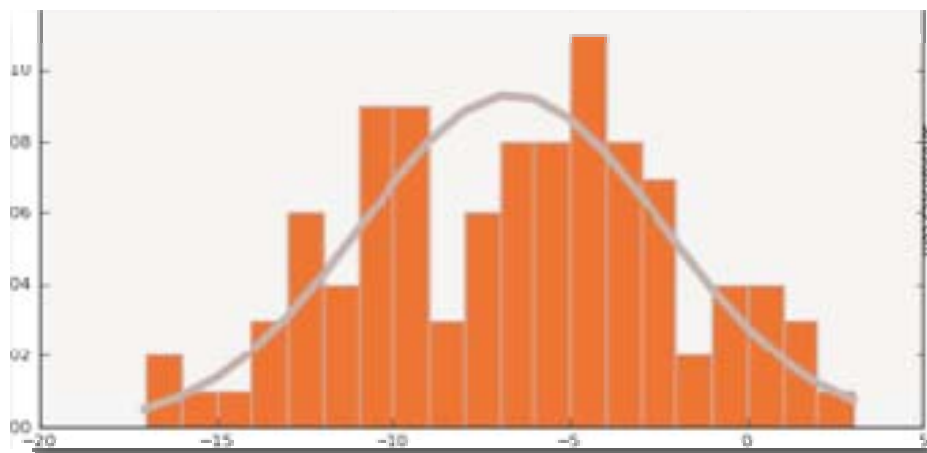


Figure 3: Difference in between the nasal and temporal angle, where the X axis shows the difference in degrees and the Y axis shows the number of subjects. A negative value equals a narrower nasal angle and a positive the opposite. Note the shift from zero.

A significance,  $p=0.045$ , showed that subjects with exophoria had a bigger difference in between the nasal and temporal angle compared to the groups of orthophoria and esophoria.

No difference in between the inferior and superior angles was found with a  $p$  value of 0,975.

No correlation between corneal thickness and the difference in anterior chamber angle between the temporal and nasal angles were found  $p=0.585$ .

No significance was found between any of the groups of ametropia and the difference in angle.

## 4 Discussion

The study chose a young age group to determine if there is any difference in the angles in the specific group since earlier studies by Chen et al. [9] have shown that the temporal angle is the one that narrows the most with age. This was the reason why we chose the particular age group since a mixed group would have made us to take the age parameter in consideration. This doesn't exclude the fact that an older population could have the same difference.

Alongside Chen HB et al. [9] who earlier has shown that there is no correlation between corneal thickness and different angle depth, neither could we find any significant correlation.

The standard deviation showed a larger difference in the nasal compared to the temporal angle which might be a result of when all the groups were combined into one, since there then was a variety of strabismus within the joint group. This might be the result of us not dividing the grade of strabismus into different groups, trying to correlate the grade as well, which was not the aim of this study.

Only 6 out of the 100 eyes had a narrower temporal angle with a maximum difference of 2.33 degrees, to be compared with the largest difference of the subjects with a wider temporal angle which was 16 degrees, see (Figure 3) where



there is a shift from zero towards a negative value which equals a narrower nasal angle. When looking at this population in consideration of their individual grade of ametropia, these results can be compared with a normal population. This since the subjects in our study matched the distribution within the group Logan examined in 2005 when examining a normal young population for different grades of ametropia.

Compared to Nolan 2007, who in an Asian study on glaucoma patients found that the inferior angle was the most frequently to be closed, we could not confirm any narrowing of the inferior angle compared to the other meridians. However since we did not compare glaucoma patients, we can neither confirm nor disprove. Although, to be noted, we did not in this study exclude subjects with known or unknown heredity for glaucoma. To make such statements future studies are needed to over several years follow subjects with a known heredity of Glaucoma, to see if there is any difference in the development of angle-closure with the aim to search for early signs in development of glaucoma.

The difference of the angle depth within the group of exophorias compared to orthophorias showed a significance which may be the result of a de-centered pupil. This particular phenomenon was observed when examining several subjects with exophoria. This can be shown in the Scheimpflug pictures of the eyes with exophoria, where the pupil seems to decentralize towards the nasal side, see (Figure 2) and (Figure 4). However, no such corresponding observations were shown in subjects with esophoria. Although to be noted, no scientific evidence up to date can verify this.

The overall result including all subjects as one group, shows an average difference of the nasal and temporal angles of 6.7 degrees which is over half a step on the van Herick scale which in some cases would differ a specific chamber angle from being narrow or not.

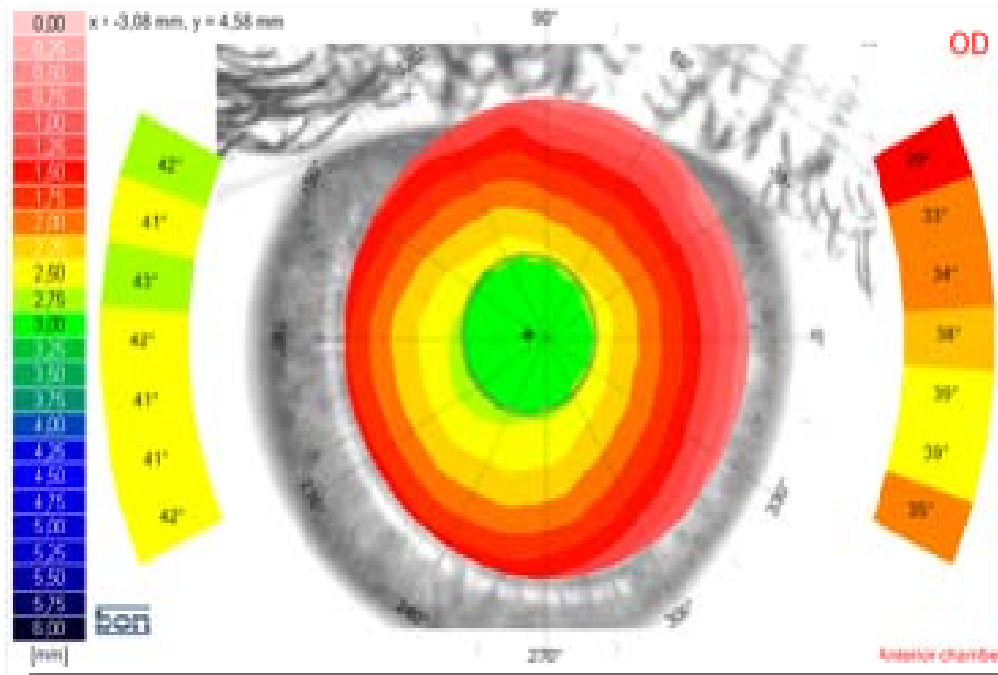


Figure 4: The angle depth by the Scheimpflug camera whereas the more narrow nasal angle is shown on your right hand side. In this picture you can also see the pupil being slightly de- centered both up and towards the nasal side.

## 5 Conclusion

When examining the chamber angle it is important to take this difference into notice and always examine both the nasal and temporal angle, since a young patient normally will have a narrower nasal angle. This is especially important when examining patients with exophoria.

## References

- [1] B. Thylefors, A.-D. Negrel, R. Pararajasegaram and K.Y Dadzie, Global data on blindness, *Bulletin of the world health organization*, **73**, (1995), 115-121.
- [2] S. Resnikoff, D. Pascolini, D. Etya'ale, et al., Global data on visual impairment in the year 2002, *Bull World Health Organization*, **82**, (2004), 844-851.
- [3] P.J. Foster, The epidemiology of primary angle closure and associated glaucomatous optic neuropathy, *Semin Ophthalmol*, **17**, (2002), 50-58.
- [4] L.M. Sakata, R. Lavanya, D.S. Friedman, et al., Comparison of gonioscopy and anterior segment ocular coherence tomography in detecting angle closure in different quadrants of the anterior chamber angle, *Ophthalmology*, **115**, (2008), 769-774.
- [5] F.C. Hollows and PA. Graham, Intraocular pressure, glaucoma and glaucoma suspects in a defined population, *Br. J. Ophthalmol*, **50**, (1966), 570-586.
- [6] L. Bonomi, G. Marchini, M. Marrafa, et al., Epidemiology of angle-closure glaucoma. Prevalence, clinical types, and association with peripheral anterior chamber depth in the Egna-Neumakt glaucoma study, *Ophthalmology*, **107**, (2000), 998-1003.
- [7] A.M. Brooks, R.H. West and W.E. Gillies, The risks of precipitating acute angle-closure glaucoma with the clinical use of mydriatic agents, *Med. J. Aust*, **145**, (1986), 34-36.
- [8] R. Lavanya, M. Baskaran, R.S. Kumar, H.T. Wong, P.T. Chew, P.J. Foster, D.S. Friedman and T. Aung, Risk of acute angle closure and changes in intraocular pressure after pupillary dilation in Asian subjects with narrow angles, *Ophthalmology*, **119**(3), (2012), 474-480.
- [9] Chen HB, Kashiwagi K, Yamabayashi S, et al., Anterior chamber angle biometry: quadrant variation, age change and sex difference, *Curr Eye Res.*, **17**, (1998), 120-124.

- [10] B.R. Shaw and R.A. Lewis, Intraocular pressure elevation after pupillary dilation in open angle glaucoma, *Arch Ophthalmol*, **104**, (1986), 1185-1188.
- [11] L.S. Harris, Cycloplegic-induced intraocular pressure elevations: a study of normal and open-angle glaucomatous eyes, *Arch Ophthalmol*, **79**, (1968), 242-246.
- [12] G.L. Portney and T.W. Purcell, The influence of tropicamide on intraocular pressure, *Ann Ophthalmol*, **7**, (1975), 31-34.
- [13] T.C. Chen, Risk factors for intraocular pressure elevations after pupillary dilation in patients with open angles, *Ann Ophthalmol*, **37**, (2005), 69-76.
- [14] J. Hancox , I. Murdoch and D. Parmar, Changes in intraocular pressure following diagnostic mydriasis with cyclopentolate 1%, *Eye (Lond)*, **16**, (2002), 562-566.
- [15] A. Dellaporta, Historical notes on gonioscopy, *Surv ophthalmol*, (1975), 137-149.
- [16] D.S. Friedman and M. He, Anterior chamber angle assessment techniques, *Surv Ophthalmol*, **53**, (2008), 250-273.
- [17] W. Van Herick, R.N. Shaffer and A. Schwartz, Estimation of width of angle of anterior chamber. Incidence and significance of the narrow angle, *American Journal of Ophthalmology*, **68**, (1969), 626-629.
- [18] J. Kanski, *Clinical Ophthalmology*, Butterworth & co, Ltd, 1989.
- [19] A. Wegener and L.J. Heike, Photography of the anterior eye segment according to Scheimpflug's principle: options and limitations-a review, *Clin. Experiment Ophthalmol*, **37**, (2009), 144-154.
- [20] K. Fujisawa and K. Sasaki, Changes in light scattering intensity of the transparent lenses of subjects selected population-based surveys depending on age: analysis through Scheimpflug images, *Ophthalmic Res*, **27**, (2005), 89-101.
- [21] O. Hockwin, V. Dragomirescu, H. Laser and A. Wegener, Scheimpflug photography of the anterior eye segment. Principle, instrumentation and

- application to clinical and experimental ophthalmology, *J. Toxicol Cutaneous Ocul Toxicol*, **6**, (1987), 251-271.
- [22] T.M. Rabsilber, R. Khoramnia and G.U. Auffarth, Anterior chamber measurements using Pentacam rotating Scheimpflug camera, *J. Cataract Refract Surgery*, **32**, (2006), 456-459.
- [23] M. Koc and K.Özülken, Measurement of the Anterior Chamber Angle According to Quadrants and Age Groups Using Pentacam Scheimpflug Camera, *Journal of glaucoma*, (2011).