

# Strabismus Surgery in Adults: A New Formula for Calculating in Recessing-Resecting Muscles

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**Abstract:** The author introduces a new formula is simple for calculating the amount of muscle to recess-resect for the surgical correction of esotropic strabismus and exotropic strabismus. There are many ways to measure the angle of strabismus and many methods to calculate the amount of muscle recess-resect in a pair of opposing muscles. The Hirschberg method for measuring the kappa angle was described details here for diagnosis. Based on this diagnosis, a new formula was proposed will be easily calculating in surgical correction of strabismus in adults.

**Keywords:** esotropic or exotropic strabismus, strabismus surgery, recess-resect muscle surgery, a formula for calculating.

## 1. Introduction

In normal vision, the image of a point of fixation will fall on the fovea of each eye. This is the visual axis. In the presence of strabismus, a condition of ocular deviation, the image falls on the fovea of only one eye. The amount of deviation is determined by the angle formed by the visual axis of the two eyes. In normal eyes, the Kappa angle is measured between the visual axis and an axis perpendicular to the cornea through the center of the pupil or pupillary axis, approximately 5 degrees (Fig. 1). [1]

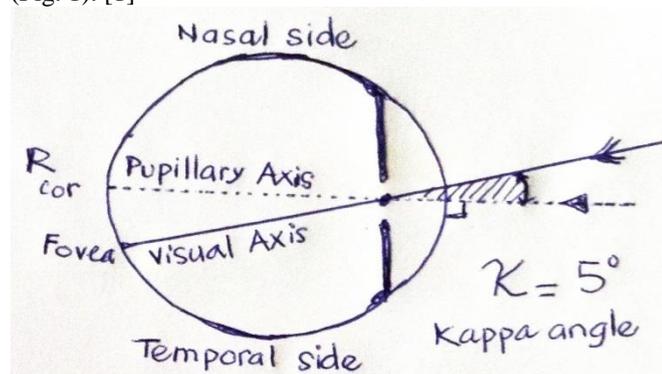


Figure 1. Kappa angle

Broadly speaking, strabismus is caused by an unequal pulling of one or more of the muscles that move the eyes (nonparalytic strabismus), or by paralysis of one or more of these eye muscles (paralytic or paretic strabismus). In strabismus, the deviation may be inward (esotropia), outward (exotropia), upward (hypertropia) or downward (hypotropia).

Strabismus may also be intermittent, related to the distance of the point of fixation, secondary to psychological stress, or associated with A or V syndrome. In 'A' esotropia, the deviation is greater in eyes pointing up than in eyes pointing down; in 'A' exotropia, the deviation is greater in eyes pointing down than in eyes pointing up. Conversely, in 'V' esotropia, the deviation is greater in eyes pointing down than in eyes pointing up; and in 'V' exotropia, the deviation is greater in eyes pointing up than in eyes pointing down [2, 3].

For the purposes of treatment, strabismus is classified into two categories: paralytic and functional. Before surgical intervention is considered, correction of strabismus should be attempted by 1) the use of spectacles in patients with refractive errors (myopia in exotropic patients, hyperopia in esotropic patients); and 2) total or partial occlusion of the deviated eye in children aged 7 to 14 years. Strabismus may cause lack of binocular vision, loss of useful vision, psychologic manifestations, and social and economic problems. For these reasons, a child with strabismus should be examined as soon as

possible. In many cases, treatment can be initiated in infancy [4, 5, 6,]. In Vietnam, strabismus is present in 0.53% of the population and is responsible for 2% of all cases of blindness [7].

There are many ways to measure the angle of strabismus and many methods to calculate the amount of muscle recess-resect in a pair of opposing muscles. The planned amount of resection (strengthening) or recession (weakening) of muscles is derived from retrospective analyses of dose response curves. There are multiple surgical tables published which list the millimeters of resection or recession of a muscle based on prism diopters of deviation. [8]. In this paper, the Hirschberg method for measuring the kappa angle in diagnosis. A new formula which based on Hirschberg degree was proposed for calculating the amount of muscle to recess-resect for the surgical correction of strabismus in adult patients with either esotropia or exotropia as detail [9,10,11]. A comparison of this formula's the amount of muscle with other author was noted. [4,12]

## 2. Methodology

**Design:** A new formula was described in calculating the amount of muscle to recess-resect for the surgical correction of strabismus in patients with either esotropia or exotropia.

**For diagnosis:** We used the Hirschberg method to measure the kappa angle. Normally, when light strikes the cornea, a reflex occurs on the center of the cornea of each eye. In cases of strabismus, the corneal reflex falls at some other position than at the center and thus the related deviation can be assessed in degrees of arc as in the following examples of corneal reflex position: central reflex = 0 degree; reflex at the pupillary margin = 15 degrees; half-way to the limbus reflex = 30 degrees; at the limbus reflex = 45 degrees; and 1 mm beyond the limbus = 60 degrees [2, 3, 4].

**For surgical treatment:** The goals of our surgery were: 1) to change the position of the eyeball in order to alter the alignment of the eye as soon as possible; 2) to reduce (weaken, lengthen, recess) or to enhance (shorten, strengthen, advance, resect) the action of individual muscles; and 3) to create and maintain normal rotation of the eyeball and concomitance [5, 6, 8].

+ A New Formula: Theoretically, the circumference of the eyeball is 72 mm; therefore, a displacement of 1 mm should move the optic axis 5 degrees ( $360/72$ ). Lancaster points out that 1 mm of displacement on the sclera corresponds to 40 of rotation, but at the center of the cornea the correspondence is 5 degrees. Wiener and Alvis reported that 1 mm of the recession on both corrected muscles resulted in 10 degrees of correction. Jameson has reported that 1 mm of recession results in 5 degrees of correction if the recession was performed on the

internal rectus muscle, and 2 degrees of correction if the recession was performed on the internal rectus muscle [2]. The following Kunz Formula: [4]

$$k = s1 \times [m1 / (m2 + m2)] + s2 \times [m2 / (m1 + m2)]$$

If  $s1 = s2$

$$k = s, \text{ where}$$

$k$  = the change in position of the globe ( $o$ );

$s1, s2$  = the amount of displacement of the muscles (mm);

$m1, m2$  = muscle and opposing muscle.

Proposed A New Formula:

As demonstrated in Figure 2, we propose a simple formula as follows:

$$d1 = d2 = \frac{1}{2} \times D / 2 = D / 4$$

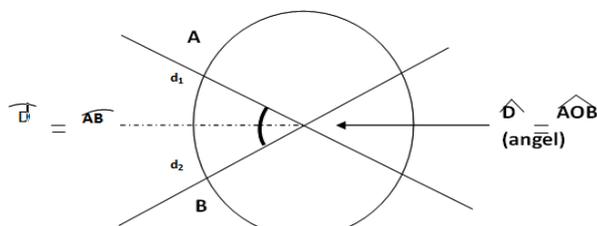
$d1 = d2$ : resect = recess muscle (mm), where

$D$  = Deviation degree calculated by the Hirschberg method:

Reflex at the pupillary margin = 15 degrees,  $d1 = d2 = 15 / 4 = 3,75$  mm.

Reflex at the half-way to the limbus = 30 degrees,  $d1 = d2 = 30 / 4 = 7,50$  mm;

Reflex at the limbus = 45 degrees,  $d1 = d2 = 45 / 4 = 11,25$  mm. (See Table 2)



AS  $k = s$   
 Then  $d_1 + d_2 = AB = D = \frac{1}{2} \text{ AOB} = \frac{1}{2} D$   
 If  $d_1 = d_2 = \frac{1}{2} D = \frac{1}{2} \times D / 2$  ( $D$ : angle measured by Hirschberg method)

Fig. 2 A new formula. Our formula is easily done in practice on the adult patients comparing with others [4,8,12]

### 3. Results and Discussion:

For Kunz's table of surgical resection - recession of muscle with details in Table 1.

In table 2:

With 15 degree of strabismus author's method 7,5mm vs. 9mm Kunz method

With 30 degree of strabismus author's method 15 mm vs. 15mm Kunz method

With 40 degree of strabismus author's method 20 mm vs. 19mm Kunz method

In table 3:

With 15 degree of strabismus author's method 3,75mm x 2=7,5mm vs. 8mm recession of A M Sousa and L N de Oliveira. The standardization in the surgical treatment of strabismus has long been the desire of surgeons. So the number of millimeters of recession or resection to perform is always a difficult decision [12]

Table 1. Kunz's table of surgical resection and recession of muscle[4]

Deviation (degree)	Resection (mm)	Recession (mm)
10 to 11	3	4
12 to 13	3.5	4.5
14 to 16	4	5
17 to 18	4.5	5.5
19 to 20	5	6
22 to 23	5.5	6.5
24 to 26	6	7
27 to 28	6.5	7.5
29 to 31	7	8
32 to 33	7.5	8.5
34 to 36	8	9
37 to 38	8.5	9.5
39 to 40	9	10

Table 2. Comparison of author's method with Kunz's table of surgical resection and recession of muscle.

Deviation (degrees)	Our method		Kunz's method	
	resect (mm)	recess (mm)	resect (mm)	recess (mm)
15	3.75	3.75	4	5
20	5	5	5	6
25	6.5	6.5	6	7
30	7.5	7.5	7	8
35	8.75	8.75	8	9
40	10	10	9	10

Table 3. Recession according to A. MATOS SOUSA AND L. N. FERRAZ DE OLIVEIRA [12]

Examples of Calculations

Angle of Deviation without glasses	Angle of Deviation with glasses	Calculation	Recession (mm.)
+12°	+10°	$R = 1 + \frac{14}{5} = 3.8$	4
+25°	+15°	$R = 1 + \frac{35}{5} = 8$	8
+25°	+18°	$R = 1 + \frac{32}{5} = 7.4$	7
+28° to +32°	+22° to +26°	$R = 1 + \frac{34}{5} = 7.8$	8
		$R = 1 + \frac{38}{5} = 8.6$	
+21° to +22°	+15° to 18°	$R = 1 + \frac{27}{5} = 6.4$	6
		$R = 1 + \frac{26}{5} = 6.2$	

### 4. Conclusion:

Strabismus surgery treatment should be considered only as a supplement to optical and orthoptic treatment. Effect of surgery on the extraocular muscles depends on many factors, including the age at onset of the squint, the age of the patient at the time of surgery, the stability of the angle of squint, the size of the angle of squint, and the technique used. We established our diagnoses based on the Hirschberg method, and we propose a new formula which was described above for calculating recessing-resecting muscles. Our formula is easily done in practice on the adult patients.

### References

- i. H. Gharaee, M. Shafiee, R. Hoseini, M. Abrishami, Y. Abrishami and M. Abrishami. Angle Kappa Measurements: Normal Values in Healthy Iranian Population Obtained With the Orbscan II. Iran Red Crescent Med J. 2015 Jan; 17(1): e17873. Available: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4341357/>
- ii. Gibson GG, Harley RD. Anomalies of binocular position, visual perception and ocular motility in strabismus: Am Acad Ophthalmol Otolaryngol 1966: 35-85.
- iii. Vaughan A, Asbury T, Cook R. General Ophthalmology. 6th ed. Los Altos, California: Lange Medical Publications, 1971: 170-192.

- iv. Sugar HS. *The extrinsic of orthoptic instruction. Am Acad Ophthalmol Otolaryngol* 1964: 51-72.
- v. Burian HM. *Syllabus of orthoptic instruction. Am Acad Ophthalmol Otolaryngol* 1962: 1-45.
- vi. [Saraux H, Biais B, Rossazza C. *Ophthalmologica. Paris: Masson, 1988: 365-405.*
- vii. Ngo Nhu Hoa. *Some consideration on the epidemiology of cataract in Hochiminh City. Ophthalmic Information of HCM City, Vietnam* 1988; N1: 72-73
- viii. [http://eyewiki.aao.org/Strabismus\\_Surgery,\\_Horizontal](http://eyewiki.aao.org/Strabismus_Surgery,_Horizontal)
- ix. Miller S. *Clinical Ophthalmology. Bristol, Wright, 1987: 412-423.*
- x. Von Noorden G. *Main causes of failure in strabism surgery. Highlights of Ophthalmology* 1996; 24(1): 2.
- xi. Duong Dieu, *Strabismus and surgical correction, Medical Progress, Hong Kong MediMedia Publisher* 2002, 29(7): 23-26.
- xii. A M Sousa and L N de Oliveira. *Horizontal squint surgery. The mathematical approach -Br J Ophthalmol* (1968) 52: 149-152 doi: 10.1136/bjo.52.2.149

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