Improved Strabismus Surgical Outcomes with a New Table

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Abstract—

Purpose: To find out the most scientific formula for strabismus surgery.

Patients and method: 84 subjects having normal eyes ranging from 3 years of age to 48 years over 4 years from 2011 to 2015 were photographed by iPhone with flash to locate reflex of the light on a part of eye, while 6 extra ocular muscles moved the eye to the extremes, in the direction of their action. The distance of the reflex was measured from center of the pupil.

The diameter of the cornea was measured from white to white by caliper. Pupil diameter was also measured in every case.

Each mm of reflex away from the center of the pupil is equal to 15 prism diopter (PD)[1]. So the total deviation of eye at extreme action of a particular muscle is measured and converted to PD.

Each extraocular muscle has different length.

Assumption: The length of the muscle is responsible for total deviation of the eye by full action of the muscle.

Then the surgical table was applied to surgically correct 84 eyes having, either esotropia or exotropia.

Results: 1 mm of resection or recession of Lateral Rectus (LR) corrects 5PD.Similarly, 1mm of either recession or resection of Medial Rectus (MR), Superior Rectus (SR), Inferior Rectus (IR) and Superior Oblique (SO) corrects 2.5PD. 1mm of recession or resection of Inferior Oblique (IO) corrects 4PD.This finding is statistically significant and p value less than 0.05.

Conclusion: The strabismus surgical table created by the author is accurate as verified by strabismus operations over 4 years.

Keywords— Strabismus, surgical table, surgical correction.

I. INTRODUCTION

Many strabismus surgical tables were proposed by erudite authors of strabismology in different established journals and also faithfully followed all over the world. These tables are empirical, rather than scientific. So, dissatisfactory outcome and reoperation are being done to correct the strabismus.

First a strabismus surgical table was invented in this article and then applied to surgical correction of eyes having either an esotropia or an exotropia.

The success of the operation made the hypothesis a thesis.

II. MATERIAL AND METHOD

84 pairs of normal eyes of subjects ranging from age 3 years to 48 years of age. Equal numbers of male and female individuals were selected. From 3 years to 14 years 42 persons and equal 42 persons from the age of 15 years to 48 years were also selected. Each group had equal number of males and females.

The diameter of each eye was measured from limbus to limbus by caliper. The diameter of the pupil was also recorded.

By iPhone the photos of the extreme position of the pair of eyes were photographed with flash light active. Lateral rectus and medial rectus were evaluated by asking the patient to look at the extreme on horizontal plane. The position of the eyes was photographed from 2 ft, so that reflexes on cornea and sclera could be photographed without using accommodation of eye. Similarly, right superior rectus and left inferior oblique were evaluated by asking the subject to look right superior temporal and left superior rectus and right inferior oblique were evaluated by asking to look to left superior temporal. Right Inferior rectus and left superior oblique were measured by moving the eye ball to right inferior temporal and left inferior rectus and right superior oblique were evaluated asking to move the eye to left inferior temporal.

Position of the light reflex was measured from the center of the pupil. These positions were converted to prism diopters. From the center of pupil to the border of the pupil is 2mm, from the border of the pupil to the limbus is 4 mm and midpoint between these 2 is 2mm from the pupil.
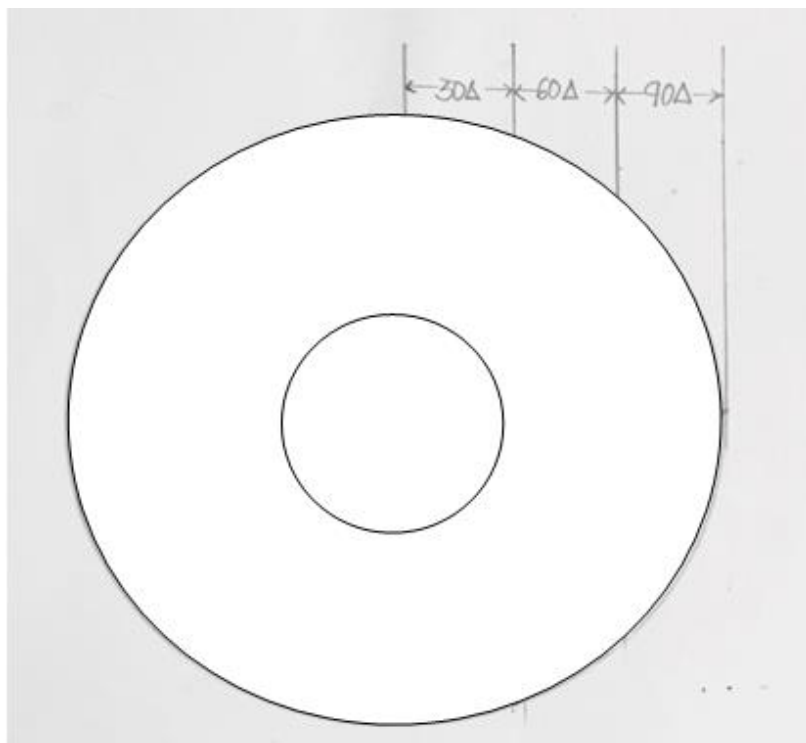

FIGURE 1: Position of the light reflex

PHOTO 1: corneal reflex eyes looking straight

PHOTO 2: Scleral reflex on right eye medial side, eyes looking at extreme right, showing full action of lateral rectus of right eye and medial rectus of left eye

PHOTO 3: Scleral reflex on right eye medial side, eyes looking at extreme right and left eye occluded

PHOTO 4: Corneal reflex on limbus of left eye, looking extreme right due to full action of medial rectus

PHOTO 5: Corneal reflex on limbus, looking extreme left superior temporal due to full action of superior rectus (left eye) & inferior oblique (right eye)
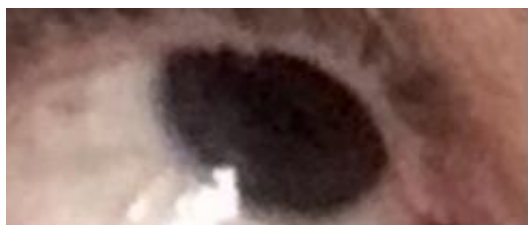

PHOTO 6: Corneal reflex on limbus, looking extreme left superior temporal due to full action of inferior oblique (right eye)

PHOTO 7: Corneal reflex on limbus, looking extreme left inferior temporal due to full action of inferior rectus (left eye)

The length of lateral rectus from its origin to insertion including tendinous part is 38.4mm ,medial rectus 38.5,superior rectus 38.2mm,inferior rectus 37.2mm,superior oblique 39.2mm and inferior oblique 22.5 mm [2].

The deviation of eye in PD was divided by the length of the muscle to find out the possible deviation the muscle can create per 1mm of action of the muscle.

TABLE 1

Name of muscle	Length in mm
Lateral Rectus	38.4
Medial Rectus	38.5
Superior Rectus	38.2
Inferior Rectus	37.2
Superior Oblique	39.2
Inferior Oblique	22.5

Photograph 1: **Lateral Rectus**; light reflex was found on sclera 6 to 7.5 mm away from limbus. In average its 6.75 mm away from limbus on moving lateral rectus on horizontal deviaition and 12.75 mm away from center of the pupil. (90 PD/6mm)=15PD. Total distance of light reflex on sclera from pupil is (6+6.75) =12.75mm. So,15 x12.75=191.25 PD/ length of lateral rectus=191.25/38.4 mm=4.99= **5 PD/1mm.**

Photograph 2: **Medial rectus**; corneal reflex is on the limbus= 90PD/38.5 mm=2.35=2.4= **2.5 PD/1mm** (for convenience)

Photograph 3: **Superior rectus**; corneal reflex is on the limbus= 90PD/38.2mm=2.36=2.4= **2.5 PD/1mm** (for convenience)

Photograph 4: **Inferior rectus**; corneal reflex is on the limbus= 90PD/37.2mm=2.42=**2.5 PD/1mm**(for convenience)

Photograph 5: **Superior Oblique**; corneal reflex is on the limbus= 90PD/39.2mm=2.3=**2.5 PD/1mm** (for convenience)

Photograph 6: **Inferior Oblique**; corneal reflex is on the limbus= 90PD/22.5mm=4 **PD/1mm**

TABLE 2

Name of the muscle	Correction in PD/ 1 mm
Lateral Rectus	5
Medial Rectus	2.5
Superior Rectus	2.5
Inferior Rectus	2.5
Superior Oblique	2.5
Inferior Oblique	4

Surgical procedures used to correct esotropia and exotropia are a combination of recession and resection. The table for strabismus surgery thus generated was applied on 84 cases, spreading from age 3 years to 45 years. They were divided into 2 groups; pediatric from 3 years to 14 years. The second group was from 15 years to 45 years. The number of pediatric group was 42 and adult were 42 cases. Eyes with esotropia were 42 and exotropia were 42. Each patient had undergone cycloplegic refraction of refractive error. Fundus examination and amblyopia therapy was done before the operation. The results of the operation were recorded on 1st postop day, 1 month, and 3 months after the surgery and followed till 3 years. Any refractive error was also corrected and amblyopia therapy was applied as necessary.

III.   RESULTS

All the 84 cases were perfectly operated resulting accurate alignment and motility correct in all 9 cardinal positions.

Photo 8a preoperative: ESOTROPIA with INFERIOR OBLIQUE OVERACTION.

Photo 8b-BILATERAL LATERAL RECTUS RESECTION WITH INFERIOR RECTUS TRANSPOSITION ANTERIORLY AND NASAL TO INFERIOR RECTUS.40PD of IO overaction.10mm of transposition of Inferior oblique.
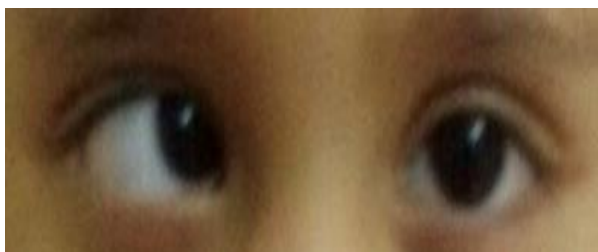

PHOTO 8a: Preoperative ESOTROPIA

PHOTO 8b: Postop

PHOTO 9a: Preop ESOTROPIA

PHOTO 9b: Postop

PHOTO 10a: preop ESOTROPIA with mild inferior oblique overaction
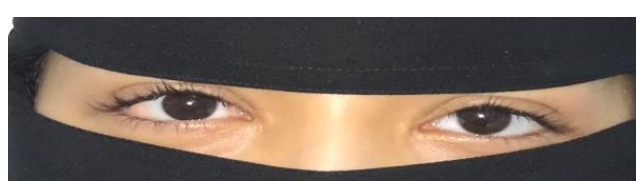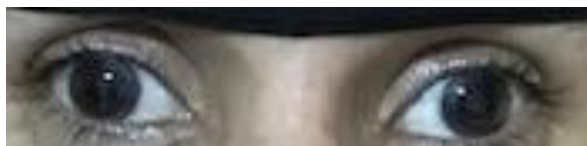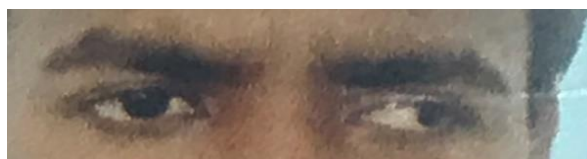

PHOTO 10b: Postop

PHOTO 11a: Preop EXOTROPIA

PHOTO 11b: Postop

PHOTO 12a: Preop EXOTROPIA

PHOTO 12b: Postop

PHOTO 13a: Preop EXOTROPIA

PHOTO 13b: Post op

IV.   DISCUSSION

Standardization of surgical treatment of strabismus has long been the ambition of surgeons[3]. Even for the most experienced, the number of millimeters (mm) of recession and resection to perform is always a difficult decision. Because of individual variation in response to similar surgical procedures, Cooper (1961) believed it difficult to predict the result. Knapp [1](1958) considered accurate estimation impracticable and Scobee[5,6] (1952) and Stallard (1965) regarded it as impossible.

The general principle of muscle surgery are discussed often enough, but precise detail regarding the amount of muscle to move or remove is frequently omitted and the decision is left to the surgeon's skill and experience in each individual case. Lyle (1950), Scobee (1952), Castanova Puyeo[3] (1958) and Cooper (1961)[2],who have all described the conditions that may influence the result of the operation vary considerably in their estimation of the relationship between the amount of recession or resection and the degree of correction of strabismus.Lyle[4] (1950) stated that 1 5mm recession of the medial rectus produced an average final reduction between 7^0 and 12^0 and that the average effect of resection of the lateral rectus "is to reduce the angle of deviations by about $10^{0,}$" adding that "it is usually combined with either recession or tenotomy of the medial rectus".

Castanova Puyeo (1958) stated that for each millimeter of recession of the medial rectus that should be correction of $3^{o,}$ but for each millimeter of resection of the lateral rectus only 1° or even less. Stallard (1965) held that roughly 1mm of recession of the rectus corrected about 4° of strabismus and 1mm of adjustment to the lateral rectus about 2°.

Among the most interesting attempts to standardize the surgical treatment of horizontal strabismus, reference must be made to the work of Urist[7,8] (1951).His surgery, as he stated 'is theoretically based on the concept that the position of the eyes is determined by a state of balance between convergence and divergence innervations', and his operative procedure is predetermined by the amount of deviation present for distance vision and downward gaze.

V.   STRABISMUS SURGICAL TABLES BY PARKS

TABLE 3
SURGERY OF ESOTROPIA

Esotropia PD	Bilatera Medial Rectus Recessions(mm)
15-20	3
21-30	4
31-40	5
41-50	6
51-60	7

TABLE 4

BILATERAL LATERAL RECTUS RESECTION

Esotropia (PD)	Lateral Rectus (mm)
15-20	4
21-30	5
31-40	6
41-50	7

TABLE 5

UNILATERAL MEDIAL RECTUS RECESSION AND LATERAL RECTUS RESECTION

Esotropia (PD)	Medial Rectus Recession(mm)	Lateral Rectus Resection(mm)
15-20	3	5
21-30	4	6
31-40	5	7
41-50	6	8

TABLE 6

SURGERY ON EXOTROPIA; BILATERAL LATERAL RECTUS RECESSION

Exotropia (PD)	Lateral Rectus Recession (mm)
15-20	5
21-30	6
31-40	7
41-50	8
51-60	9

TABLE 7

BILATERAL MEDIAL RECTUS RESECTION

Exotropia (PD)	Medial Rectus Resection (mm)
15-20	3
21-30	4
31-40	5

TABLE 8

UNILATERAL MEDIAL RECTUS RESECTION & LATERAL RECTUS RECESSION

Exotropia (PD)	Media Rectus Resection (mm)	Lateral Rectus Recession (mm)
15-20	3	5
21-30	4	6
31-40	5	7
41-50	6	8

VI.   AUTHOR'S SURGICAL TABLE

TABLE 9
ESOTROPIA: BILATERAL MEDIAL RECTUS RECESSION WITH 5mm OF OVERCORRECTION

Esotropia (PD)	Medial Rectus Recession(mm)
15+5=20	4
20+5=25	5
30+5=35	7
40+5=45	9
50+5=55	11

TABLE 10
ESOTROPIA: BILATERAL LATERAL RECTUS RESECTION WITH 5 mm OF OVERCORRECTION

Esotropia (PD)	Bilateral Lateral Rectus Resection(mm)
15+5=20	2
20+5=25	2.5
30+5=35	3.5
40+5=45	4.5
50+5=55	5.5
60+5=65	6.5
70+5=75	7.5
80+5=85	8.5
90+5=95	9.5

TABLE 11
ESOTROPIA: UNILATERAL RECESSION AND RESECTION WITH 5 mm OF OVERCORRECTION

Esotropia (PD)	Medial Rectus Recession(mm)	Lateral Rectus Resection(mm)
15+5=20	4	2
20+5=25	4	3
30+5=35	4	5
40+5=45	8	5
50+5=55	8	7
60+5=65	8	9
70+5=75	10	10

TABLE 12
EXOTROPIA: BILATERAL MEDIAL RECTUS RESECTION WITH 5 mm OF OVERCORRECTION

Exotropia (PD)	Bilateral Medial Rectus Resection (mm)
15+5=20	4
20+5=25	5
30+5=35	7
40+5=45	9
50+5=55	11

TABLE 13
EXOTROPIA: BILATERAL LATERAL RECTUS RECESSION WITH 5 mm OF OVERCORRECTION

Exotropia (PD)	Bilateral Lateral Rectus Recession (mm)
15+5=20	2
20+5=25	2.5
30+5=35	3.5
40+5=45	4.5
50+5=55	5.5
60+5=65	6.5
70+5=75	7.5
80+5=85	8.5
90+5=95	9.5

TABLE 14
EXOTROPIA: UNILATERAL MEDIAL RECTUS RESECTION & LATERAL RECTUS RECESSION WITH 5 mm OF OVERCORRECTION

Exotropia (PD)	Medial Rectus Resection(mm)	Lateral Rectus Recession(mm)
15+5=20	4	2
20+5=25	4	3
30+5=35	4	5
40+5=45	6	6
50+5=55	6	8
60+5=65	8	9
70+5=75	8	11

It is evident from above discussion that the strabismus surgical table proposed by the author is most scientific and most applicable as proved by strabismus surgery on esotropic and exotropic cases of horizontal deviations. However, the formulae to correct strabismus due to vertical muscles and oblique deviations due to superior oblique muscle have to be proved by application of these formulae on surgery.

VII. CONCLUSION

1mm of either recession or resection of lateral rectus corrects 5PD of strabismus. But resection and recession of medial rectus, superior rectus, inferior rectus and superior oblique corrects 2.5PD of strabismus. 1mm of recession and resection of inferior oblique corrects 4PD of strabismus

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