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Artículo original

Resultados a largo plazo de la miopexia retroecuatorial del músculo recto medial para el tratamiento de la esotropía infantil y la esotropía no acomodativa adquirida

Long-term outcomes of retroequatorial medial rectus myopexy for the treatment of infantile esotropia and acquired non accommodative esotropia

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Resumen

Objetivo: Examinar los resultados a largo plazo de la miópexia retroecuatorial del recto medial (MRRM) en pacientes con esotropía infantil (EI) o esotropía no acomodativa adquirida (ENAA). **Métodos:** Análisis retrospectivo de pacientes sometidos a MRRM con un seguimiento mínimo de 24 meses. **Resultados:** Se incluyeron 33 pacientes, con un seguimiento promedio de 8,67±4,64 años. El número promedio de cirugías fue 1,42±0,69, y la tasa de éxito quirúrgico (esotropía ≤10 dioptrías prismáticas [DP] en distancia y cerca) fue del 60,6%. Se realizó resección bilateral del recto lateral posteriormente en nueve pacientes. La esodesviación preoperatoria mediana fue de 35,0 [26,3;44,4] DP, y la esodesviación media al final del seguimiento fue de 5,76±8,15 DP a distancia (Z=-4,682; p<0,001). Nueve pacientes presentaron esodesviaciones postoperatorias de 10-20 DP, y uno ≥20 DP. Tres pacientes desarrollaron exotropía consecutiva. Diez pacientes lograron fusión y siete lograron estereopsis. Nueve pacientes con EI y uno con ENAA desarrollaron hiperfunción del oblicuo inferior (p=0,019), y seis pacientes con EI presentaron desviación vertical disociada (p=0,028). Ningún factor preoperatorio influyó significativamente en los resultados quirúrgicos (p>0,05). **Conclusiones:** Los resultados a largo plazo de la MRRM en el tratamiento de EI o ENAA fueron favorables, con un 61% de pacientes que lograron éxito quirúrgico con un promedio de 1,42 cirugías en 8,67 años de seguimiento.

Palabras clave: *Estrabismo, esotropía, músculos oculomotores, procedimientos quirúrgicos oftalmológicos, trastornos de la motilidad ocular.*

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Summary

Purpose: To examine the long-term outcomes of retroequatorial medial rectus myopexy (RMRM) in patients diagnosed with infantile esotropia (IE) or acquired non accommodative esotropia (ANAE). **Methods:** A retrospective analysis was performed on patients who underwent RMRM at a single center, with a minimum postoperative follow-up of 24 months. **Results:** Thirty-three patients were included, with a mean follow-up of 8.67±4.64 years. The mean number of surgeries was 1.42±0.69, and the surgical success rate (esotropia ≤10 prism diopters [PD] at distance and near) was 60.6%. Bilateral lateral rectus resection was subsequently performed in nine patients. The median preoperative esodeviation was 35.0 [26.3;44.4] PD, and the mean esodeviation at the final follow-up was 5.76±8.15 PD at distance (Z=-4.682; p<0.001). Postoperative esodeviation ranged from 10–20 PD in nine patients and was ≥20 PD in one patient. Three patients developed consecutive exotropia. Ten patients achieved fusion, and seven achieved stereopsis. Nine patients with IE and one with ANAE developed inferior oblique overaction (p=0.019), and six patients with IE developed dissociated vertical deviation (p=0.028). No preoperative factors significantly influenced surgical outcomes (p>0.05). **Conclusions:** Long-term outcomes of RMRM for IE or ANAE were favorable, with 61% of patients achieving surgical success with an average of 1.42 surgeries over 8.67 years of follow-up.

Keywords*:* *Strabismus, esotropia, oculomotor Muscles, ophthalmologic Surgical Procedures, Ocular Motility Disorders.*

INTRODUCTION

Esotropia, a form of strabismus with inward eye deviation, can manifest variably across life stages. Infantile esotropia (IE) and acquired nonaccommodative esotropia (ANAE) present as consistent, nonaccommodative esodeviation developing before and after six months of age, respectively, in healthy children without significant refractive error.[1–4]

Management often involves surgical correction of ocular misalignment to support binocular vision. However, optimal timing and intervention for IE remain debated. Proponents of early surgery suggest it prevents further binocular vision loss, with some suggesting it may restore binocular vision, although early surgery has been linked to a higher reoperation rate.[2,4–8] Additionally, many children with early-onset esotropia experience spontaneous angle reduction to microstrabismus without surgery, maintaining gross binocular vision.[4,6,7,9]

Among surgical techniques, retroequatorial medial rectus myopexy (RMRM), or the Faden operation (from the German term for "suture"), as first described by Cüppers[10], and also known as posterior fixation suture, has emerged as a viable option for esotropia treatment.[2,6,11] Traditional methods typically involve bilateral medial rectus recessions or combined recession-resection. Notably, the Early vs. Late Infantile Strabismus Surgery Study (ELISSS) provided a distinct evaluation of RMRM, finding no significant differences in binocular vision, strabismus angle, or visual acuity compared to other surgical techniques.[2,6,11]

In the RMRM procedure, the rectus muscle is sutured to the sclera 12-14 mm posterior to its insertion near the globe's equator. This technique creates a new muscle insertion posterior to the original one, changing the arc of contact between the muscle and the globe, and displacing the pulley sleeve posteriorly during duction toward the operated-on muscle, thereby weakening the rotational force of the muscle.[12,13] Since the muscle is sutured rather than cut, this technique remains reversible and can be easily undone by simply cutting the sutures in the event of hypercorrection. Furthermore, unlike traditional surgical methods, it preserves anatomical integrity, as no blood vessels are severed, thereby minimizing the risk of anterior segment ischemia.[6]

This study aimed to evaluate the outcomes of RMRM, alone or with medial rectus recession (MRR) or lateral rectus resection (LRR), in treating IE and ANAE and to examine any decrease in posterior fixation effects over time.

PATIENTS AND METHODS

We retrospectively reviewed the medical records of 33 patients who underwent RMRM, with or without MRR or LRR, for IE and ANAE at a single center between June 2012 and September 2020.

The inclusion criteria for the study comprised patients diagnosed with either IE or ANAE, requiring a minimum follow-up of 24 months post-surgery. Patients with neurological disorders were carefully excluded from the latter group. Patients with loss to follow-up, a history of partially or fully accommodative esotropia, ocular anatomical abnormalities, neurological deficits, or previous extraocular muscle surgery were excluded from the study. The exclusion of patients with either partially or fully accommodative esotropia was due to their distinct clinical characteristics and diverse treatment approaches. Amblyopia treatment preceded surgery, and all patients demonstrated alternate fixation at the time of surgery.

Prior to surgical intervention, all patients received complete ophthalmic and orthoptic examinations. Preoperative characteristics recorded included sex, age at onset, prematurity history, refractive error, best-corrected visual acuity (BCVA), preoperative deviation angle, abduction limitation, inferior oblique overaction (IOOA), dissociated vertical deviation (DVD), gaze-evoked nystagmus, and torticollis. Ocular motility and primary gaze angle of deviation were measured at both distance (6 meters) and near (30 centimeters) using the prism and alternate cover test.

The age at the first surgery and the type of surgery were documented. Based on a modified Cüppers technique as described by de Decker[14], posterior fixation sutures were performed. All children received superior and inferior sutures at 12-14 mm posterior to the scleral muscle insertion using a nonabsorbable 5/0 polyester with a spatulated double needle. The sutures were placed after careful dissection of connective tissues around the muscle body and cautious identification of vorticose veins and the long ciliary artery that runs intrasclerally below the muscle body. In cases where MRR was performed, the medial rectus was recessed by 4 mm in conjunction with the RMRM. Surgeries were conducted under microscope view and general anesthesia.

Postoperative examinations included BCVA, deviation angle, surgical success rate, stereoacuity, fusion, IOOA, DVD, vertical strabismus, and torticollis assessments. Fusion was evaluated using the Worth 4-Dot test or Vectogram (Luneau L29 chart projector; Luneau SAS, Chartres, France), and stereopsis was assessed using the Titmus test (Stereo Optical Co. Inc., Chicago, IL, USA) at a distance of 30 centimeters. Stereopsis achievement was considered satisfactory with a positive result on the Titmus Housefly test.

This study complied with all relevant laws and the Declaration of Helsinki principles.

Statistical analyses were conducted using IBM SPSS software. Data normality was assessed using the Shapiro-Wilk and Kolmogorov-Smirnov tests. Group comparisons employed the Mann-Whitney U test and Fisher's exact test for qualitative or quantitative variables, respectively. Continuous variables pre- and post-operation were compared using the Paired Samples T-test or Wilcoxon Signed-Ranks test based on data distribution. A P-value below 0.05 was deemed statistically significant.

RESULTS

Thirty-three patients met inclusion criteria for this study, with baseline demographic and clinical data detailed in Table 1. Among participants, 17 (51.5%) had IE and 16 (48.5%) had ANAE. The cohort included 16 males (48.5%) and 17 females (51.5%), with a median strabismus onset age of 13 [2.5; 25.0] months—5 [1.5; 6.0] months in the IE group and 23 [13.5; 42.0] months in the ANAE group ($p < 0.001$).

Table 1. Baseline Demographic and Clinical Characteristics (n = 33)

	Total	Infantile esotropia	Acquired non-accommodative esotropia	P-value	Success group	Failed group	P-value
No. of patients (%)	33	17 (51.5)	16 (48.5)	n/a	20 (60.6)	13 (39.3)	n/a
Sex (male: female)	16: 17	10: 7	6: 10	0.341[c]	13: 7	7: 6	0.716[c]
Age at onset (months)	13 [2.5; 25.0]	5 [1.5; 6.0]	23 [13.5; 42.0]	<0.001[d]	7.5 [2.0; 23.5]	8.0 [4.0; 15.5]	0.878[d]
Prematurity (%)	2 (6.1)	2 (11.8)	0	0.498[c]	2 (10.0)	0	0.488[c]
Refractive error†	0.38 [0; 1.38]	1.00 [0; 1.56]	0.25 [0; 1.25]	0.834[d]	0.56 [0; 1.44]	0.38 [0; 1.38]	0.872[d]
BCVA (logMAR)	0.01 [0; 0.01]	0.01 [0; 0.18]	0.01 [0; 0.01]	0.148[d]	0.01 [0; 0.01]	0.01 [0; 0.14]	0.504[d]
Angle of esodeviation before surgery (PD) at distance	35.0 [26.3; 44.4]	35.0 [26.3; 58.8]	29.6 [26.1; 38.8]	0.128[d]	35.0 [26.3; 42.8]	35.0 [26.3; 67.5]	0.376[d]
≤ 40 PD (%)	19 (57.5)	10 (58.8)	9 (56.2)	0.449[c]	11 (55.0)	8 (61.5)	0.714[c]
40 - 60 PD (%)	9 (27.3)	6 (35.3)	3 (18.8)	1.000[c]	6 (30.0)	3 (23.1)	0.343[c]
≥ 60 PD (%)	5 (15.2)	4 (23.5)	1 (6.2)	0.370[c]	3 (15.0)	2 (15.4)	0.144[c]
Limitation of abduction (%)	8 (24.2)	8 (47.1)	0	0.009[c]	2 (10.0)	6 (46.2)	0.092[c]
IOOA (%)	14 (42.4)	11 (64.7)	3 (18.8)	0.057[c]	5 (25.0)	9 (69.2)	0.066[c]
DVD (%)	7 (21.2)	6 (35.3)	1 (6.3)	0.087[c]	4 (20.0)	3 (23.1)	1.000[c]
Gaze evoked nystagmus (%)	12 (36.4)	7 (41.2)	5 (31.3)	0.742[c]	7 (35.0)	5 (38.5)	1.000[c]
Torticollis (%)	4 (12.1)	4 (23.5)	0	0.121[c]	1 (5.0)	3 (23.1)	0.199[c]

Values are presented as mean ± standard deviation or median [p25; p75]. P-values from [c]Fisher's exact test and [d]Mann-Whitney test. Surgical success was defined within 10 PD esotropia or orthophoria. † Average of spherical equivalent in the two eyes. BCVA: best-corrected visual acuity; DVD: dissociated vertical deviation; IOOA: inferior oblique overaction; logMAR: logarithm of minimum angle of resolution; n/a: not applicable; SE: spherical equivalent; PD: prism diopters.

Two IE patients had a history of prematurity. The median refractive error was a spherical equivalent of 0.38 [0; 1.38] diopters, and the median BCVA was 0.01 [0; 0.01] logMAR. The median preoperative esodeviation angle at distance was 35.0 [26.3; 44.4] PD. Among participants, 19 (57.5%) had an esodeviation angle ≤ 40 PD, nine (27.3%) between 40 and 60 PD, and five (15.2%) ≥ 60 PD. Abduction limitation was noted in eight patients (24.2%), all with IE, while IOOA was present in 14 patients (42.4%), primarily in those with IE (11 patients). DVD was observed in seven patients (21.2%), predominantly among IE cases (six patients). Gaze-evoked nystagmus was present in 12 patients (36.4%), and torticollis in four (12.1%). A sub analysis was conducted, stratifying the study population into successful and failed subgroups based on the final angle of deviation. No significant baseline differences were detected between these subgroups.

Median age at first surgery was 5.0 [4.0; 6.5] years, with notable group differences: 4.0 [3.5; 5.0] years for IE and 6.5 [5.3; 9.5] years for ANAE (p = 0.001). Surgical types are summarized in Table 2, with an average of 1.42 ± 0.69 surgeries per patient; 21 (63.6%) underwent only one procedure. Adjunctive MRR and/or LRR was conducted in cases where initial deviation angle warranted it, or in subsequent procedures if the initial surgery alone was insufficient. MRR was performed in four patients (6.9%), three diagnosed with IE, and one diagnosed with ANAE. Seven patients (24.1%) underwent LRR, five diagnosed with IE, and two diagnosed with ANAE. Two patients (6.1%) had both procedures, and both diagnosed with IE. Thus, bilateral LRR was subsequently performed in a total of 9 patients. The reasons for the need for a follow-up procedure are summarized in Table 3 and were attributed to inadequate placement distance of the suture—specifically, less than 14

Table 2. Types of Surgery *(n = 33)*

	Total (n = 33)	Infantile esotropia (n = 17)	Acquired non-accommodative esotropia (n = 16)	P-value	Success group (n = 20)	Failed group (n = 13)	P-value
Age at 1st surgery (years)	5.0 [4.0; 6.5]	4.0 [3.5; 5.0]	6.5 [5.3; 9.5]	0.001d	6.0 [4.0; 7.8]	5.0 [4.0; 5.5]	0.362d
No. of surgeries	1 [1; 2]	2 [1; 2]	1 [1; 2]	0.332d			
- One (%)	21 (63.6)	10 (58.8)	11 (68.8)	0.351c	14 (70.0)	7 (53.8)	0.425c
- Two (%)	10 (30.3)	7 (41.2)	3 (18.8)	0.249c	5 (25.0)	5 (38.5)	0.614c
- Three (%)	2 (6.1)	1 (5.8)	1 (6.3)	1.000c	1 (5.0)	1 (7.7)	1.000c
RMRM (%)	20 (60.6)	11 (64.7)	9 (56.3)	0.564c	14 (70.0)	6 (46.2)	0.172c
RMRM + MRR (%)	4 (6.9)	3 (17.6)	1 (6.3)	0.218c	2 (10.0)	2 (15.4)	0.878c
RMRM + LRR (%)	7 (24.1)	5 (29.4)	2 (12.5)	0.465c	3 (15.0)	4 (30.1)	0.301c
RMRM + MRR + LRR (%)	2 (6.1)	2 (11.8)	0	0.735c	1 (5.0)	1 (7.7)	0.767c

Values are presented as mean ± standard deviation or median [p25; p75]. P-values from cFisher's exact test and dMann-Whitney test. LRR: lateral rectus resection; MRR: medial rectus recession; RMRM: retroequatorial medial rectus myopexy

mm from the rectus muscle insertion—and/or a large preoperative angle of deviation exceeding 60 PD. There were no statistically significant differences between the strabismus subgroups or the success and failed groups. There were no reports of severe intraoperative or postoperative complications recorded.

The average follow-up was 8.67 ± 4.64 years. Postoperative outcomes, detailed in Tables 4 and 5, show that 20 patients (60.6%) achieved surgical success (orthophoria or esotropia within 10 prism diopters [PD] at distance and near), without significant differences between the two strabismus subgroups. There were no preoperative factors, namely age at onset, history of prematurity, refractive error, BCVA, angle of esodeviation, presence of limitation of abduction, IOOA, DVD, nystagmus or torticollis influencing the surgical outcome ($p > 0.05$). Mean postoperative esodeviation was 5.76 ± 8.15 PD at final follow-up, ($Z = -4.682$; $p < 0.001$). Postoperative esodeviation angles were between 10 and 20 PD in nine patients (27.3%) and ≥ 20 PD in one patient (3.0%). Consecutive exotropia developed in three patients (9.1%), all with IE. Fusion was achieved in 10 patients (30.3%), and stereopsis was recorded in seven patients (21.2%) per the Titmus

Table 3. Reoperation Rate After Retroequatorial Medial Rectus Myopexy OU *(n=9)*

RMRM measurements	Additional surgery	Angle of esodeviation before surgery	Esotropia
14 mm OD; 12 mm OS	LRR OU	40 PD	Infantile
12 mm OU	LRR OU	40 PD	Infantile
14 mm OU	LRR OU	60 PD	Acquired nonaccommodative
14 mm (+ MRR 4 mm OU)	LRR OU	70 PD	Infantile
14 mm (+ MRR 3 mm OU)	LRR OU	78 PD	Infantile
13 mm OD; 12 mm OS	LRR OU	78 PD	Infantile
12 mm OD; 13 mm	LRR OU	45 PD	Acquired nonaccommodative
13.5 mm OD; 12.5 mm OS	LRR OU	17.5 PD	Infantile
14 mm OU	LRR OU	60 PD	Infantile

LRR: lateral rectus resection; MRR: medial rectus recession; OD: right eye; OS: left eye; OU: both eyes; PD: prism diopters; RMRM: retroequatorial medial rectus myopexy.

Table 4. Postoperative Outcomes in Infantile Esotropia and Acquired Nonaccommodative Esotropia and Success and Non-success Groups *(n = 33)*

	Total	Infantile esotropia	Acquired nonaccommodative esotropia	P-value	Success group	Failed group	P-value
Follow-up (years)	8.67 ± 4.64	9.44 ± 4.62	7.58 ± 4.64	0.296[e]	9.16 ± 5.74	8.01 ± 2.87	0.271[e]
BCVA (logMAR)	0 [0; 0.01]	0 [0; 0.01]	0 [0; 0.07]	0.165[d]	0 [0; 0.10]	0 [0; 0.10]	0.373[d]
Angle of deviation at distance / near	5.76 ± 8.15 / 7.10 ± 7.71	4.12 ± 7.99 / 6.88 ± 7.58	8.08 ± 8.13 / 7.42 ± 8.21	0.202[e] / 0.858[e]	3.00 ±3.16 / 3.63 ± 3.42	9.15 ± 5.74 / 11.38 ± 9.38	0.020[e] / 0.002[e]
Surgical success [≤ 10 PD] (%)	20 (60.6)	11 (64.7)	9 (56.3)	0.890[c]	n/a	n/a	n/a
Outcome > 10 PD and < 20 PD (%) Angle of deviation at distance /near	9 (27.3) 14.00 ± 4.77/ 14.00 ± 5.32	5 (29.4)	4 (25.0)	1.000[c]	n/a	n/a	n/a
Outcome ≥ 20 PD (%) Angle of deviation at distance / near	1 (3.0) 18 / 25	0	1 (6.3)	0.414[c]	n/a	n/a	n/a
Outcome consecutive exotropia (%) Angle of deviation at distance / near	3 (9.1) -8.33 ± 4.93 / -1.00 ± 7.81	3 (17.6)	0	0.246[c]	n/a	n/a	n/a
Fusion (%)	10 (30.3)	5 (29.4)	5 (31.3)	1.000[c]	8 (40.0)	2 (15.4)	0.152[c]
Stereoacuity (%)	7 (21.2)	2 (11.8)	5 (31.3)	0.198[c]	6 (30.0)	1 (7.7)	0.183[c]
IOOA (%)	10 (30.3)	9 (52.9)	1 (8.3)	**0.019**[c]	6 (30.0)	4 (30.8)	1.000[c]
Vertical strabismus (%)	6 (18.3)	6 (35.3)	0	0.028[c]	4 (20.0)	2 (15.4)	0.663[c]
DVD (%)	7 (24.1)	6 (35.3)	1 (6.3)	0.087[c]	5 (25.0)	2 (15.4)	0.329[c]
Torticollis (%)	1 (3.0)	1 (5.9)	0	1.000[c]	0	1 (7.7)	0.448[c]

Values are presented as mean ± standard deviation or median [p25; p75]. P-values from [c]Fisher's exact test, [d]Mann-Whitney test and [e]independent t-test. Surgical success was defined within 10 PD esotropia or orthophoria. *BCVA:* best-corrected visual acuity; *DVD:* dissociated vertical deviation; *IOOA:* inferior oblique overaction; *logMAR:* logarithm of minimum angle of resolution; *n/a:* not applicable; *PD:* prism diopters.

test. After surgery, nine patients (52.9%) with IE and one patient (8.3%) with ANAE presented IOOA (p = 0.019), and six patients (35.3%) with IE presented with vertical strabismus (p = 0.028). DVD was unchanged in seven patients, and one patient (3.0%) exhibited torticollis.

DISCUSSION

Optimal surgical strategies for esotropia remain a point of debate. The ELISSS study noted a preference among European surgeons for recession-resection surgery, while a Cochra-

Table 5. Postoperative outcomes

	Before surgery	After surgery	P-value
Angle of esodeviation (PD)	35.0 [26.3; 44.4]	5.76 ± 8.15	<0.001[f]
IOOA (%)	14 (42.4)	10 (30.3)	0.248[f]
DVD (%)	7 (21.2)	7 (21.2)	1.000[f]
Torticollis (%)	4 (12.1)	1 (3.0)	0.083[f]

Values are presented as mean ± standard deviation or median [p25; p75]. P-values from fWilcoxon test. DVD: dissociated vertical deviation; IOOA: inferior oblique overaction; PD: prism diopters.

ne review cited no definitive best technique, with non-surgical options and timing still open questions.[2,6] While bimedial rectus recession is common, a lack of randomized trials has led to diverse surgical preferences. RMRM offers a promising alternative, with this study highlighting its long-term efficacy, safety, and potential role in managing IE and ANAE.

Baseline characteristics of IE and ANAE subgroups were largely comparable except for age at onset ($p < 0.001$) and abduction limitation ($p = 0.009$), which were expected based on the natural history of each type. Although not statistically significant, IE patients had higher rates of IOOA, DVD, and torticollis. In our clinical practice, we do not specifically address IOOA since the RMRM procedure has the potential to improve or correct it. RMRM showed potential for IOOA correction, with 4 out of 14 cases achieving full correction through this technique alone. Our center has reported IOOA correction rates as high as 65.5% with RMRM.[15]

Age at initial surgery was younger in the IE group. Trends at our center indicate a shift toward earlier surgeries, facilitated by advancements in technique, theoretical understanding, and earlier referrals, particularly as access to healthcare improves in socioeconomically disadvantaged populations served by our institution.

Most patients (21 out of 33) required only one surgery. When secondary surgeries were needed, it was typically due to large deviation angles or suboptimal initial suture placement.

In some initial and exceptional cases, myopexy was not performed bilaterally during the same surgical intervention. MRR was used as an adjunct to myopexy in four patients within the same surgery, reflecting an initial trend of combining both techniques, although this is no longer standard practice at the authors' center. LRR was performed as a standalone procedure in seven patients, five diagnosed with IE, during a secondary intervention; it was combined with MRR in two patients, as summarized in Table 3. Notably, both of these latter patients presented with deviations ≥ 70 PD. Interestingly, of the seven patients who underwent LRR as a secondary intervention, five had initially received RMRM at only 12 mm from the scleral insertion due to technical challenges.

The surgical technique's precision is crucial, especially the meticulous separation of the pulleys and adherence to a 14 mm distance. Notably, a 12 mm separation is generally reserved for infants up to two years old, considering the anatomical nuances of this age group. Additionally, the two remaining patients presented with deviations of ≥ 60 PD. All five patients initially identified with deviations ≥ 60 PD subsequently underwent LRR. While myopexy alone may not completely correct deviations over 60 PD, it remains valuable for reducing such deviations. Given the variability in surgical outcomes, our current approach is to perform LRR as a secondary procedure, adjusting the resection extent based on residual deviation.

Previous studies on strabismus surgery have primarily focused on postoperative binocular vision and alignment, with limited discussion on the number of operations required. This study highlights the long-term stability of postoperative alignment, showing minimal need for additional surgical interventions over time.

This study's nearly nine-year follow-up period allowed for robust long-term analysis of RMRM outcomes, an aspect rarely addressed in existing literature.

The reduction of mean esodeviation angle from 35 PD preoperatively to approximately 6 PD at the final follow-up ($Z = -4.682$; $p < 0.001$) demonstrates RMRM's efficacy in reducing deviation angle in IE and ANAE.

The long-term surgical success rate of approximately 61% is promising. However, aiming for alignment within a 10 PD deviation may be overly ambitious, especially for patients with high-angle infantile esotropia. Beyond improving ocular alignment, an important consideration is whether treatment promotes and enhances binocular vision development. Many experts believe that alignment within 10 PD offers the best potential for developing binocularity.[4,6,7,16,17] When considering a less stringent target of 20 PD—commonly reported in the literature as both aesthetically acceptable and clinically effective—the success rate rises to an impressive 87.9%. Additionally, it is worth noting that surgical success in this study was defined as a deviation ≤ 10 PD for both near and distance vision. This criterion may underestimate success in cases where alignment meets the target for only one distance, especially for distance rather than near vision.

RMRM has become a routine IE procedure at our institution. In only one case did deviation angle exceed 20 PD postoperatively, with three (9.1%) patients developing consecutive exotropia, a result comparable to existing studies (e.g., 17% in Happe et al. and 5% in Akar et al.).[11,18] Documenting only three cases of consecutive exotropia over a long-term follow-up period—a timeframe not commonly reported in the literature—offers valuable insight into the sustained effectiveness of this surgical technique. This outcome may be attributable to a myopexy distance greater than 14 mm or the inclusion of more than one-third of the muscle mass within the suture.

Beyond deviation angle correction, this study reports 30% fusion achievement and 21% gross stereopsis, data not frequently covered in literature and challenging to compare due to varied reporting standards.

Limitations of this study include procedural variations across surgeons and significant follow-up losses post-first year. Nonetheless, given the limited sample sizes, follow-up durations, and varied populations in existing studies, these findings add valuable insights into the long-term viability of RMRM.

CONCLUSIONS

RMRM demonstrates long-term efficacy in IE and ANAE correction, achieving a 61% success rate for ≤10 PD alignment and 88% for ≤20 PD. Distance fusion and gross stereopsis outcomes further emphasize the favorable potential of this technique. RMRM's reversibility and anatomy-preserving nature, with minimal vascular disruption, present a significant advantage over traditional surgeries. While encouraging, this study's limitations—procedural variation among surgeons and long-term follow-up challenges—warrant caution. Despite these factors, this study provides valuable insights into RMRM outcomes, underscoring its potential as a safe and effective option for managing esotropia. Future research with larger cohorts and extended follow-up will further elucidate RMRM's safety and efficacy in esotropia management.

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BIBLIOGRAFÍA

1. Jacobs SM, Green-Simms A, Diehl NN, Mohney BG. Long-term Follow-up of Acquired Nonaccommodative Esotropia in a Population-based Cohort. Ophthalmology. 2011 Jun; 118(6): 1170-4.
2. Elliott S, Shafiq A. Interventions for infantile esotropia. Cochrane Database of Systematic Reviews. 2013 Jul 29.
3. Claxton MR, Bang GM, Martinez-Thompson J, Hodge DO, Mohney BG. Prevalence and clinical characteristics of age-related distance esotropia. Strabismus. 2022 Jul 3; 30(3): 115-20.
4. The clinical spectrum of early-onset esotropia: experience of the congenital esotropia observational study. Am J Ophthalmol. 2002 Jan; 133(1): 102-8.
5. Polling JR, Eijkemans MJC, Esser J, Gilles U, Kolling GH, Schulz E, et al. A randomised comparison of bilateral recession versus unilateral recession-resection as surgery for infantile esotropia. British Journal of Ophthalmology. 2009 Jul 1; 93(7): 954-7.
6. Simonsz HJ, Kolling GH, Unnebrink K. Final Report of the Early vs. Late Infantile Strabismus Surgery Study (ELISSS), a Controlled, Prospective, Multicenter Study. Strabismus. 2005 Jan 8; 13(4): 169-99.

7. Birch EE, Stager DR. Long-Term Motor and Sensory Outcomes After Early Surgery for Infantile Esotropia. Journal of American Association for Pediatric Ophthalmology and Strabismus. 2006 Oct; 10(5): 409-13.
8. Gerth C, Mirabella G, Li X, Wright T, Westall C, Colpa L, et al. Timing of Surgery for Infantile Esotropia in Humans: Effects on Cortical Motion Visual Evoked Responses. Investigative Opthalmology & Visual Science. 2008 Aug 1; 49(8): 3432.
9. Simonsz HJ, Eijkemans MJC. Predictive Value of Age, Angle, and Refraction on Rate of Reoperation and Rate of Spontaneous Resolution in Infantile Esotropia. Strabismus. 2010 Sep 15; 18(3): 87-97.
10. Cüppers C. The so-called «Fadenoperation»: Fells P, ed Second Congress of the International Strabismological Association Marseille: Diffusion Générale de Librairie. 1976; 395-400.
11. Happe W. Long-term results after bimedial posterior fixation sutures for infantile esotropia. Strabismus. 1997 Jan 8; 5(3): 117-24.
12. Clark RA, Isenberg SJ, Rosenbaum AL, Demer JL. Posterior fixation sutures: a revised mechanical explanation for the fadenoperation based on rectus extraocular muscle pulleys. Am J Ophthalmol. 1999 Dec; 128(6): 702-14.
13. Faden Operation (Posterior Fixation Suture). In: Color Atlas of Strabismus Surgery. New York, NY: Springer New York; p. 200-4.
14. de Decker W. The Faden operation. When and how to do it. Trans Ophthalmol Soc U K. 1981;101 (Pt 2): 264-70.
15. Martins de Almeida I, Costa Ferreira C, Monteiro M, Coimbra de Matos J, Salgado Borges J. Cirugía del Hilo y hiperfunción del oblicuo inferior en la esotropia congénita. ¿Cuál es la relación? Acta Estrabológica. 2013; XLII(2): 191-6.
16. Ing MR. Early Surgical Alignment for Congenital Esotropia. Ophthalmology. 1983 Feb; 90(2): 132-5.
17. Ing MR. Outcome Study of Surgical Alignment before Sup Months of Age for Congenital Esotropia. Ophthalmology. 1995 Dec; 102(12): 2041-5.
18. Akar S, Gokyigit B, Ozturk A, Yilmaz OF. Consecutive Exotropia Development Risk Following a Medial Rectus Faden Operation. Journal of American Association for Pediatric Ophthalmology and Strabismus. 2006 Feb; 10(1): 82.