Evaluation of reinforced plication as an alternative to resection in exotropia

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Purpose: To evaluate the surgical efficacy of reinforced plication of the medial rectus muscle to resection as an effective muscle strengthening procedure in exotropia. Methods: This is a prospective randomized trial in patients with exotropia who underwent complete orthoptic evaluation followed by random assignment into two groups by using a computer-drawn random number table. Group 1 patients underwent standard resection with recession procedure, and group 2 patients underwent reinforced plication with recession procedure. Follow-up was performed at day 1, 1 week, 1 month, 3 months, and 6 months to assess the surgical efficacy. Results: A total of 80 patients were included in the study of which 39 were in group 1 and 41 in group 2. The mean age in group 1 was 23.48 ± 11.94 years and 23.29 ± 10.02 years in group 2. The mean preoperative deviation in group 1 for distance was 50.13 ± 11.95 PD and 50.12 ± 9.79 PD in group 2 (P = 0.499). In group 1 with a mean surgical dose of 5.27 mm medial rectus resection and 8.04 mm lateral rectus recession, a 7.11 ± 3.95 PD deviation was noted at the end of 6 months. Similarly, in group 2 with a mean surgical dose of 5.16 mm medial rectus plication and 8.16 mm lateral rectus recession, a 6.00 ± 2.46 PD deviation was noted at the end of 6 months. Between groups, ocular surface changes, inter-surgeon comparison, and exotropia subtypes did not reveal any significant differences. Conclusion: In our observation, the reinforced medial rectus muscle plication showed clinically comparable results as compared to the standard resection procedure at the end of 6 months. Therefore, this innovative modification can be considered as an alternative to standard resection.

Key words: Medial rectus plication, medial rectus plication versus resection for exotropia, reinforced medial rectus plication

Exotropia can be corrected either by recessing the lateral rectus alone or by combining it with the resection of the medial rectus.[1] Resection of the medial rectus muscle is a standard strengthening procedure involving dis-insertion of the muscle, cutting a distal portion of the tendon-muscle complex, and then re-insertion at the original site. In contrast, plication is a muscle-tightening procedure that involves folding the muscle on itself.[2] Owing to direct dissection of the ciliary vessels during medial rectus resection, plication can be considered as a safer alternative. Moreover, this procedure has various advantages, such as shorter surgical time and less invasive maneuvering, leading to lesser inflammation and lower risk of hemorrhage. Moreover, the muscle is not cut; therefore, the complications of slippage and muscle loss are also avoided.[3] However, this surgery did not gain popularity due to the disadvantages of eventual relaxation of muscle and clinical recurrence of the deviation as muscle to muscle suturing was done, causing a long-term “cheese-wiring” effect. In recent years, Wright’s modification with sutures being passed from muscle to sclera[4] results in effective anchoring and reduction in eventual relaxation and thus recurrence in deviation has declined.[5-11] We have modified the existing technique by employing a muscle-sclera-muscle (MSM) suturing pattern, whereby further reinforcement is likely to provide an extra edge in achieving successful results in cases of exotropia. In this study, we highlight the surgical technique, clinical efficacy, and other parameters related to plication in various subsets of patients.

Methods

The study was a prospective randomized interventional study on patients with intermittent or constant exotropia presenting to our strabismus clinic. Ethical clearance was obtained from the institute’s ethics committee. Written informed consent was obtained from each patient, and the present study adheres to the tenets of the Declaration of Helsinki.

Cases of exotropia undergoing medial rectus resection or medial rectus plication along with recession of the antagonist lateral rectus with no significant A and V pattern were included in the study. A total of 80 patients with exotropia who met our inclusion criteria were included. A detailed history was recorded regarding the age of onset, duration, progression, and the time period of manifestation of ocular deviation. In addition, other relevant history such as probable cause, family history, and previous treatment were also noted. Following this, a brief general and systemic examination was performed.

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for any associated systemic abnormalities. Visual acuity, anterior segment examination on slit-lamp biomicroscopy, and posterior segment examination were performed using binocular indirect ophthalmoscope by a single observer. The patients were prescribed glasses with appropriate cycloplegic refraction prior to orthoptic assessment. Orthoptic assessment was performed, which consisted of ocular deviations for near and distance measured using Prism bar cover test (PBCT), stereoaucity for near and distance, and fusional range whenever possible. The patients were then randomized into two groups based on a computer-generated random number table. Group 1 included a total of 39 patients who underwent medial rectus resection and lateral rectus recession, and group 2 included remaining 41 patients who underwent medial rectus plication along with lateral rectus recession. Medial rectus resection and lateral rectus recession surgeries were performed in a routine manner, and the reinforced plication was performed as elaborated below.

Surgical technique: Reinforced plication
After performing medial localized fornix-based conjunctival incision, the medial rectus was hooked and dissected. The amount of plication was marked along the surface using Castroviejo’s caliper; then, two single‑armed 6-0 polyglactin sutures were passed through the marked site from the center to the periphery, one partial and another full thickness in an interlocking fashion. These sutures were then passed through the sclera, just anterior to insertion again from the center to the periphery. After attaining sufficient scleral anchoring, these sutures were again rolled back toward the primary muscle mark site and passed again in a “figure of 8” pattern [Fig. 1]. After this, the iris repositor was positioned between the four 6-0 polyglactin sutures and the outer muscle surface. Iris repositor acted as a shaft over which the hooked muscle was brought toward the scleral sutures by putting a forward traction on the muscle hook. The sutures were then tightened till the desired muscle mark was reached, and peritomy was closed using 8-0 polyglactin. All patients were advised antibiotic, steroid and carboxymethylcellulose 0.5% eye drops in the post-operative period for 6 weeks in a tapering manner [Video 1 and Fig. 1].

Post operative assessment
Postoperative follow-up was done at one day, one week, 1 month, 3 months, and 6 months. In the follow-up period, the deviations were recorded for near and distance by using PBCT, and slit lamp examinations were performed to look for the ocular surface changes and the muscle lump‑related changes at the abovementioned regular intervals. The types of exotropia, that is, sensory exotropia, intermittent exotropia, and alternate divergent squint were comparable: 13, 9, and 17, respectively, in group 1, and 19, 7, and 15, respectively, in group 2.

Data collection and analysis
Pre-surgery and post-surgery clinical details, eye examination, and investigations were recorded in a proforma. Using an equivalence margin of 2, an expected difference as 0, power of study (1–β) being 90%, and α error being 5, the sample size was calculated to be 34 in each group. All the data were recorded in an Excel spreadsheet and statistical analysis was performed using the Software Stata V12.1. The Unpaired t test and Chi-square test were used to compare patient characteristics and surgical outcomes in the two groups. Mann–Whitney U test was used to analyze long-term surgical results.

Results
Patient demographic and preoperative clinical parameters
A total of 80 patients were included in the study of which 39 were in group 1 and 41 in group 2. The mean age in group 1

Figure 1: (a) After the dissection of tissue, medial rectus muscle is hooked and marked at the desired length using caliper. (b) 6-0 polyglactin sutures are passed from center to periphery in an interlocking fashion. (c) The sutures are then passed through the sclera just anterior to muscle insertion. (d) The sutures are then again passed through the muscle site to form a figure of 8. (e) An iris repositor is passed between the four sutures and the muscle. (f) With the iris repositor as a shaft, the muscle hook is now moved anteriorly to bring the muscle suture nearer to the scleral sutures to complete the plication
was 23.48 ± 11.94 years and 23.29 ± 10.02 years in group 2. Male to female ratio in group 1 was 21/18 and 23/18 in group 2. On statistical comparison, no significant difference with respect to age was noted between the two groups (P > 0.05).

Mean preoperative deviation in group 1 for distance was 50.13 ± 11.95 PD and 50.12 ± 9.79 PD in group 2 (P = 0.499 using Unpaired T test). Similarly, the mean preoperative deviation for near was 51.28 ± 10.08 PD and 50.00 ± 10.18 PD for group 1 and 2, respectively (P = 0.293 using Unpaired T test). Thus, there was no statistically significant difference in the preoperative data between the groups was noted.

Primary outcomes
Post-operative deviation
In group 1, the mean surgical dose of 5.27 mm of medial rectus resection and 8.04 mm for lateral rectus recession was planned, and a postoperative deviation of 3.28 ± 3.53 PD on day 1 and 7.11 ± 3.95 at 6 months was noted. A mean exodrift of 3.83 PD was noted between day 1 to 6 months in this group. Similarly, in group 2 with a mean surgical dose of 5.16 mm for medial rectus plication and 8.16 mm of lateral rectus recession, mean postoperative deviation of 2.88 ± 2.53 PD on day 1 and 6.00 ± 2.46 PD at 6 months was noted. In this group, a mean exodrift of 3.12 PD was noted. Between the groups, day 1 and 6 months statistical comparison revealed no significant difference (P = 0.657 and 0.071 for 1 day and 6 months, respectively; comparison using Unpaired t test) [Fig. 2].

Secondary outcomes
1. Post-surgery subconjunctival muscle lump
The evident conjunctival lump due to medical rectus resection was more evident at the end of surgery and on the first postoperative day due to hemorrhage and conjunctival chemosis. However, this swelling subsided gradually from day 1 to day 7, which in turn completely disappeared at the end of 1 month. The surface under the slit-lamp examination appeared regular and smooth with no additional irregularities even in adduction at 1 month.

2. Effect of plication in different subsets of exotropia
A total of 13 and 19 patients with sensory exotropia underwent surgery in group 1 and group 2, respectively. The mean preoperative deviation for group 1 was 42.85 PD, which went down to 1.08 PD on the first postoperative day and 6.33 PD at the end of 6 months. Similarly, in group 2, the mean preoperative deviation was 50.53 PD, 2.42 PD on the first postoperative day, and 6.33 PD at the end of 6 months. Therefore, no significant difference between the two procedures was noted in this subset of exotropia (P > 0.05). Similarly, in cases of intermittent exotropia and alternate divergent squint, the mean postoperative deviation on day one and at the end of 6 months did not reveal any statistically significant difference.

3. Congestion, chemosis, and foreign-body sensation
All these three complaints were equally encountered in both groups and subsequently subsided at the end of 1 month or later with no significant difference between the two groups; 26/39 patients in the resection and 21/41 patients in the plication group had foreign-body sensation which resolved eventually and was subjective. At 1 month, 4/39 patients in resection and 6/41 patients in plication still complained of foreign-body sensation which resolved completely by 3 months period.

4. Effect of surgeons on the results
The plication technique which as taught by the senior surgeon (PS) is routinely performed by young senior residents and others. Here, we compared the results between a senior surgeon (Surgeon 1, PS) and other senior residents (Surgeon 2). It was observed that the post-operative deviation pattern showed comparable results between the two surgeon groups with no noted adverse events neither intraoperatively nor postoperatively; therefore, the reinforced technique is simple and can be replicated with minimum learning difficulties.

In our observation over a period of 6 months during the study protocol, none of our patients required resurgery. Similarly, other complications such as muscle slippage, loosening of sutures, and ocular surface complications (conjunctival granuloma or Dellen) were not encountered in any patient. The abduction limitation was evident during the initial periods of follow-up; however, it disappeared completely at the end of three months.

Discussion
The rectus muscle plication in strabismus surgery was first described in 1883,[10] however, due to the hesitation of initial unsightly lumps and variable surgical success with older techniques, it was less preferred by surgeons till recently. Moreover, the much thought concerns of under-correction and/or reversal of the surgical effect of plication have been mitigated by constant modifications. Since its re-introduction as muscle to scleral suturing by Wright,[6] several studies have explored the clinical efficacy of plication.[5–11] However, the majority of these studies are not prospective, randomized, and multi-surgeon comparisons. Therefore, to address this major concern, this study was undertaken with a well-thought suturing technique of muscle-sclera-muscle plication (MSM).

The observations by Chaudhuri et al.,[5] Kimura et al.,[6] and Alkharashi and Hunter[12] are retrospective and noted the equal clinical efficacy of plication and resection, except...
Alkharashi and Hunter, who noted an under correction rate of 12.5% who needed resurgery to restore the alignment. The possible underlying mechanisms of recurrence of deviation could be because of 1) different subtypes of exotropia with different binocular fusional abilities, 2) different suturing techniques with surgical skills, and 3) intraoperative measurement/marking errors with inefficient scleral anchorage. In our prospective observation, the reinforced plication augmented the clinical efficacy by reducing the chances of suture loosening and subsequent recurrence of ocular deviation. In our 6 months observation period, we did not encounter any case with either residual deviation or over-corrections. In addition, being performed by multiple trained surgeons, this technique did not appear difficult to learn. The encouraging results has led to a major change over in the surgical planning, thereby reinforcing MSM plication as the preferred procedure over resection in a majority of the cases at present at our center.

Recently, Lee et al. analyzed the retrospective data of plication versus resection in intermittent exotropia. Their subjects were children with a mean age of 6.7 ± 2.5 years in the recession-resection (RR) group and a mean age of 6.6 ± 2.1 years in the recession-plication (RP) group. They noted inferior results with plication at the end of 2 years even though they had 1.5 mm over planning for plication as compared to the same amount of resection. The resection procedure failed at almost every follow up till 2 years; thus, they concluded that the exodrifts were longer in the plication group. However, in our clinical practice, we noted almost equal clinical efficacy with the same amount of plication and resection for a particular deviation in adult patients, and this role of overplanning in pediatric patients needs further exploration.

The cosmetic concerns such as elevated conjunctiva or a lump underneath due to folded muscle were found to be self-limiting events in our study. The ocular surface recovered its smooth texture at around 4–6 weeks post-operatively. The muscle site hemorrhage was more during resection, but a similar amount of clinically visible hematoma was observed on the next day after plication as well as resection. However, this clinical picture resolved after the initial few weeks. Moreover, the inflammation and other findings are in accordance with those noted by Sonwani et al. and this similar trend has been noted in the majority of the studies.

The positive implications from our study to the literature are as follows: 1) Description of an innovative modification, muscle-sclera-muscle (MSM) suturing to the existing plication technique to overcome the possible muscle relaxation related problems. 2) Prospective, randomized, and multi-surgeon compared results showing easy learning curve with equally achievable clinical results in sufficiently large numbers of patients. 3) The chances of under-correction and/or need for resurgery can be averted with appropriate suturing techniques. 4) Ocular surface problems such as hemorrhage/hematoma, muscle lump, ocular inflammation, and others are comparable with the resection group. However, no study is with its inherent limitations, and our study limitations are the relatively shorter duration of follow-up and single-center study.

Conclusion

To conclude, the modified reinforced MSM plication technique provides comparable surgical results to resection in various types of exotropia at the end of 6 months. In addition, ocular surface problems such as visible muscle lump, hemorrhage, inflammation, and others were equally comparable between the groups.

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Conflicts of interest
There are no conflicts of interest.

References

1. Suh SY, Choi J, Kim SJ. Comparative study of lateral rectus recession versus recession–resection in unilateral surgery for intermittent exotropia. J AAPOS 2015;19:507-11.
2. Wright KW. Rectus muscle plication procedure. JAMA Ophthalmol 2015;133:226-7.
3. Oltra EZ, Pineles SL, Demer JL, Quan AV, Velez FG. The effect of rectus muscle recession, resection and plication on anterior segment circulation in humans. Br J Ophthalmol 2015;99:556-60.
4. Wright KW, Lanier AB. Effect of a modified rectus tuck on anterior segment circulation in monkeys. J Pediatr Ophthalmol Strabismus 1991;28:77-81.
5. Chaudhuri Z, Demer JL. Surgical outcomes following rectus muscle plication: A potentially reversible, vessel-sparing alternative to resection. JAMA Ophthalmol 2014;132:579.
6. Kimura Y, Kimura T. Comparative study of plication–recession versus resection–recession in unilateral surgery for intermittent exotropia. Jpn J Ophthalmol 2017;61:286-91.
7. Sonwani P, Amitava A, Khan A, Gupta S, Grover S, Kumari N. Plication as an alternative to resection in horizontal strabismus: A randomized clinical trial. Indian J Ophthalmol 2017;65:853-8.
8. Kühne J, Palmowski-Wolfe A. Plication versus resection in horizontal strabismus surgery. Klin Monbl Augenheilkd 2019;236:442-5.
9. Wang X, Zhang W, Chen B, Liao M, Liu L. Comparison of bilateral medial rectus plication and resection for the treatment of convergence insufficiency-type intermittent exotropia. Acta Ophthalmol (Copenh) 2019;97:e448-53.
10. Sukhija J, Kaur S. Comparison of plication and resection in large-angle exotropia. J Am Assoc Pediatr Ophthalmol Strabismus 2018;22:348-51.
11. Anand K, Baindur S, Dhiman S, Dutta P, Mishra M, Rastogi A, et al. Surgical outcomes of plication versus resection in basic type of intermittent exotropia. Can J Ophthalmol 2020.
12. Alkharashi M, Hunter DG. Reduced surgical success rate of rectus muscle plication compared to resection. J Am Assoc Pediatr Ophthalmol Strabismus 2017;21:201-4.
13. Lee H-J, Kim S-J. Long-term outcomes following resection-recession versus plication-recession in children with intermittent exotropia. Br J Ophthalmol 2020;104:350-6.