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COMBINED LATERAL RECTUS RESECTION AND MEDIAL RECTUS RECESSION FOR UNILATERAL TYPE 1 DUANE RETRACTION SYNDROME: A PROSPECTIVE INTERVENTIONAL STUDY

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ABSTRACT

Purpose: The aim of current study was to estimate the effectiveness and complication rates of a small amount of resection of lateral rectus (LRR) blended with recession of medial rectus (MRR) performed in severe esotropia in patients with unilateral Type 1 Duane Retraction Syndrome (DRS).

Methods: Nine-teen consecutive patients (age 15.37 ± 11.03 years) with unilateral Type 1 DRS, more than or equal to 25 PD esotropia and severe (−3) restrictions of abduction were selected for the study and those with significant retraction of globe or leash phenomenon preoperatively were omitted. All were operated under combined surgery comprised of 4–6 mm MR recession, and 2–4.5 mm LR resection. Primary outcomes were extent of esotropia correction and margin of abduction improvement at 12 weeks after surgery, with abnormal posture of the head (AHP) and grade of globe retraction being the secondary ones.

Results: Pre-surgery esotropia (33.42 ± 6.25 PD) fell to 0.11 ± 0.46 prism dioptre at week 12 post-op ($p < 0.001$). The mean decrease in abduction restriction (ranging from -2 moderate abduction limitation to 0 no restriction) from -2.16 to −0.39 ($p<0.001$). There were no reported cases with progression and the median grade of globe-retraction changed from 1 (mild) to 0 (none) ($Z = −3.035$, $p = 0.002$). 66.7% of the patients with abnormal head posture improved ($p < 0.05$). Repeated-measures ANOVA verified that there were no differences in the gains in alignment between postoperative visits ($F = 424.19$, $p < 0.001$).

Conclusion: MR resection of moderate amplitude and limited LR resection (<4.5 mm) was very effective in this very select group of unilateral Type 1 DRS patients with only slight amount of retraction preoperatively. The technique provided accurate primary-position alignment and good horizontal force balance with limited globe retraction and marked improvements in abduction, which may be superior long term compared with only recession of MR.

Keywords: Duane Retraction Syndrome Type 1, Abnormal Head Posture, Leash phenomenon, Globe Retraction, Esotropia.

INTRODUCTION

An inability to perform ductions in horizontal gaze, retraction of the globe and palpebral fissure shrinkage, often associated with up or downshoots on adduction (Leash phenomenon), make up the definition of Duane Retraction Syndrome (DRS) an example of global fibrosis syndrome or CCDD (Congenital Cranial Dysinnervation Syndrome[1,2]. Type 1, its most frequent presentation, involves near-complete or complete abduction deficit, primary position esotropia, and the characteristic retraction of the globe and lid-fissure shrinkage seen on attempted adduction[3,4]. The co-contraction and mechanical tethering underlying this presentation stem from anomalous oculomotor innervation of the lateral rectus (LR), possibly compounded by fibrotic change within the horizontal recti[1].

These motility deficits commonly force patients to adopt a face turn as a compensatory mechanism toward the affected side to preserve binocular single vision and limit diplopia, with meaningful downstream effects on appearance, binocular function, and overall quality of life[5,6,7]. Surgery therefore aims to correct primary-position alignment, widen the Binocular single vision range, reduce torticollus, and lessen retraction of the globe in addition to any associated vertical overshoot[5,7].

Unilateral or bilateral MR recession (weakening) remains the standard surgical approach for esotropic Type 1 DRS and successfully corrects esotropia in primary position and head turn in the majority of cases[5,7]. It does little, however,

to enhance abduction itself, and may instead produce fragility of adduction, difficulties in convergence, or a slow outward eye deviation over time, with published series reporting an average annual exodrift near 1–1.3 PD after Medial rectus recession surgery[5]. Larger recessions, whether unilateral or bilateral, carry a further overadjustment and manifested outward deviation danger[5]. These shortcomings have driven interest in adjunctive techniques capable of boosting abducting force without exacerbating co-contraction.

Several groups have been advocated to combine these slight LR strengthening procedures with MR weakening in a very select group of unilateral (U/L) Type 1 DRS patients, in whom conventional abductor-directed procedures were unsuccessful[4,8,9]. The combination of small resections of Lateral rectus (2 - 4.5 mm) with quantified recession of MR has been proclaimed to cause only minimal adduction loss when the MR recession is performed for achieving abduction gains, and to reduce inward deviation and anomalous turning of the head to a marked degree[4,8,9,10]. At mid-term follow-up, one group of Type 1 DRS patients treated with an average 3 mm LR resection and an average 4.5 mm MR recession had an improvement in esotropia from the mid-20s (PD) to near-orthotropia, an improvement in severity of abduction limitation, complete resolution of abnormal head position, and did not have an expansion in retraction of globe or any recent onset deficiency of adduction.[4]. Comparable prospective studies have likewise found that abduction gains from unilateral recession-resection at least match those achieved with bilateral MR recession, with less adduction loss — though globe retraction risk rises once preoperative retraction exceeds a mild degree[8,9,10].

Despite these encouraging results, evidence on long-term stability, the ideal LR resection (strengthening) dose, and precise patient-selection criteria remains limited. This study was therefore designed to examine the effeciancy and safety of MR recession collaborated with mild strengthening of LR (≤4.5 mm) in U/L DRS Type 1, focusing on alignment, limitation in abduction, retraction of the globe and anomalous posture of the head , with the aim of refining the indications and dosing for this tailored surgical approach.

MATERIALS AND METHODS

This prospective interventional cohort study was conducted at the Department of Opthalmology the Medical Teaching Institute (MTI)/Khyber Teaching Hospital, Peshawar from July 2025 to November 2025. Based on reported Type 1 Duane's prevalence of 1.14%, the sample size based on 95% confidence interval for the specified level of precision (5%) was determined to be 18. We selected 19 patients using consecutive non-probability sampling method.

Inclusion Criteria:

All patients had confirmed unilateral (U/L) Type 1 DRS with at least 25 prism diopter (PD) of esotropia and clinically mild or absent globe retraction and no up/downshot on abduction, which corresponds to a very severe restriction of abduction movement (grade −4 on a scale of −4 to 0).

Exclusion Criteria:

Patients were excluded if any of the following criteria were met: previous strabismus surgery, a vertical motility disorder or a diagnosis of any systemic syndrome.

In view of this, a combination of strategies was devised to rebalance the horizontal muscular forces acting on the globe and surgical correction was performed:

1. Medial Rectus (MR) Recession: recession performed (4-6mm) with the exact amount being altered according to the findings in the operating room.
2. Lateral Rectus (LR) Resection: a small resection (2-4.5mm) was added to increase the abduction power.

Outcome was evaluated with detailed pre and postoperative examinations of ocular alignment (prism cover testing), duction grading for eye motility and formal grading of globe retraction. 1, 4 and 12 weeks postoperative follow-up was performed. Using SPSS-28, paired samples t-test was used to make comparative analysis of pre- and postoperative measures at a p value of less than 0.05.

The study followed the natural ethical considerations and the consent from the subjects was obtained along with the formal approval from Institutional Review Board (IRB no. 682/DME/KMC).

RESULTS

We enrolled 19 cases with U/L DRS type 1. They had age range of 4 to 37 years with a mean of 15.37 ± 11.03, and upon evaluation of the patients the blended surgery was successful to correct both static and dynamic motility deficits. As the mean esotropia was 33.42 ± 6.25 PD and abduction restriction −2.16 ± 0.94 at the baseline, this cohort had a significant burden of disease (Figure 1).

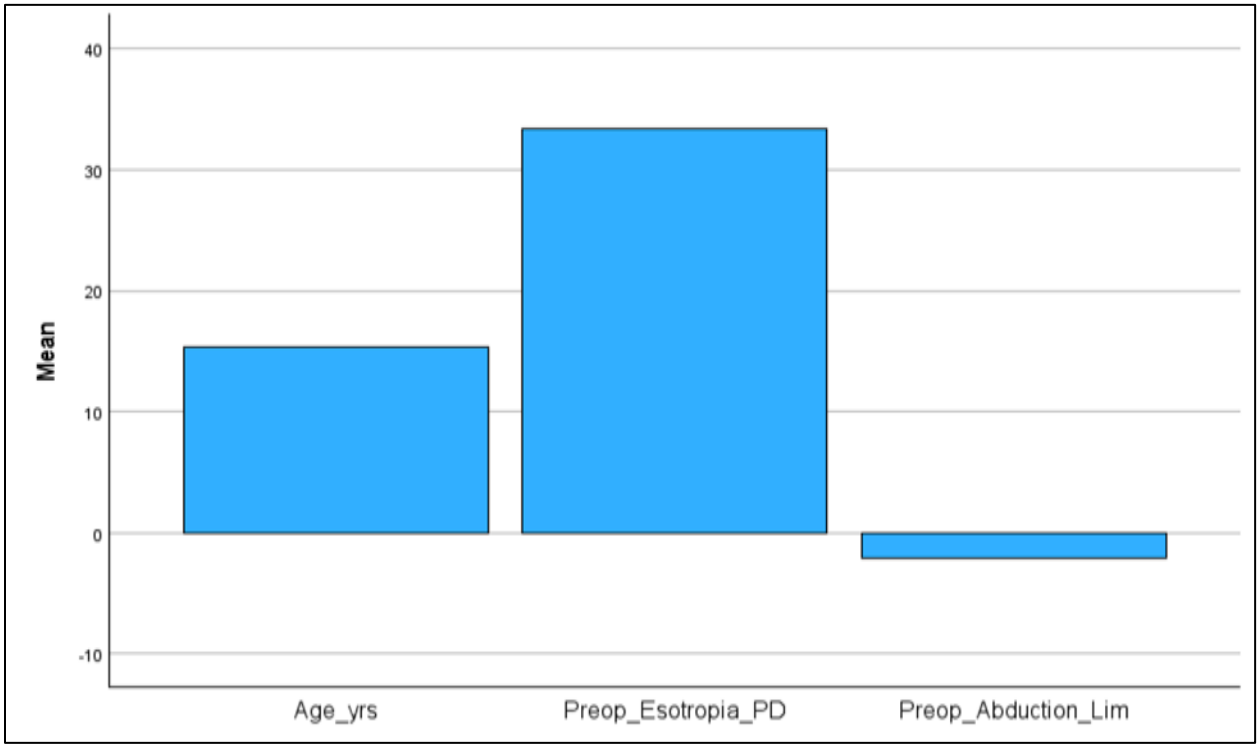

Figure 1 Sample Features (n = 19)

Esotropia decreased significantly following the combined MR recession and small amplitude LR resection, being essentially orthotropic by 12 weeks (Table 1), and repeated-measures ANOVA showed that this improvement in alignment was maintained through all postsurgical follow-up visits (Table 2).

Category	Mean ± SD	95 % CI of difference	t (df)	Probability	Cohen's d
Before Surgery	33.42 ± 6.25	—	—	—	—
After week 12	0.11 ± 0.46	30.35 – 36.28	23.62 (18)	< 0.001	5.42

Table 1 Paired samples t-test: Esotropia Pre-Op and 12th week Post-Op (n = 19)

Source	F (df)	p-value
Time	424.19 (1)	< 0.001

Table 2 Repeated-measures ANOVA: Eso-tropia across Pre and 3 Post Op follow-ups (n = 19)

Motility also showed betterment, with the mean restriction in abduction showing a declining trend by 1.79 ± 0.35 units, ending at a mean of −0.37 ($p < 0.001$) see Table 3.

Category	Mean ± SD	95 % CI of difference	t (df)	Probability	Cohen's d
Before Surgery	-2.16 ± 0.94	—	—	—	—
After week 12	-0.37 ± 0.59	-2.10 – -1.47	-11.95 (18)	< 0.001	-2.74

Table 3 Paired Samples t-test: Limitation in Abduction at Pre- and 12 Weeks Post-Op (n = 19)

The results related to globe retraction were also better and there were no reports of the mechanical problems that can be seen after DRS surgery figure 2).

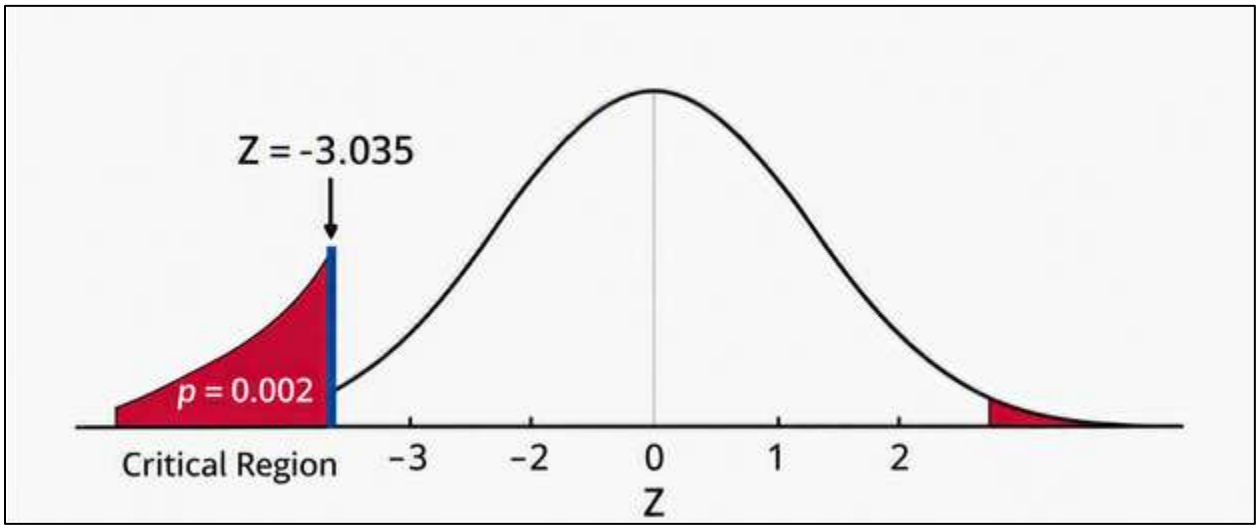

Figure 2 Wilcoxon signed-rank test: Retraction of Globe on Post Op week 1, 4 and 12 (n = 19)

Quality of life benefits also were noted: Of nine preoperatively patients with abnormal head posture, only three had persistent abnormal head posture at 12 weeks ($p < 0.05$; Table 4).

Preop AHP	**Post 1 week**		**Post 4 Week**	**Post 12 Week**	
	No	Yes		No	Yes
No	10	0	No	16	0
Yes	06	3	Yes	0	3
N	19		N	19	
Exact Sig (2-tailed)	0.031		Exact Sig (2-tailed)	1.000	

Table 4 McNemar test: Anomalous Head Posture Pre- surgery vs Follow up Visits (n = 19)

DISCUSSION

So far, MR recession (MRR) has been the principal treatment for esotropic Type 1 DRS, but is associated with ongoing abduction deficit and exodrift[5]. Results with the present series show that a combination of moderate weakening of MR and minor strengthening of LR can give a strong and well controlled restoration both in alignment and motility in carefully selected unilateral Type 1 patients of DRS. Esodeviation was effeciently eliminated (from ~34 PD to the near-orthotropia), and there was an improvement of ~2 units in abduction, a reduction in globe retraction, and anomalous head turn was completely corrected in two thirds of cases by 12 weeks, all without causing an increase in adduction loss, and worsening retraction.

These outcomes are similar to other studies that were done before recession that used similar, conservative resections of lateral rectus muscle. Çelik et al. combined a mean of 4.4 millimeter MR weakening with a 3.1 mm LR strengthening, reducing esotropia from 23 PD to 2 PD and improving abduction from −3.2 to −1.3, with complete resolution of AHP and no further deterioration in retraction or adduction[4]. In Kraft's series recession of MR of up to 5 mm combined with up to 3.5 mm resection of LR achieved orthotropia, eliminated face turn, and improved abduction to between −1 and −2.5, without substantial impairment in adduction or recent onset retraction[9]. Our outcomes extend this body of evidence to a cohort with considerably larger preoperative esodeviation (mean 34 PD), yet achieve near-orthotropia, suggesting that somewhat sizable LR strengthening combined with a moderate MR weakening can be applied securely to higher-angle esotropia provided appropriate selection criteria are observed.

The neuro-mechanical basis of Type 1 DRS lies in absent or hypoplastic abducens coupled with aberrant third nerve innervation of the LR, giving rise to co-contraction, retraction of the globe, and marked restriction of abduction[1,11,12]. Adding a small LR resection to the medial rectus recession is intended to strengthen the abducting vector without unduly amplifying co-contraction. The present data and Çelik et al.'s data indicate that 2-4.5 mm LR resection can

result in approximately 2 units improvement of abduction severity[4], matching or equaling bilateral MR recession (or MR recession alone) in comparative series[8,10]. Partial restoration of active abducting capacity after the balanced horizontal surgery may prevent the phenomenon of late exotropic drift after isolated weakening of MR. The present follow-up is only to 12 weeks but the stable, near-orthotropic alignment observed at all postoperative visits, combined with the significant gain in motility suggests better physiologic distribution of horizontal forces than those achieved with MR recession alone. The theoretical argument makes sense and is reinforced by comparison of the results of similar single operations (e.g., MR recession alone) and combined operations (e.g., superior rectus transposition plus MR recession) indicating that there is less undercorrection in the long term with combined operations[13,14, 15].

Many authors have warned in the past against the use of LR resection in DRS as this would make the already contracting misinnervated muscle more contracted and the fissure narrower[11,12, 16]. ,While comparing recession-resection (RR) with weakening of MR bilaterally, Morad and his colleagues found that although RR improved abduction while preserving adduction, globe retraction occurred in five (5) out of nine (9) unilateral Recession Resection cases, contrary to bilaterally performed MR-recession[8]. A similar study leading the authors to recommend restricting recession-resection to eyes with mild preoperative retraction and good adduction[10].

By deliberately confining LR resection and enrolling selected patients having mild globe retraction and abduction limitation, the present study reached the opposite conclusion: Postoperative follow ups showed no worsening of grade of globe-retraction. This mirrors the experience of Çelik et al., whose average 3.1 mm resection of LR likewise produced no cases of increased retraction or new adduction loss[4], and of Kraft, whose 3.5 mm resections were similarly free of significant deterioration[9]. Combined these converging findings suggest a low volume resection (preoperatively < ~3.5–4.5 mm), a mild amount of globe retraction, and clinically full adduction, minimizes the risks otherwise seen with recession resection procedures performed in DRS type 1. The outcome of the abnormal head posture improved in two-thirds of patients with this effect; showing parallel results to recession of MR alone or bilaterally symmetrical recessions of MR [5,6,10].

This simultaneous horizontal surgery combines correction of deviation at primary position, abduction (OUTward) strengthening and correction of the mechanical stigmata of co-contraction and should thus benefit the binocular visual field, the face and function. It provides surgeons with one alternative to larger MR recessions that have risks for adduction deficit and exodrift, or vertical transposition that has vertical/torsional complications and when combined with other horizontal surgery, anterior segment ischemia[5,11,13,14,15].

This study is similar to previous surgical DRS series in that it has some limitations. The number of patients is relatively small (n = 19) because the number of strictly defined unilateral Type 1 DRS is small, and age, deviation angle, and magnitude of the motility deficiency sub-group analyses are limited. The 12-week follow-up is sufficient to define early stability and to check for mechanical complications, however, this cannot reflect the drift pattern for which MR recession is combined with LR resection in the first place, as Park et al. report an average of 1.3PD/year exodrift over an average 5.6-year follow-up of MR-recession surgery[5]. Similar exodrift was noted by Federico G. Velez et al, in 14 out of 51 patients, who underwent vertical transposition along with MR recession[17]. Longer follow-up of this cohort will be necessary, however, to see if this near-orthotopic alignment will be maintained or if there is eventual exodrift or if deficits in adduction are seen.

Furthermore, the definition of inclusion in this study (mild globe retraction, full adduction and absence of marked upshoot or downshoot) restricts the generalizability to more severe forms of the DRS. Based on previous studies, it seems that LR-weakening procedures might be more appropriate than any LR-strengthening procedures for moderate to severe globe retraction and significant over or under-shoots[11,12,18]. Future research should thus be sub-grouped according to the severity of co-contraction and aim to compare, in a randomized, controlled fashion, our surgical technique with modern surgical methods, assessing long term squint, binocular single vision and patient QOL[5,13,14].

CONCLUSION

This study further confirms that a small resection of LR along with a quantified recession of MR is an efficient and very secure surgery in U/L DRS type 1 with esotropia and mild globe retraction at the time of surgery when studied within the parameters of the outcome measures and relative short follow up. The technique has been shown to provide potent amendment in alignment and abnormal head posture, substantial refinement in abduction, better globe retraction and cosmetics, and the potential for enhanced prolonged horizontal muscle equilibrium when equated to MR weakening exclusively.

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