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ORIGINAL ARTICLE

Expansion of binocular fields in the treatment of lateral rectus paresis

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Abstract

Purpose: The purpose was to study the expansion of binocular fields in patients of chronic lateral rectus paresis (LR paresis) treated by bilateral medial rectus recession (BMRr) and compare with ipsilateral recession resection.

Method: A total of 20 patients of chronic LR paresis were randomly divided into two groups of 10 patients each. In Group A, ipsilateral recession resection was done, while in Group B, BMRr was performed.

Results: In Group A, the mean deviation for distance was 40.10 ± 10.8 prism diopter (PD) and, for Group B, was 41.70 ± 12.2 PD preoperatively. Postoperatively, eight (80%) cases in Group A and nine (90%) cases in Group B achieved acceptable alignment (± 10 PD) in the primary position (P = 0.3). Field of binocular single vision (BSV) increased from a mean value of 70% to 77.7% in Group A and from 68.8% to 79.2% in Group B (P = 0.01)) after 6 months.

Conclusion: BMRr is an equally effective option for chronic unilateral LR paresis and gives a wider field of BSV as compared to ipsilateral recession-resection surgery.

Introduction

Sixth nerve palsy is the most common of all ocular motor nerve palsies in adults.[1] As non-surgical modalities are not of much help, surgery remains the mainstay of treatment in cases of non-recovery or partial recovery.[1,2] Surgery is directed at correcting the esodeviation, improving abduction, as well as increasing size and centration of diplopia free binocular field.[1] Similar to the variable prevalence and etiology of strabismus in sixth nerve palsy, results and outcome of strabismus surgery in these patients have been reported to be variable.[1,2] The conventional operation consisting of combined medial rectus recession and lateral rectus (LR) resection is a time-honored treatment of chronic LR paresis.[1] Almost all procedures described for sixth nerve paresis correct the esodeviation, but even after giving an amazing cosmetic effect, the patients still suffer from problems while driving and even walking due to the restricted binocular fields.

Weakening of a muscle of the good eye can be done in cases of incomplete palsy to increase the innervation to its paretic yoke muscle by Hering's law.[3] The goal of our study is to assess the binocular field expansion by weakening the medial rectus of the good eye for LR paresis and compare it with the conventional ipsilateral rectus recession resection.

Patients and Methods

A prospective, randomized, and comparative study was undertaken at Guru Nanak Eye Center, New Delhi, India. The study conformed to the Declaration of Helsinki, and the institute ethics clearance was obtained.

The study population consisted of 20 patients of chronic LR paresis. Chronic was defined, as longer than 6 months in duration since onset. The inclusion criteria were chosen as shown in Table 1. Patients with previous surgical intervention or treatment with botulinum toxin and patients with any previous ocular surgery for strabismus and with motility disorders in addition to the sixth nerve were excluded from the study. We also excluded patients with complete sixth nerve palsy through a forced generation test.

Data at enrollment included time and age of onset, age, sex, etiology of sixth nerve palsy, laterality, course of paresis, and variability in deviation. All patients had complete ocular

Table 1: Inclusion criteria in our study

No further recovery at the end of 6 months from onset and stable deviation at least for the past 12 weeks
Age >18 years
Vision at least 6/60 in each eye
Distance esotropia >15 PD in primary gaze
Absence of associated 3rd and 4th nerve involvement

PD=Prism diopter

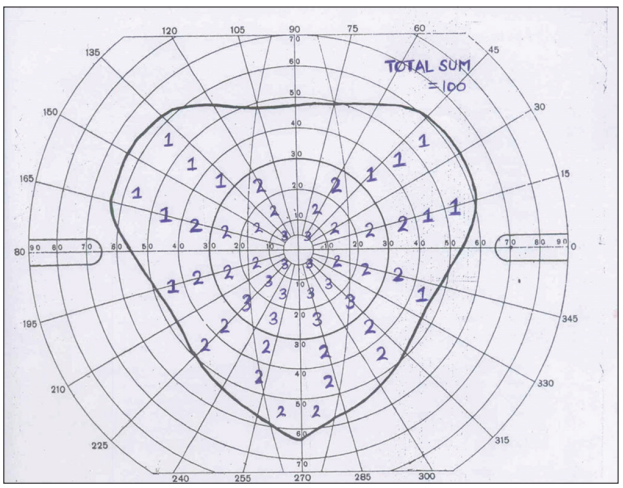

Figure 1: Template for calculating total binocular field of single vision

examination including motility examination. Visual acuity (by Snellens), fixation preference, binocularity (synoptophore), and assessment of stereopsis (by Titmus Fly Test) and convergence assessment were done. The degree of strabismus using prism bar test-9 gaze for near (33 cm) and distance (6 m) was done. The degree of monocular abduction deficit was measured on a scale: zero (normal), 1 (75% of normal rotation), 2 (50% of normal rotation), 3 (25% full rotation), 4 (midline), and 5 (inability to abduct till midline). Defects of Grades 1, 2, and 3 were defined as incomplete palsy or paresis.

Face turn was measured by goniometer. Diplopia charting-near and distance/Lees charting, binocular visual field charting (by arc perimeter, Figure 1), refraction, fundus examination, and photographic documentation were done.

All patients were informed about the nature of the study performed including the risks and were randomly divided (by lottery) into two groups of 10 patients each.

- Group A: Treated by recession resection unilaterally and
- Group B: Treated with bimedial recession.

The decision on the amount of recession and resections performed was decided on the basis of the amount of deviation calculated by prism bar tests in individual cases. All surgeries were performed by the same surgeon (K). Surgery was performed under local anesthesia in all patients using limbal incisions and conventional recessions. No adjustable sutures were used. All study parameters were reassessed postoperatively on days 1, 7, and 21, 12 weeks, and 6 months. All measurements pre-operative as well as post-operative were taken by an observer masked to the surgical details. Final outcome and comparison were done at 6 months in terms of the following surgical goals: (1). Ocular alignment and surgical correction in esodeviations in the primary position (fixing on a distance target), (2) improvement in diplopia in primary position, (3) centering and expanding binocular single vision fields, and (4) decreasing or eliminating head turn. Success was defined as the absence of diplopia and ±10 prism diopter (PD) distance deviation in primary position. Data analysis was done using *t*-test on the SPSS software version 21.

Results

The patient profile showed 12 cases with right lateral paresis and 8 with the left. According to our study criteria, 10 patients were treated by unilateral resection-recession procedure and 10 with bilateral recession. The pre-operative and post-operative details of the two groups are summarized in Tables 2 and 3.

The mean age of the patients was 32.18 ± 6.4 years (range 29–38 years). No statistically significant difference was noted between the two groups in terms of age (P = 0.23). The ratio of male to female was 1:1. In both the groups, trauma was the most important cause (40%). Other causes were vascular (20%), tumor in 5%, and preceding viral fever in 20% of cases. The mean time period of the paresis was 8.70 ± 1.2 months in Group A and 9.40 ± 1.1 months in Group B (P = 0.3).

All patients had a documented face turn in the direction of the paretic muscle. The mean head posture in two groups preoperatively was comparable (mean in Group A = 11.40 and Group B = 12.90 in degrees [P = 0.380]). The face turn reduced to a mean of 0.4 in Group A and 0.8 in Group B which was significant improvement as compared to the pre-operative values (P = 0.000) but comparable among the two groups (P = 0.45).

In the patients of Group A, the pre-operative angle of deviation in the primary position was 40.10 ± 10.8 PD compared with −1.0 ± 8.12 PD after the surgery. Eight of 10 patients (80%) were successfully aligned to within 10 PD of orthophoria with the elimination of diplopia in the primary position. The other two had a consecutive exotropia >10 PD and hence were not included in surgical success.

In Group B patients, the pre-operative angle of deviation in the primary position was 41.70 ± 12.2 PD compared with 1.2 ± 6.45 PD after surgery. Nine patients were satisfactorily treated with one developing an exotropia of 12 PD. Diplopia was eliminated in the primary position in all patients. Thus, both the groups achieved satisfactory alignment. (P = 0.3, no significant difference in the two groups) [Figure 2].

The abduction improved in all patients. The mean post-operative abduction deficit in Group A was 1.2 ± 1.1 and Group B was 0.2 ± 0.42 from a value of 2.8 preoperatively in both the groups (P = 0.000). There was a similar improvement in abduction deficit in patients treated with bilateral medial rectus recession (BMRr) and unilateral surgery (P = 0.06). None of the patients required a resurgery.

Table 2: Clinical parameters of patients in Group A

Patient No.	Laterality	Pre-operative deviation	Post-operative deviation	Abduction defecit pre op	BSVF (%) Pre-operative	BSVF (%) post-operative	Abduction defecit post-operative
1.	R	30 PD	8 PD XT	−2	70	80	0
2.	R	50 PD	ORTHO	−4	78	86	−2
3.	L	40 PD	8 PD ET	−3	72	84	−2
4.	R	55 PD	ORTHO	−2	68	72	−3
5.	R	25 PD	12 PD XT	−2	60	66	−1
6.	R	46 PD	ORTHO	−4	62	70	−2
7.	L	50 PD	6 PD ET	−3	64	73	−1
8.	R	35 PD	8 PD XT	−3	66	73	0
9.	L	25 PD	14 PD XT	−2	78	83	0
10.	L	45 PD	ORTHO	−3	82	90	0

XT: Exotropia, ET: Esotropia, BSVF: Binocular singular field of vision, Ortho: Orthotropia, PD: Prism diopter

Table 3: Clinical parameters of patients in Group B

Patient No.	Laterality	Pre-operative deviation	Post-operative deviation	Abduction defecit pre-operative	BSVF (%) pre-operative	BSVF post-operative	Post-operative abduction deficit
1.	R	45 PD	ORTHO	−3	62	78	0
2.	R	40 PD	ORTHO	−3	66	80	0
3.	R	45 PD	ORTHO	−3	70	82	0
4.	L	60 PD	12 PD ET	−4	66	75	−1
5.	L	55 PD	8 PD ET	−4	68	78	0
6.	L	25 PD	8 PD XT	−2	72	80	0
7.	R	40 PD	ORTHO	−2	76	84	0
8.	R	52 PD	8 PD ET	−3	75	80	−1
9.	R	30 PD	ORTHO	−3	66	75	0
10.	L	25 PD	8 PD XT	−1	67	80	0

XT: Exotropia, ET: Esotropia, BSVF: Binocular singular field of vision, Ortho: Orthotropia, PD: Prism diopter

The binocular field of vision increased from a mean value of 70% to 77.7 % in Group A and from 68.8% to 79.2% in Group B. The difference was statistically significant ($P = 0.01$) [Figures 3 and 4]. No convergence or adduction deficits were noted postoperatively. None of the patients required a resurgery. No significant post-operative complications were seen. Overall 85% of patients achieved orthotropia within 10 PDs.

Discussion

Few studies have been conducted on the outcome of patients with chronic sixth nerve paralysis in terms of expansion of binocular fields. The conventional surgery consisting of two muscle surgery on the affected eye, i.e., an ipsilateral combined medial rectus recession and LR resection is a well-practiced treatment of chronic LR paresis.[1] However, any strengthening procedure of the palsied agonist will only generate a mechanical effect without enhancing rotations, and ocular motility may be further limited.[1] Furthermore, esotropia tends to recur with maximal recession resections due to the unopposed action of the medial rectus.[4]

BMRr is a common surgical approach for the correction of esotropia. In cases of sixth nerve paresis, the idea of operating on the healthy eye is on the grounds that large recession in the healthy eye causes similar adduction limitations in the affected eye, allowing for a larger visual field in the absence of diplopia. The normal fixating eye will oppose the fixation duress and return to straight head position with respect to the head if the normal medial rectus is recessed.

We attempted to use the same principle in our study and it is gratifying to observe the large binocular diplopia free fields in patients operated by bimedial recession. We found out that BMRr is a useful technique to treat patients of sixth nerve palsy. Overall comparison demonstrated that both the procedures reduced the primary deviation equally. Currently, little data exist regarding the surgical dosages, complication rates, and reoperation rates of BMRr in chronic sixth nerve paresis. A comparison with other surgical procedures and their effect on binocular fields is given in Table 4.

Surgery on the non-affected eye in accordance with the Hering's law was similarly suggested by Murray[5] and Wright *et al*.[6] as the treatment of LR paresis, but this procedure is

incompletely understood and grossly understudied. Gonzalez *et al*. described an 86% success rate in a retrospective study, indicating that innervational surgery in the form of a recession of the MR in the good eye added to that of the MR in the involved eye in patients with unilateral chronic sixth nerve paresis is an effective surgical procedure.[7]

Figure 2: Group B; illustrative Case 2: Right lateral rectus paresis for 6 months pre-operative esotropia on PBCT: 40 prism diopter, abduction deficit -3. Bilateral medial rectus recession was done. Postoperatively, patient was orthotropic without any abduction deficit

Almost all patients with long-standing sixth nerve paresis have some contracture of the ipsilateral medial rectus. This contracture must be released in all cases but is often insufficient to correct the esodeviation and provide abduction in the setting of a weak LR. We have to add on it a LR resection to bring the eye to orthotropic position. The results of our study suggest that we can consider adding on a recession of the good eye medial rectus when the deviation is large instead of resecting the weak LR. Due to the smaller number of patients studied, a cutoff value for this deviation could not be determined from our results. Gonzalez *et al*. gave the cutoff as 28 PD.[7]

In our study, BMRr gave a success rate of 90% with a promising improvement in abduction and diplopia free field. Recessing the healthy medial rectus in sixth nerve palsy can also give rise to troublesome adduction deficit in the affected eye in primary position. However, in our study, we did not encounter any of such adverse effects and whatever adduction deficit was introduced seemed to be accepted well by the patients. It is also our unpublished experience that BMRr can be effectively tried in complete palsies also because we are not touching the palsied LR. hence avoiding the complications with transposition surgeries such as vertical deviations and anterior segment ischemia.

Our surgery suffers from the shortcomings of fewer numbers due to the rarity of the cases found. This study has a relatively short duration of follow-up and, however, is encouraging, and further study can be based on the data presented herein. Etiology of palsy can introduce bias.

This paper attempts to give a rationale for the treatment of patients with incomplete sixth nerve paresis who have recovered

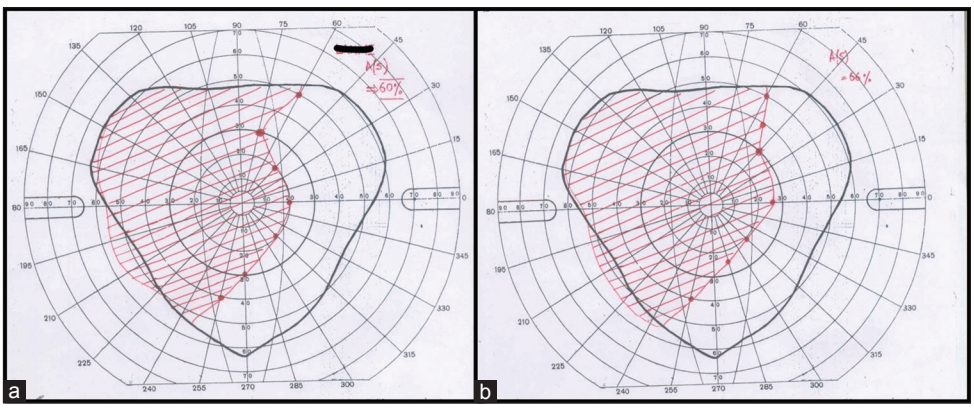

Figure 3: (a) Pre-operative (b) Post-operative. Group A illustrative case 5 treated with unilateral recession resection binocular fields increase from 60% to 66%

Table 4: Expansion of binocular fields by other procedures commonly done for sixth nerve palsy

Procedure	Augmented transposition	Transposition with MR recess	Transposition with BTX	Jensen with MR recess	Present study
Total post--operative BSVF (%)[8-10]	72	44	51	41	79.2

MR: Medial rectus, BTX=Botox, BSVF=Binocular single visual field

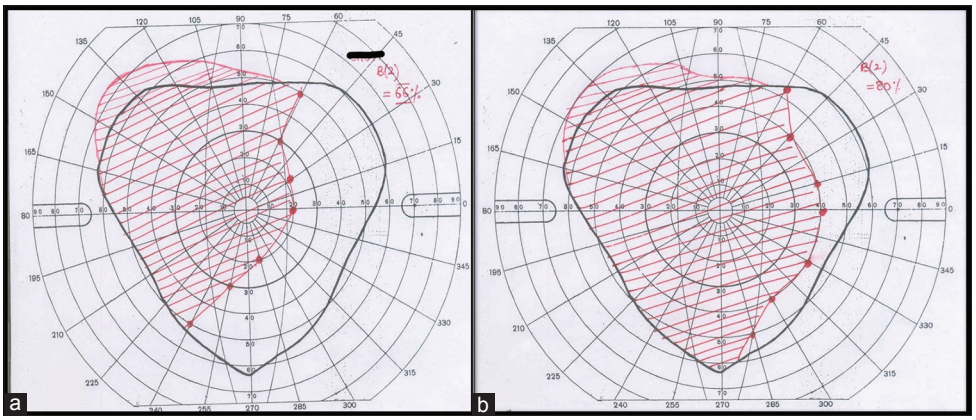

Figure 4: (a) Pre-operative (b) Post-operative. Group B illustrative case 2 treated with bilateral medial rectus recession binocular fields increased from a pre-operative value of 66% to post-operative 80%

some function of the LR. Such patients may still have some contracture of the ipsilateral medial rectus revealing bimedial recession as an equally effective alternative to the conventional surgery. Besides achieving the required deviation surgically, this procedure gives the patient a larger diplopia free field of binocular vision.

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