
MANAGEMENT OF VITH NERVE PALSY—AVOIDING UNNECESSARY SURGERY

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SUMMARY

Unresolved VIth nerve palsy that is not adequately controlled by an abnormal head posture or prisms can be very suitably treated by surgery. It is however essential to differentiate partially recovered palsies, which are amenable to horizontal rectus surgery, from unrecovered palsies, which must be treated initially by a vertical muscle transposition procedure. Botulinum toxin is a valuable tool in making this distinction. It also facilitates full tendon transposition in unrecovered palsies, which appears to produce the best functional outcome of all the transposition procedures, with a reduction in the need for further surgery. A study of the surgical management of 12 patients with partially recovered VIth nerve palsy and 59 patients with unrecovered palsy provides clear guidelines on how to attain a successful functional outcome with the minimum amount of surgery.

Surgery is not often required for VIth nerve palsy. In almost 50% of cases there is spontaneous recovery¹ and in many others the symptoms are adequately controlled by an abnormal head posture or prisms, with or without the aid of medial rectus botulinum toxin², or by suppression. Amongst the cases of unresolved VIth nerve palsy that do require surgery, the frequent presence of good binocular function and the various surgical procedures available should give an excellent prognosis for a good functional outcome.

In partially recovered VIth nerve palsy horizontal rectus muscle surgery is recommended^{3,4}, although there is very little objective evidence in the literature to support this approach. In unrecovered palsy the risks of anterior segment ischaemia associated with the older methods of vertical muscle transposition, have resulted in an unjustifiably bad reputation for transposition surgery. This has often resulted in the inappropriate use of horizontal rectus muscle procedures or failure to undertake any surgery, condemning the patient to a lifetime of diplopia and poor cosmesis. It is accepted that resecting a paretic muscle does not restore its function and that initial surgery

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for unrecovered VIth nerve palsy must involve a transposition procedure^{3,4}. The availability of botulinum toxin to overcome the contracture of the ipsilateral medial rectus now allows for full tendon transplantation techniques⁵⁻⁷, with the potential for greatly increased improvements in final fields of binocular single vision, and deferment of any necessary surgery to the medial recti, which is also likely to improve the final outcome.

This study provides definite evidence, from a large series of patients, of the potential functional outcome from the surgical treatment of unresolved VIth nerve palsy, together with clear guidance as to the forms of surgery that should be undertaken in specific cases. The fundamental role of botulinum toxin in establishing the degree of lateral rectus function and hence the correct choice of initial surgery, and as an adjunct to transposition surgery for unrecovered palsy, is discussed.

MATERIALS AND METHODS

Since 1983, 71 patients with unresolved non-progressive VIth nerve palsy requiring surgery for intolerable diplopia, despite an abnormal head posture or prisms, or for an unacceptable cosmetic appearance, have undergone assessment in the Botulinum Toxin Clinic at Moorfields Eye Hospital. The group consists of 36 men and 35 women. Their ages ranged from two to 84 years with a mean of 43 years. The palsy was unilateral in 34 patients and bilateral in 37. Sixty six per cent of palsies were due to blunt head trauma, the majority of these resulting from road traffic accidents (Table I). In all patients at least six months had elapsed from the onset of the palsy to the time of surgery to allow for spontaneous recovery and to exclude any progression. In 23 patients previous surgery had been undertaken for the VIth nerve palsy, either vertical muscle transposition without adjunctive botulinum toxin or horizontal rectus muscle surgery.

All patients underwent ipsilateral medial rectus botulinum toxin, repeated if necessary to achieve adequate medial rectus paralysis, to allow assessment of lateral rectus function. In bilateral palsies both medial recti were occasionally injected at the same session. Botulinum toxin

Table I. Aetiologies of VIth nerve palsies requiring surgery

	(%)
Road traffic accident	49
Head injury	17
Intracranial tumour*	11
Microvascular	7
Chronic**	7
Congenital	9
Meningitis	
CVA	
Viral	
Sarcoid	

*Intracranial tumours may have undergone neurosurgery.

**Chronic palsy indicates isolated non-progressive palsy of greater than 1 year duration with no identifiable cause despite complete medical and neuroradiological investigation.

injection was usually undertaken as an outpatient procedure under local anaesthesia. In the case of young children ketamine anaesthesia was used. All injections were carried out under electromyographic control.

A partially recovered palsy was diagnosed if the affected eye became divergent following medial rectus paralysis with botulinum toxin, or if the eye could then be actively abducted across the midline. If the eye could not be actively abducted across the midline with the medial rectus paralysed, the palsy was diagnosed as unrecovered. Force generation tests and lateral rectus EMG were used when necessary to confirm this diagnosis. In longstanding palsies, particularly if there was marked medial rectus contracture, as suggested by globe retraction or a rise in intraocular pressure on attempted abduction, or by the results of a forced duction test, inability to actively abduct across the midline was not taken to indicate an unrecovered palsy unless the force generation test or the lateral rectus EMG were confirmatory.

In partially recovered palsy unilateral or bilateral horizontal rectus muscle surgery, with or without adjustable sutures, was carried out according to the size of the esodeviation after full recovery from the medial rectus botulinum toxin injection. The aim was to produce a minimal— esodeviation for distance.

In unrecovered palsy combined medial rectus botulinum toxin and lateral transposition of the vertical rectus muscles was performed. In bilateral palsies either the more severely affected eye was treated initially, or surgery was carried out on both eyes simultaneously. In all cases further surgery was delayed until full recovery from the medial rectus botulinum toxin injection.

RESULTS

a) *Partially recovered palsies*

Twelve patients were diagnosed as having partially recovered palsies, of which five were unilateral and seven were bilateral. In six patients the eyes became divergent following medial rectus botulinum toxin injection, and in five others partial lateral rectus function was confirmed by the presence of abduction across the midline following toxin injection. In one patient with a palsy of 30 years' duration, it was still not possible actively to abduct the eye across

the midline but globe retraction on attempted abduction and a positive force duction test indicated a partial palsy with marked medial rectus contracture. The average esodeviation prior to medial rectus botulinum toxin was 39 prism dioptres (PD) (range 10–75 PD) for unilateral palsies, and 44 PD (range 25–90 PD) for bilateral palsies.

None of the patients with only partially recovered palsies had previously undergone surgery for VIth nerve palsy. Seven patients underwent unilateral medial rectus recession and lateral rectus resection (two muscle surgery). Two underwent bilateral medial rectus recession and unilateral lateral rectus resection (three muscles), and three patients underwent bilateral medial rectus recession and lateral rectus resection (four muscles). Adjustable sutures were used in eight patients. In two patients the surgery was modified to treat simultaneously a vertical deviation.

Follow-up is available on all 12 patients with an average of 8 months from the time of final surgery. No patient has required further surgery for the horizontal deviation. Two patients with associated IVth nerve palsies have undergone further surgery for vertical deviations. The average pre-operative deviation was 28 PD for unilateral palsies and 41 PD for bilateral palsies. Post-operatively the unilateral palsies had an average residual esodeviation of 6 PD, and the bilateral palsies had an average exodeviation of -4 PD. The average change in deviation with surgery ranged from 27 to 56 PD according to the number of muscles upon which surgery was performed (Table II).

Pre-operatively only three patients had a field of binocular single vision (BSV), all requiring an abnormal head posture or prisms to achieve it. Three other patients were free of diplopia in the primary position with an abnormal head posture or prisms, four were diplopic and two were suppressing. At final follow-up 11 patients (92%) were achieving a field of BSV, with an average field of BSV score of 53%, measured according to the modified method of Fitzsimons and White⁸. Only two of these patients required an abnormal head posture or prisms. The only patient without a field of BSV is suppressing with a microtropia related to childhood esotropia.

The only complication encountered was surgical overcorrection in a patient with a bilateral palsy. The final outcome was a distance exodeviation of 20 PD, increasing to 45 PD for near. He is able to control the distance deviation, but requires base-in prisms in his reading glasses.

b) *Unrecovered palsies*

Fifty-nine patients were diagnosed as having an unrecovered VIth nerve palsy in at least one eye. Twenty-nine had a unilateral palsy, which includes those with a bilateral

Table II. Average change in deviation with horizontal rectus surgery for partially recovered VIth nerve palsy

	Prism dioptres
2 muscle surgery	27
3 muscle surgery	32
4 muscle surgery	56

palsy in which there had been complete recovery on one side. Of the 30 patients with bilateral palsy, 20 had a partially recovered palsy in the less affected eye and 10 had bilateral unrecovered palsies (Table III).

Thirty to forty-five per cent of all groups had previously undergone surgery for the VIth nerve palsy. Of the previously operated patients 54% in the unilateral palsy group, 83% in the bilateral group with a partially recovered palsy in the less affected eye, and 25% in the bilateral unrecovered palsy group had previously undergone horizontal rectus muscle surgery rather than vertical muscle transposition (Table III). In the previously unoperated patients the esodeviation prior to surgery averaged 61 PD (range 25–95 PD) in the unilateral group, 85 PD (range 50–115 PD) in the bilateral group with a partially recovered palsy in the less severely affected eye, and 73 PD (range 50–90 PD) in the bilateral unrecovered group.

Forty-eight of the patients who had not previously undergone transposition surgery underwent a full tendon transfer of the vertical recti, and one underwent a Jensen procedure. The ten patients who had previously undergone transposition surgery underwent revision of the transposition to a full tendon transfer, or revision of a previous full tendon transfer. Botulinum toxin injection to the ipsilateral medial rectus was performed two to 20 days pre-operatively in 51 patients, per-operatively in four patients, and two to seven days post-operatively in four patients. Two patients had supplementary injections in the initial two weeks after surgery.

Final outcome is available in 50 patients with an average follow-up of 11 months from the time of final surgery. Tables IV–VI detail the surgical and functional outcomes in these patients. For example 33% of the previously unoperated unilateral palsy group have required further surgery for the horizontal deviation, and 84% have obtained a useful field of BSV, with an average field of BSV score of 59%. The adverse effects of previous transposition surgery and particularly of previous horizontal rectus surgery are also shown.

Of all the 59 patients who have undergone vertical muscle transposition combined with medial rectus toxin, five were still exotropic after full recovery from the botulinum toxin. Two of these patients had initially undergone horizontal rectus surgery, one had undergone a previous transposition, and one had undergone simultaneous bilateral transposition surgery. Four out of the 59 patients developed a vertical deviation necessitating either surgery, prisms, or both. Two had undergone a previous

Table III. Previous surgery undertaken for unrecovered VIth nerve palsy

	Unilateral	Bilateral Contralateral eye	
		Partial	Unrecovered
No previous surgery	16	14	6
Previous surgery			
Transposition	6	1	3
Horizontal rectus	7	5	1
Total patients	29	20	10

transposition, and one had previously undergone horizontal rectus surgery. Mild anterior segment ischaemia was detected clinically in five patients and by iris angiography in one patient. Two of these patients had tumours involving the cavernous sinus and one had previously undergone a Hummelsheim procedure with simultaneous medial rectus recession.

DISCUSSION

The outcome of horizontal rectus muscle surgery in the 12 patients with partially recovered palsies provides objective evidence that this is the appropriate surgical management for this group of patients. The aim should be to produce a minimal esodeviation for distance, and this may be most easily achieved by the aid of adjustable sutures. The number of muscles to be operated on is not determined by whether the palsy is unilateral or bilateral but by the size of the esodeviation. Deviations of more than 30 PD are likely to need three muscle surgery, and those of more than 40 PD are likely to need four muscle surgery. If medial rectus botulinum toxin is used beforehand to allow assessment of lateral rectus function, full recovery from the toxin must take place before surgery as there may be a

Table IV. Final outcome in unilateral unrecovered VIth nerve palsy

	No previous surgery	Previous transposition	Previous horizontal rectus surgery
Number of patients	12	6	6
Requiring additional surgery for horizontal deviation (%)	33	33	50
Average procedures prior to transposition and BTX	0	1.5	1.7
Average total procedures	1.3	2.8	3.2
Obtained field of BSV (%)	84	67	33
Average BSV field score (%)	59	54	33

Table V. Final outcome in bilateral unrecovered VIth nerve palsy with partial palsy in the less affected eye

	No previous surgery	Previous horizontal rectus surgery
Number of patients	10	5
Requiring additional surgery for horizontal deviation (%)	60	20
Average procedures prior to transposition and BTX	0	1.8
Average total procedures	1.6	3.0
Obtained field of BSV (%)	60	20
Average BSV field score (%)	48	47

Table VI. Final outcome in bilateral unrecovered VIth nerve palsy

	No previous surgery	Previous transposition
Number of patients	6	3
Requiring additional surgery for horizontal deviation (%)	83	33
Average procedures prior to transposition and BTX	0	2.0
Average total procedures	2.8	3.3
Obtained field of BSV (%)	50	33
Average BSV field score (%)	49	39

reduction in the size of the esodeviation as a result of the toxin injection.

The crucial matter is deciding which patients have a partially recovered palsy. It is important to stress that the degree of esodeviation is not a good guide to the degree of lateral rectus function. Although there is a trend of increasing size of esodeviation with unrecovered versus partially recovered palsies and bilateral versus unilateral palsies, a unilateral partially recovered palsy may have an esodeviation as great as 75 PD and a bilateral unrecovered palsy an esodeviation as little as 50 PD. The degree of lateral rectus function must be assessed in its own right, and if possible in isolation from the contracture of the ipsilateral medial rectus, the overaction of the contralateral medial rectus, and the inhibition of the contralateral lateral rectus that are also features of the esodeviation of a VIth nerve palsy. Clinically the degree of lateral rectus function may be obvious from the extent and velocity of active abduction; whether it is possible actively to abduct the eye across the midline and whether the abducting movement has the velocity of a saccade. Paralysis of the ipsilateral medial rectus with botulinum toxin greatly simplifies this assessment. Only in longstanding palsies might the degree of medial rectus contracture prevent the presence of lateral rectus function becoming apparent after medial rectus botulinum toxin. Forced duction and force generation tests, and lateral rectus EMG then need to be relied upon.

There is increasing evidence to support the theoretical concept that the best results in transposition surgery for unrecovered VIth nerve palsy are produced by full tendon transposition rather than half muscle transfer (Hummelsheim) or muscle union (Jensen) procedures^{5-7,9-13}. The availability of botulinum toxin as a chemical means of temporarily weakening the medial rectus has now made such full tendon transposition an increasingly favoured option in adults⁵⁻⁷, as well as in children. Our results are certainly comparable with those of other groups using full tendon transposition, with or without botulinum toxin, in terms of percentage of patients achieving a useful field of BSV and the extent of such BSV fields. Furthermore they support the superiority of the functional outcome following full tendon transposition over that achieved with other transposition procedures.

A fundamental advantage of combined botulinum toxin and transposition that is now apparent in this study is the amount of medial rectus surgery that is avoided. In unilateral unrecovered palsy initially treated with combined toxin and full tendon transposition, only 33% of patients require further surgery for the horizontal deviation. That is 67% of patients never require any surgery to the ipsilateral medial rectus and thus surgery has been confined to only two rectus muscles. Even in bilateral palsy with a partially recovered palsy in the less affected eye, 40% of patients will not require surgery to the medial rectus or any surgery to the eye with the partial palsy. In bilateral unrecovered palsy virtually all patients will require further transposition surgery and surgery to the medial recti.

Performing horizontal rectus surgery as the initial pro-

cedure in unrecovered VIth nerve palsy not only increases the number of surgical procedures eventually required but significantly limits the possible functional outcome. In unilateral unrecovered palsy previous horizontal rectus surgery increased the amount of surgery required following combined botulinum toxin and transposition, despite the patients having undergone an average of 1.7 such horizontal rectus procedures prior to the transposition. The percentage of patients finally obtaining a field of BSV was reduced from the 84% seen in previously unoperated patients to 33% in those initially treated with horizontal rectus surgery. The average field of BSV score was similarly reduced from 59% to 33%. In bilateral palsy with a partially recovered palsy in the less affected eye, initial horizontal rectus muscle surgery once again increased the total number of procedures required and significantly impaired the functional outcome.

It may be argued that this is not a controlled study and that it is unfair to compare patients initially treated with horizontal rectus muscle surgery with the previously unoperated patients. Possibly the reason that the patients had not responded well to horizontal rectus surgery was related to a greater severity of lateral rectus dysfunction or more marked medial rectus contracture. It is actually more likely that patients treated with horizontal rectus surgery are those adjudged in the first instance to have a less severe palsy, and if there is a high degree of medial rectus contracture this should be well dealt with by horizontal rectus procedures. Other unidentified factors may have been operating to limit the success of horizontal rectus surgery. But comparison of the unilateral palsy patients treated initially with horizontal surgery and those initially treated by transposition surgery without botulinum toxin, a group that also seemed to be resistant to surgical treatment, demonstrates that once again initial horizontal rectus surgery results in a greater number of procedures subsequent to combined toxin and transposition, and a worse functional outcome. The reasonable conclusion, which is well supported by theoretical considerations, is that unrecovered VIth nerve palsy should not be treated in the first instance by horizontal rectus surgery but should undergo a transposition procedure.

A previous retrospective study of the surgical management of lateral rectus paralysis suggested similar results from horizontal rectus surgery, the Hummelsheim procedure, and the Jensen procedure¹⁴. The results of the final cover-uncover tests were said to be comparable for the three groups, despite the percentage of residual esotropia being 37% for the horizontal rectus surgery group compared to 30% for the Hummelsheim group and 25% for the Jensen group. As discussed by the authors, the pre-operative and post-operative "lateral versions" were significantly better for the horizontal rectus surgery group than either of the transposition groups indicating that the patients selected for horizontal rectus surgery were more likely to have a partially recovered palsy than patients in the other groups. Although the authors mention that the results of the three surgical groups are still comparable if

patients with lesser degrees of lateral rectus palsy are excluded, the details are not provided for further analysis.

In unresolved VIth nerve palsy which is not adequately controlled with an abnormal head posture or prisms, and which is thus deemed to require surgical treatment, botulinum toxin provides an invaluable tool in providing a successful functional outcome with the minimum of surgery. Paralysis of the medial rectus with botulinum toxin greatly simplifies assessment of the degree of lateral rectus weakness and hence the decision as to the correct form of surgery. The partially recovered palsies which do not benefit sufficiently from the toxin to avoid surgery, can then be treated with a single horizontal rectus muscle procedure with a successful functional outcome in all cases. The unrecovered palsies should be treated with a vertical muscle transposition procedure, amongst which combined medial rectus botulinum toxin and full tendon transposition appears to produce the most successful results with the least amount of additional surgery.

Key words: Botulinum toxin, sixth nerve palsy, surgery.

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