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The effectiveness of inferior transposition of the horizontal recti in improving symptoms in patients with a deficit of downgaze: a case series of nine patients

KAREN RUSSELL BSc, SHADROKH NABILI MD MRCOphth MRCS AND CAROLINE J. MACEWEN MD FRCS FRCOphth

Ninewells Hospital and Medical School, Dundee

Abstract

Aim: **To evaluate the outcome of inferior transposition of the horizontal recti in patients with reduced downgaze in one eye.**
Methods: **The case notes of 9 patients who underwent inferior transposition of horizontal recti were retrospectively reviewed. The pre- and post-operative orthoptic findings are presented and the outcome of surgery discussed.**
Results: **Indication for surgery was a reduction in downgaze, caused by trauma in 5 cases, fourth nerve palsy in 3 cases and in 1 case decompensated congenital fourth nerve palsy in association with a facial fracture. The median vertical deviation in the primary position was 14$^{\Delta}$ pre-operatively (range 4–25$^{\Delta}$) reducing to 3$^{\Delta}$ post-operatively (range 0–13$^{\Delta}$). No patient was overcorrected in downgaze. Pre- and post-operative Hess chart scores indicated a reduction in vertical displacement for all patients. Binocular single vision (BSV) scores demonstrated a more centralised field of BSV in all but 1 patient.**
Conclusions: **Inferior transposition is useful in patients with poor depression in one eye. It improves downgaze, centralises the field of BSV and relieves symptoms of diplopia.**

Key words: Blow-out fracture, Inferior transposition of horizontal recti, Inverse Knapp procedure, Knapp type V fourth nerve palsy

Introduction

Cooper and Greenspan first described inferior transposition of horizontal recti to the inferior rectus to treat a congenitally absent inferior rectus.[1] It has subsequently been used for the treatment of double depressor palsy or inferior rectus deficit.[2–4] The aim of this study was to review the effectiveness of inferior transposition of the horizontal recti to the inferior rectus in the management of patients with limited downgaze.

Correspondence and offprint requests to: C. J. MacEwen, Ninewells Hospital and Medical School, Dundee D1 9SY. Tel: 01382 632714. Fax: 01382 632893. e-mail: c.j.macewen@dundee.ac.uk

Methods

This retrospective study reviewed 9 patients who underwent a full transposition of the horizontal recti to the inferior rectus insertion. Details regarding age, sex, diagnosis, and follow-up periods were obtained. Pre-operative and post-operative examinations included a prism cover test in the primary position; angle of deviation in 15° of downgaze, measured using the synoptophore; the presence of a compensatory head posture, and scoring of Hess charts and fields of binocular single vision (BSV). For each Hess chart the vertical and horizontal displacement scores were calculated[5] in order to objectively and quantitatively assess muscle imbalance. Scores are calculated from the displacement of individual points on the Hess chart using weighting factors for the centre, inner and outer zones; for example, the centre is given 8 times the weight of the outer zone. The horizontal and vertical displacement of each box is established and entered into a formula. Summing the scores for each eye derives the total horizontal and vertical score. A normal Hess chart would score zero.

Field of BSV charts were plotted pre- and post-operatively using Aimark or Goldmann perimeters and scored using the method described by Fitzsimmons and White[6] and Woodruff *et al.*[7]* Some patients had no area of BSV pre-operatively and therefore could not be scored at this point.

The surgical procedure in all cases consisted of full transposition of the horizontal recti to the level of the inferior rectus. All procedures were performed by one surgeon (C. J. M.). All patients had negative forced duction tests. No adjustable sutures were used. There were no intraoperative complications. Post-operative complications included 1 patient with scleral thinning due to conjunctival recession; this required conjunctival resuturing.

* The method described by Fitzsimmons uses the Aimark perimeter. A transparent template is placed over the plotted field. The template is divided into 59 segments each with a score of 1. The areas of BSV present within each segment are summed to calculate the score. The method described by Woodruff uses the Goldmann perimeter. A transparent scoring template is placed over the plotted field. The template is divided into 55 segments each with a score between 1 and 4, the total value being 124. Greater weight is given to functionally important areas such as the primary position and downgaze. The patient's scores are summed and calculated as a percentage of the normal full field of BSV.

Results

The group comprised 9 patients (3 men, 6 women). The mean age was 38.8 years (range 21–71 years). The median follow-up period was 3 months (range 1.25–12 months). The underlying aetiology was blow-out fracture in 4 cases, diffuse orbital trauma in 1 case, fourth nerve palsy in 3 cases and a combination of facial fracture and long-standing fourth nerve palsy in 1 case.

Table 1 summarises patient details including the Hess chart scores and binocular single vision (BSV) scores where available. Five of the 9 patients had previously undergone extra-ocular muscle surgery. One had undergone an orbital floor repair. All patients demonstrated a general reduction in depression across all positions of gaze (i.e. depression in adduction and abduction were both affected to some degree). These findings are typical of fourth nerve palsies as classified by Knapp (type V) and are frequently seen in inferior rectus palsies, which may be congenital, associated with third nerve palsies or may follow trauma.

Improvement in the vertical deviation was observed in all patients both in the primary position and in downgaze. The median vertical deviation for all patients in primary position improved from 14^{Δ} (range $4–25^{\Delta}$) to 3^{Δ} (range $0–13^{\Delta}$). Median measurements in downgaze preoperatively were 14^{Δ} (range $8–30^{\Delta}$), reducing to a median of 2.5^{Δ} (range $1–5^{\Delta}$) post-operatively.

Prior to surgery all 9 patients experienced symptomatic diplopia on downgaze, with 5 patients aware of diplopia in the primary position. Post-operatively 5 patients still had diplopia on extreme downgaze and 1 patient was aware of intermittent diplopia in the primary position.

Fig. 1 shows an example of Hess scores for patient 1, before and after surgery. In all cases there was an improvement in the vertical Hess chart score. The median vertical score for all patients pre-operatively was 579 (mean 752), reducing to 384 (mean 312) post-operatively, showing a good reduction in vertical displacement. The horizontal score remained virtually unchanged in the majority, indicating that moving the horizontal rectus muscles downwards has surprisingly little effect on the horizontal rotations in most cases. This score was, however, significantly adversely affected in 2 cases (patients 3 and 8), indicating that sacrifice of horizontal movements may occur in some individuals in order to improve the vertical deviation in fourth nerve palsies. All but 1 patient showed an improvement in the field of BSV.

Of the 4 patients with a compensatory head posture pre-operatively, only 1 still utilised a head posture after surgery, but this was felt to have improved both subjectively and objectively. No overcorrection was noted post-operatively and no subsequent ocular muscle surgery has been performed.

Discussion

In this study, inferior transposition of the horizontal rectus muscles proved to be effective in reducing the vertical deviation in the primary position, but it was particularly useful in improving downgaze and therefore reducing the angle of deviation when looking down. A subjective and objective improvement in compensatory head posture and patients' symptoms accompanied these results.

Inferior transposition of the horizontal recti has previously been shown to be effective following orbital trauma.[8] The majority of our study group had a weakness of downgaze following trauma, due to blow-out fracture in 4 patients and diffuse orbital trauma in 1 patient. All these patients experienced a moderate to marked reduction of depression and 2 also had a large hypertropia in the primary position (due to inferior rectus weakness).

Inferior rectus muscle resection with or without recession of its ipsilateral antagonist has been successfully used for the treatment of inferior rectus weakness. For partial palsy of the inferior rectus muscle the simple ipsilateral inferior rectus resection/superior rectus recession procedure has been advocated as the first surgical choice.[9] For complete inferior rectus muscle weakness, inferior transposition of horizontal recti may be a better choice than a vertical resection/recession procedure for four reasons. First, if the muscle palsy is complete, its strength will not be improved by resection. Second, recession of the ipsilateral superior rectus and resection of the inferior rectus would have an effect on the primary position and a significant proportion of our patients had minimal deviation in the primary position. The effect of inferior transposition is to strengthen depression and therefore its effect in the primary position is less than that of recess/resect procedures. Inferior transposition is a versatile procedure that seems to have its maximum effect on improving downgaze and can be used for patients with no or minimal deviation in the primary position. Third, it would have a maximum effect on improving depression in abduction and the patients in this series had a more generalised reduction in depression which may be due to spread of concomitance or because of the underlying severe damage to the inferior rectus. Fourth, the risk of lower lid malposition subsequent to resection of the inferior rectus muscle is high.[8]

Other surgical procedures used in the management of fourth nerve palsies, such as superior oblique tuck or inferior oblique weakening (each with or without contralateral inferior rectus recession), are indicated for other patterns of motility disturbance associated with this condition (Knapp types I–IV) and do not deal with the depression deficit typical across all depressed positions of the Knapp type V.

Three of the 4 patients with superior oblique weakness gained some benefit from a compensatory head posture pre-operatively. After inferior transposition all these patients enjoyed a fuller, more centralised field of BSV without the need for a compensatory head posture. In cases of fourth nerve palsy that demonstrate this pattern of weakness inferior transposition appears to be effective in reducing symptoms.

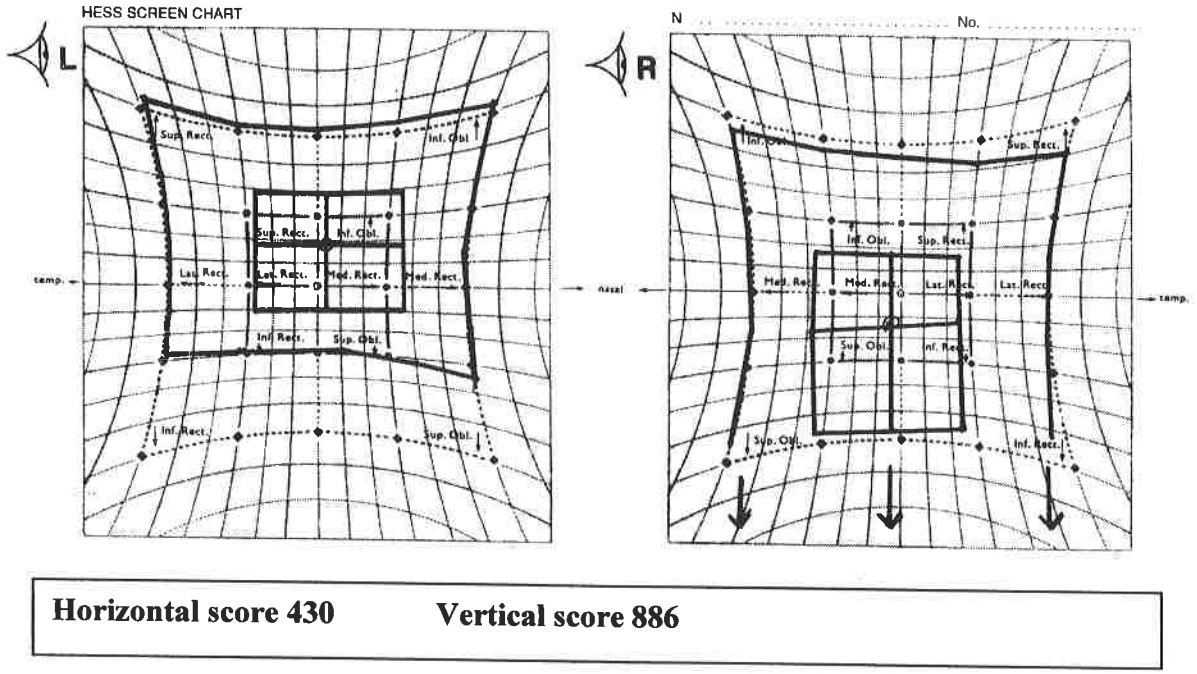
Conclusion

Inferior transposition is an effective strabismus operation for markedly reduced downgaze in one eye. This

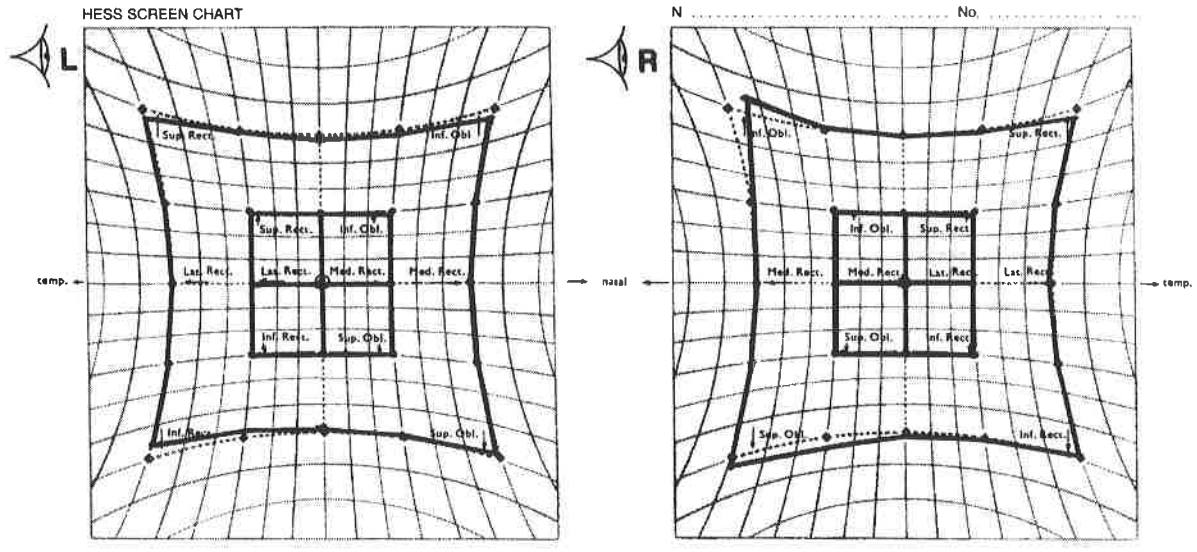
Table 1. Summary of patient details including the Hess chart scores and binocular single vision (BSV) scores where available

Patient no.	Aetiology	Previous surgery	CHP pre-op.	Diplopia in primary position pre-op.	Angle of deviation in primary position		Angle of deviation in downgaze		Hess score				BSV score		CHP post-op.	Diplopia in primary position post-op.	Follow-up (months)
									Horizontal		Vertical						
					Pre-op.	Post-op.	Pre-op.	Post-op.	Pre-op.	Post-op.	Pre-op.	Post-op.	Pre-op.	Post-op.			
1	Trauma to LIR	Nil	No	Yes	14^{Δ}/LR	0	22^{Δ}L/R	2^{Δ}L/R	430	13	886	29	0	75.8% (W)	No	No	8
2	L orbital floor[a]	Orbital floor repair	No	Yes	25^{Δ}L/R	3^{Δ}L/R	–	–	307	299	1766	426	0	76.6% (W)	No	No	2
3	L 4th nerve palsy	LSO tuck	Yes	Int.	18^{Δ}L/R	4^{Δ}L/R	30^{Δ}L/R	–	198	448	800	529	0	63.7% (W)	No	No	4
4	Congenital R 4th nerve palsy; Le Forte type III fracture	RIO recession, RIO disinsertion	No	Yes	8^{Δ}R/L	4^{Δ}R/L	8^{Δ}R/L	1^{Δ}R/L	276	199	437	243	2	13 (F)	No	No	2
5	R blow-out,[a] medial and inferior wall	RMR and RIR recession, RIR re-advanced	Yes	Yes	20^{Δ}R/L	13^{Δ}R/L	–	–	739	567	1024	605	–	–	Yes	Int.	3
6	L orbital floor[a]	Nil	No	No	4^{Δ}L/R	1^{Δ}L/R	8^{Δ}L/R	–	283	114	579	102	34.6%	54.8% (W)	No	No	4
7	L blow-out[a]	Nil	No	No	6^{Δ}L/R	1^{Δ}L/R	14^{Δ}L/R	3^{Δ}L/R	150	93	314	84	67.7%	80.6% (W)	No	No	2
8	Acquired L 4th nerve palsy	L Harado-Ito	Yes	Yes	14^{Δ}L/R	3^{Δ}L/R	–	–	508	959	559	403	7	14 (F)	No	No	12
9	L Brown's syndrome	LSO tenotomy	Yes	Yes	7^{Δ}L/R	2^{Δ}L/R	14^{Δ}L/R	5^{Δ}L/R	208	218	401	384	38.7%	74.1% (W)	No	No	3

BSV, binocular single vision; CHP, compensating head posture; L, left; R, right; IR, inferior rectus; SO, superior oblique; IO, inferior oblique; MR, medial rectus; Int., intermittent; (W), Woodruff; (F), Fitzsimmons.



Horizontal score 430 **Vertical score 886**



Horizontal score 13 **Vertical score 29**

Fig. 1. Hess scores for patient 1, pre-operatively (above) and post-operatively (below). The typical reduction in depression across abduction and adduction is evident pre-operatively, as is the improvement following transposition surgery.

operation is particularly useful in patients with a vertical deviation that increases with progressive downgaze, and in those with downgaze deficit in both adduction and abduction. This study has shown this to be effective for patients with a double depressor type fourth nerve palsy (Knapp type V) and in cases of post-traumatic inferior rectus underaction, with or without blow-out fracture. The majority of patients regained BSV in the primary position and a more centralised, useful field of BSV.

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The Tayside Committee on Medical Research Ethics approved this study.

References

1. Cooper EL, Greenspan JA. Congenital absence of the inferior rectus muscle. *Arch Ophthalmol* 1971; **86:** 451–454.
2. Dunlap EA. Vertical displacement of horizontal recti. In *Symposium on Strabismus*. St Louis: CV Mosby, 1971: 307–329.
3. Lipton JR, Page AB, Lee JP. Management of diplopia on downgaze following orbital trauma. *Eye* 1990; **4:** 535–537.
4. Burke JP, Keech RV. Effectiveness of inferior transposition of the horizontal rectus muscles for acquired inferior rectus paresis. *J Paediatr Ophthalmol Strabismus* 1995; **32:** 172–177.
5. Aylward GW, McCarry B, Kousoulides L, Lee JP, Fells P. A scoring method for Hess chart. *Eye* 1992; **6:** 659–661.
6. Fitzsimons R, White J. Functional scoring of the field of binocular single vision. *Ophthalmology* 1990; **97:** 33–35.
7. Woodruff G, O'Reilly C, Kraft SP. Functional scoring of the field of binocular single vision in patients with diplopia. *Ophthalmology* 1987; **94:** 1554–1561.
8. Maurino V, Kwan JP, Lee JP. Review of the inverse Knapp procedure: indications, effectiveness and results. *Eye* 2001 **15:** 7–11.
9. von Noorden GK, Hansell RH. Clinical characteristics and treatment of isolated inferior rectus muscle paralysis. *Ophthalmology* 1991; **98:** 253–257.