THE ROLE OF SACCADIC VELOCITY TESTING IN THE MANAGEMENT OF ORBITAL FRACTURES

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Abstract

The aim of this study was to record and compare saccadic ocular movements in patients who sustained orbital trauma and/or orbital fractures. Seventeen patients were used. Ocular saccadic velocities were measured vertically (and horizontally) using a Tracoustic Saccadic Velocity Recorder. Patients with only orbital oedema and haemorrhage, who presented with a clinical picture of blow out fracture, gave normal saccadic velocity readings and ocular deviation disappeared soon after trauma. In patients with orbital fractures, saccadic velocity measurements proved to be helpful in identifying those patients who would have a persistent deviation after surgical repair of the fracture.

It is shown that saccadic velocity measurements can differentiate limitation of ocular rotation secondary to orbital oedema and haemorrhage and tissue incarceration, from those due to inferior rectus muscle paresis, even in mild cases. This information is of value to the surgeon in deciding management of the case.

Key words: *Saccadic velocities, orbital trauma, limitation of rotation, extraocular muscle paresis.*

INTRODUCTION

Saccades are rapid and precise conjugate eye movements from one fixation point to another. A saccade is induced by a sudden burst of motor unit activity which is immediately followed by an orderly firing pattern. During a saccade, there is a heightened burst of activity of the agonist, inhibition of the antagonist, and coactivity of the auxiliary extraocular muscles. The duration and velocity of saccadic eye movements are dependent upon the strength of the agonist. Reduction in saccadic velocity is an excellent index of qualitative reduction in muscle function. Conversely, recovery of velocity is an index of recovery in muscle function.

In patients with orbital fracture, in particular with orbital floor fracture, the orbital content, including orbital fat, extraocular muscle or muscles and Tenon's capsule, may be forced into the fracture site.

Findings of orbital tissue incarceration include ocular muscle imbalance, diplopia and restriction of ocular rotation. Depending upon the extent of the trauma and the injury caused by the incarceration, the extra ocular muscle involved may be paretic or functionally normal.

Additionally, paresis of an extraocular muscle, orbital oedema and haemorrhage may produce findings similar to those of orbital tissue incarceration and needs to be differentiated, in order to carry out the most appropriate treatment.

In all situations, diagnosis of the true condition may be assisted by roentgenographic (plain x-ray) and polytomographic views. These often show displaced bone or clouding of involved sinuses sometimes leaving the diagnosis unclear.

The purpose of this study was to investigate the use of saccadic velocity recordings to differentiate ocular muscle involvement in patients with orbital trauma and/or orbital fracture, thus aiding the management of these patients.

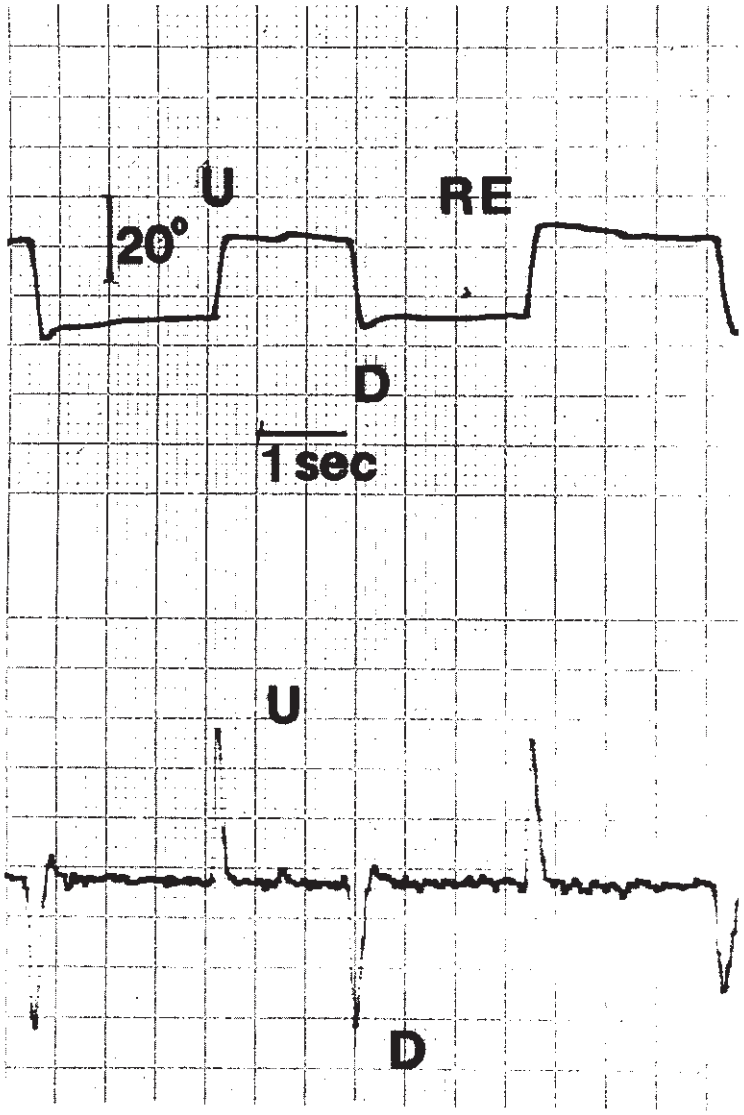

Figure 1: Velocity recording of vertical saccades of patient with orbital oedema and haemorrhage without fracture, right eye. Upper tracing, eye position, lower tracing, velocity. Upward (U) and downward (D) saccades are rapid and equal (300 degrees/sec cm) indicating normal ocular muscle function.

METHOD

A Tracoustic Saccadic Velocity Recorder, a form of electrooculography, was used to record and measure saccadic eye movements in patients with trauma to the orbit and/or with orbital fractures.

The recorder utilizes 5 miniature electrodes. To measure vertical saccades, electrodes were placed above the brow and below the lower lid of each eye, with a neutral placed centrally on the forehead. For horizontal saccadic measurements, electrodes were placed medially and laterally at each canthus with the neutral placed as above.

Saccades were generated by voluntary movements made between fixation points

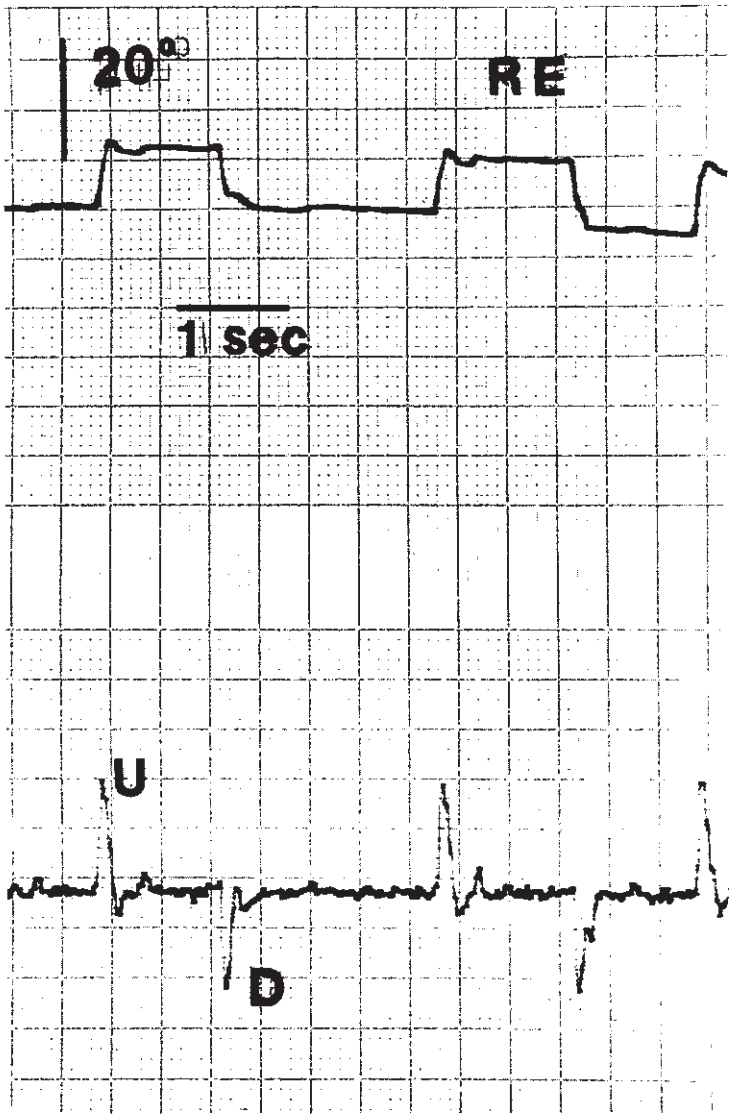

Figure 2: Velocity recording of vertical saccades of patient with orbital floor fracture, right eye. Upper tracing, eye position, lower tracing, velocity. Upward (U) saccades (240 degrees/sec cm) are slightly greater than downward (D) saccades (220 degrees/sec cm) indicating mild right inferior rectus paresis.

situated 20 and 40 degrees apart. Eye movements were made where the eye was able to move freely.

Patients

The study included 17 patients who were divided into three main groups:

1. Five patients sustained trauma to the orbit, producing orbital oedema and haemorrhage and a clinical picture of blowout fracture. Roentgenographic and polytomographic findings were normal.

2. Six patients had orbital floor fracture, confirmed surgically and/or roentgenographically and polytomographically. In this group there was no persistent ocular deviation in the primary position.

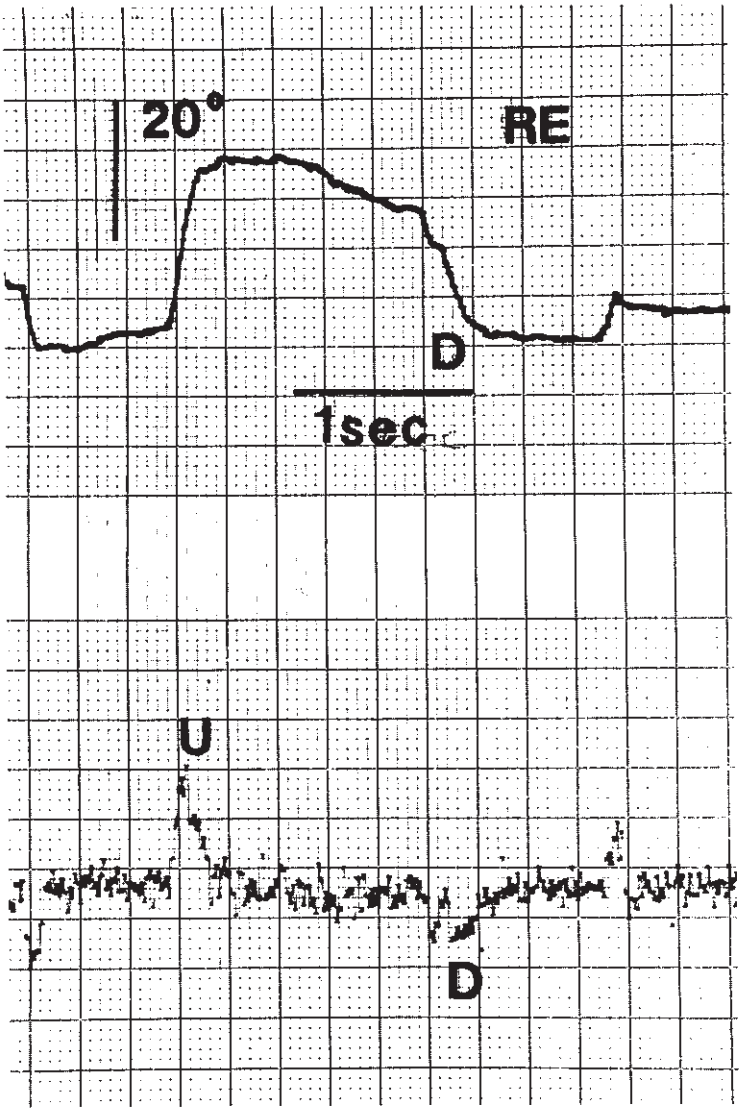

Figure 3: Velocity recording of vertical saccades of patient with orbital floor fracture, right eye. Upper tracing, eye position, lower tracing, velocity. Upward (U) saccades are rapid (250 degrees/sec cm) while downward (D) saccades are slow (100 degrees/sec cm) indicating normal right superior rectus muscle and paresis of right inferior rectus muscle.

3. Five patients had orbital floor fracture, confirmed as above. Three patients in this group also had associated zygomatic fractures and all patients had persistent ocular deviation in the primary position, on the side of the trauma.

There was one additional patient with a fracture of both the medial wall and orbital floor. This patient also had a persistent ocular deviation in the primary position, on the side of the trauma.

RESULTS

Saccadic velocities were recorded and measured on all subjects.

Based on the Metz *et al.*[1] method of calculation of saccadic velocities, the average percentage difference between upward (U) and downward (D) and between left (L) and right (R) saccadic velocity was used to assess the patients in this study.

In group one, saccadic velocities were equal and rapid in all cases (Fig. 1). Ocular deviation disappeared soon after trauma. Surgical intervention was not required.

In the second group, the average percentage difference between upward and downward saccadic velocity was 26%, with a range of 10% to 33% (Fig. 2). In all cases there was no deviation in the primary position, either without surgery or within four months after repair. Two patients had surgical repair of the fracture site.

In group three (Table 1) the average percentage difference between upward and downward saccadic velocity was 97.8% with a range of 60% to 150% (Fig. 3). Upward saccades were always faster than downward saccades. In all cases there was a residual hyperdeviation in the primary position up to eight months after repair. Two cases also had associated exotropia. All patients had surgical repair of the fracture site.

TABLE 1

Patient (group 3)	Post-op deviation in primary position (Δ)		Average % difference in saccadic velocities (U > D)
1	3Δ Hypert	3Δ Exot	60%
2	4Δ Hypert		66%
3	8Δ Hypert		89%
4	10Δ Hypert	4Δ Exot	124%
5	14Δ Hypert		150%

A correlation between the amount of postoperative residual deviation and the average percentage difference in saccadic velocities was found. The greater the hyperdeviation, the greater the percentage difference in saccadic velocities (Table 1).

The patient with the right medial wall and floor fracture had a vertical saccadic velocity reading of 100% difference (U > D) and a horizontal reading of 128% difference (L > R). A hyperdeviation of 10 prism dioptres and a divergent deviation of 12 prism dioptres remained. Surgical repair of the fracture site was performed.

DISCUSSION

Saccadic velocity recordings proved helpful in identifying those patients who would have a persistent deviation either with or without repair of the fracture site.

Results of this study showed that:

1. Patients whose range of vertical saccadic velocities was less than 35% difference from upward to downward (U > D) had no residual deviation or diplopia either without surgical repair, or within four months after repair and required no further treatment. The clinical significance of this finding is that any patient whose saccadic velocity reading was less than 35% difference from upward to downward (U > D) will eventually gain full ocular motility.
2. Those patients whose range of vertical saccadic velocities was 60% or greater (U > D) had a residual hyperdeviation and diplopia after surgical repair of the fracture site. The deviation persisted up to eight months after repair. The clinical significance of these results suggest that patients who have a 60% or greater difference from upward to downward (U > D) saccadic velocity will have impairment of ocular motility due to inferior rectus paresis. In the case of the medial wall and floor fracture patient saccadic velocity measurements indicate inferior rectus (100% U > D) and medial rectus (128% L > R) paresis.

A clinical correlation was found in the 60% or greater group (3), the greater the hyperdeviation, the greater the percentage difference between upward and downward saccadic velocity.

The findings of this study compare well with the results of the study by Metz *et al.*[1] who found that when the difference between upward and

downward saccadic velocity (U > D) was less than 30%, (group 1) patients could fuse either with or without surgical repair. When the difference between upward and downward saccadic velocity (U > D) was 51% or more, (group 2) patients had persistent vertical diplopia and hyperdeviation, post surgical repair. This was secondary to inferior rectus weakness. In their second group, generally, the greater hyperdeviation had the greater percentage difference between upward and downward saccadic velocity.

According to some investigators[2,3,4] a large majority of blowout fractures of the orbital floor do not require surgical treatment. They explain many of the typical symptoms and findings as secondary to orbital haemorrhage and oedema or mild paresis of the inferior muscles.

As can be seen from this study, saccadic velocity measurements can differentiate limitation of ocular rotation secondary to orbital oedema and haemorrhage and tissue incarceration, from those due to inferior rectus muscle paresis, even in mild cases.

This information is of great value in the management of patients with orbital trauma and/or orbital fractures, especially if there is inconsistency in signs, symptoms and roentgenographic and polytomographic findings.

Measurement of saccadic velocity also gives an index of the extent of ocular muscle paresis and documents recovery or lack of recovery of muscle function during the follow up period. This information is of assistance to the surgeon in deciding, if surgery is indicated, when to operate and which procedure would give the best functional result.

Saccadic velocity recording can be performed on children, causes no discomfort and is a technique easy to perform and interpret.

SUMMARY

Seventeen patients were used in the study. Ocular saccadic velocities were measured vertically (and horizontally) using a Tracoustic Saccadic Velocity Recorder.

Patients with only orbital oedema and haemorrhage who presented with a clinical picture of blow out fracture, gave normal saccadic velocity readings and ocular deviation disappeared soon after trauma.

In patients with orbital fractures, saccadic velocity measurements proved to be helpful in identifying those patients who would have a persistent deviation after surgical repair of the fracture.

Patients with orbital floor fracture, whose range of vertical saccadic velocities was less than 35% difference from upward to downward (U > D), had no residual deviation or diplopia either without repair of the fracture site, or within four months after repair and required no further treatment. Those patients with orbital floor fracture whose range of vertical saccadic velocities was 60% or greater (U > D) had a persistent hyperdeviation and diplopia, after repair of the fracture site, up to eight months after repair. This indicates inferior rectus paresis. The patient with the right orbital floor and medial wall fracture gave a vertical saccadic velocity reading of 100% difference (U > D) and a horizontal saccadic velocity reading of 128% difference (L > R). This patient had a persistent vertical and horizontal deviation and diplopia after fracture repair. This indicates right, inferior rectus and medial rectus paresis. These patients will be followed at regular intervals to measure recovery or lack of recovery in muscle function.

This information is of value to the surgeon in deciding, if surgery is indicated, when to operate and which procedure would give the best functional result.

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