

Maximizing Functional Outcomes in Orbital Roof Fracture



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Abstract

Background: Orbital fractures, while anatomically small, can have significant impact to the entire body.

Case Report: In this case, the patient had an orbital roof fracture which did not warrant surgical repair at the time of injury. As healing progressed, optometric examination of the patient showed diplopia, obvious deviation of vertical gaze, and restricted supraversion of the right eye. Physical therapy evaluation of the patient showed guarding of the upper trapezius muscles and neck muscles resulting from a compensatory head tilt to the left. Surgical correction of the fracture was considered but postponed and the patient desired short-term intervention. Vision therapy was utilized to prevent fibrosis of the superior orbital muscles should surgical correction be required. After two months of regular work by subject patient, eye alignment was orthophoric on cover test (a small hyperphoria was still present on Maddox rod testing) in all gazes and surgical correction was not necessary.

Discussion: Using therapeutic interventions helped prevent a patient with trauma-induced strabismus avoid surgery. Attention to subtle shifts in posture helped prevent life-long physical impairments which could have shortened this patient's career.

History

21-year-old male active-duty enlisted service member in the United States Air Force (USAF) referred by neurology provider

- Complaint of vertical double vision
 - Constant both distance and near, all directions.
 - Improved if he manually pushed his right eye up.
 - Closing right eye for relief
 - Started after motor vehicle accident (MVA) 2.5 weeks prior to exam
- Denied dizziness or headaches

Pertinent Ocular and Medical History

- (-) Personal or family history of
 - Refractive correction
 - Eye injuries or surgeries
 - Strabismus or amblyopia
- No medications prior to his injury
- Discontinued Percocet for pain by the time of initial optometric evaluation.
- Previous surgery tonsillectomy (childhood)

Social History and Goals

- Pt living on base approximately 1.5-2 hours travel from regional medical center
- Duty assignment Fire Protection Services
- Primary goal return to full duty

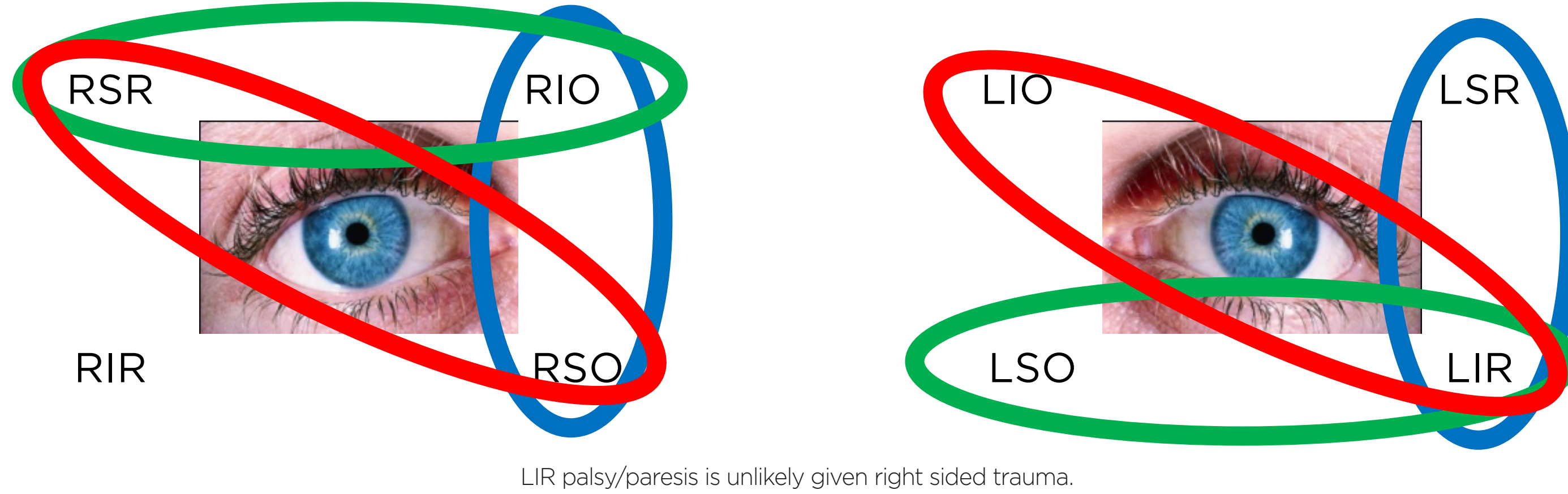
MVA on 6 Nov 2010

- Seated in passenger seat
- Vehicle hit a pot-hole, spun, subsequently struck by a large truck/transport vehicle on passenger side
- 20 minutes of post-trauma amnesia
- Transported to a local hospital
- Transferred to regional Army Medical Center
- In hospital two days for observation
- Right orbital roof and frontal sinus fracture (MRI)
- Rib fractures and contused lung
- Ophthalmology consult during initial hospital stay
 - Intact ocular structures (dilated exam)
 - Right lid swollen shut and motility not fully assessed
- Traumatic brain injury (TBI) screening questionnaire (administered by a nurse case manager)
 - Moderate category

TABLE 1: INITIAL EVALUATION, 24 NOV 2010

COMPONENT	FINDING
Visual Acuity, Distance (Uncorrected, Snellen)	OD: 20/25-2 OS: 20/20-1 OU: 20/25-1, (+) diplopia
Visual Acuity, Near (Uncorrected, Snellen)	OD: 20/25 OS: 20/25 OU: 20/40, (+) diplopi
Refractive Error (Autorefractor)	OD: +0.25-0.25X008 OS: +0.25-0.25X037
Pupils	PERRL, (-)APD
Color Vision (Ishihara)	OD: 14/14 pass OS: 14/14 pass
Visual Field	Confrontation: OD, OS: Full to finger count FDT C-20-5 screening: OD, OS: (-) defects; (-) fixation loss; (-) false positives
Ocular Motility	OD: Upgaze restricted, -2 (50%); (+) pain on upgaze OS: Full range of motion; (-) pain; (+) Diplopia all gazes
Hirschberg	OD: Reflex displaced; Superior 0.5 to 1 mm in all gazes OS: Central, steady reflex
Cover Test	10° right HypoTropia, 1° gaze
Eye Alignment	Park's 3-Step: Right Gaze 6° right HypoT Left Gaze 10° right HypoT Right Tilt 10° right HypoT Left Tilt 6° right HypoT Implicated Muscle: Left Inferior Rectus
Head Posture	Aligned
Anterior Segment	Scar in right eyelid and eyebrow, Otherwise unremarkable
Intraocular Pressure (Non-Contact Tonometry)	OD: 22 mmHg OS: 17 mmHg

FIGURE 1: PARK'S 3-STEP, INITIAL EVALUATION



LIR palsy/pareisis is unlikely given right sided trauma.

Assessment

Right hypotropia secondary to orbital roof bone displacement

- Differential right hypoglobus

Treatment Options for Rehabilitation

- Oculomotor dysfunction (hypotropia and gaze restriction)
 - No intervention. Monitor changes at 3-6 months.
 - Vision therapy to re-establish oculomotor control.

2. Diplopia

- Occlusion
 - Constant right eye patching
 - Constant left eye patching
 - Alternate right/left eye patching
 - Partial field occlusion of either or both eyes
- Prism: Prism was not chosen as the initial option for treatment as there was an expectation that decreased inflammation would resolve some of the diplopia issues. The patient did not have habitual spectacles or need them; therefore, Fresnel press-on prism was not a viable option at the initial evaluation. I was hesitant to prescribe an amount of prism that would be too much for the deviation by the time the patient could order and receive a spectacle Rx. Occlusion was an option to relieve the patient's diplopia. He was instructed to use the eye patch over his left eye for one day and switch the patch to his right eye the next day; patching was to be continued as long as the patient felt it was needed or until his next progress evaluation.
 - Compensatory to place the image where the deviated eye was looking
 - Oppositional to move the image away from the position of the deviated eye making the patient work harder to acquire the image

c. Optometric Vision Therapy to improve oculomotor control and normalize eye alignment

- Surgery: An oculoplastics consult was ordered to address reconstruction of the orbit. At the time of the oculoplastics surgeon's evaluation, it was determined that surgical correction was not warranted as the patient was demonstrating some resolution of his diplopia. Strabismus surgery was not an option during initial management due to the recent onset of the strabismus secondary to trauma.
 - Reconstruction of the orbit
 - Strabismus correction

TABLE 2: ORBITAL ROOF FRACTURE CLINICAL PEARLS¹⁵

BY THE NUMBERS	TREATMENT
<ul style="list-style-type: none"> Orbital fracture occurs in 18-50% of craniomaxillofacial trauma. Orbital comprise an estimated 1-9% of all facial fractures. Typically these fractures result from high-energy impact <ul style="list-style-type: none"> Motor vehicle accidents are the reported etiology in 49-53% of orbital roof fracture cases. It is uncommon for orbital roof fractures to occur in isolation: <ul style="list-style-type: none"> 95% with a frontal sinus injury 60% with injury to the orbital rims 60% with complex injuries to the general orbital area 33% with other orbital wall fractures 27% with LeFort fractures (fracture of maxillary bone which is generally bilateral) 	<ul style="list-style-type: none"> Varies from immediate surgical intervention to monitoring Surgical intervention for orbital fractures is deemed critical <ul style="list-style-type: none"> When the volume of the orbit is compromised (potential for exophthalmos or enophthalmos to result) When bone fragments are distorting or injuring the optic nerve If soft-tissue entrapment is present/ocular motility is compromised Treatment of orbital injuries is deferred until the patient is stabilized from other, more life-threatening injuries. At least one case of spontaneous healing of an orbital roof fracture <ul style="list-style-type: none"> Resolution approximately 8 weeks post injury The authors suggest resolving intracranial edema as mechanism

Plan

- Initiate vision therapy
 - Eye Control, monocular assigned at first exam
 - Return for further therapy instruction
- Alternate right/left eye patching to relieve diplopia
- Refer for oculoplastics/ophthalmology consult
 - Patient educated that strabismus from traumatic injuries could recover without surgical intervention within 6-12 months depending on severity of the insult
 - At consult appointment, surgeon elected to monitor healing as patient was already showing signs of improvement
- Generate a duty-limiting performance profile
 - Firefighter: job performance could be impaired by his diplopia and upward gaze restriction of the right eye
 - Restricted from running outdoors, contact sports, and high impact tasks
 - Initially 6 months, plan to lift if resolution before that time, ultimately, it was recommended to lift in January (3 months post-injury)

Vision Therapy

Patient was seen for 5 vision therapy sessions, twice weekly over a 2 1/2-week period starting from his progress evaluation. Vision therapy sessions lasted 20-30 minutes. The following list of exercises is given in the order of introduction to the patient. Vision therapy protocols for vertical deviations of alignment are based on therapy protocols for horizontal deviations. Some call for starting with prism neutralization of the vertical tropia and training horizontal fusional ranges to provide stability. Some start with prism neutralization and training both horizontal and vertical fusional ranges.⁶ In this case, the deviation varied from primary gaze to right head tilt and changed dramatically between the first and second evaluation. Therefore, prism was not the initial mode of treatment. The basic vision therapy protocol elected in this case was similar to that listed in Scheiman & Wick's Clinical Management of Binocular Vision Disorders.⁶ Initially, monocular fixation and smooth pursuit movement was stabilized with monocular eye control and smooth pursuit activities. Horizontal fusional ranges were then engaged; initially the patient was allowed to tilt his head to relieve the vertical diplopia. As his horizontal fusional ranges were building, he was required to move his head into primary gaze and finally into oppositional head tilt to challenge smooth vertical fusion capabilities. Variable vectograms and life-saver card provided training for horizontal and horizontally-supported-vertical fusional ranges. Finally, isometric vertical fusion was incorporated in the form of prism reading.

- Monocular Eye Control, smooth pursuit into position (up, down, left, right, and into four corners), hold position for 3-5 seconds, and then perform 10 cycles of saccades between primary gaze and the held position.
- Monocular smooth pursuit activity. He was to look down with his right eye and perform horizontal tracking motion left to right; with his left eye he was to look up and perform the same tracking motion. This was assigned for 1-2 minutes per eye, 3-5 times per day.
- Variable vectograms. Horizontal ranges were worked in-office for 5-15 minutes. Initially head posture was allowed to be maintained with slight left head tilt. After initial introduction, head posture was straightened by the vision therapist and a bean bag was placed on the patients head to give postural awareness. When stability was achieved in primary gaze, head shaking was added; low-frequency shaking of about 30 cycles per minute was used. Head shaking helped to challenge his VOR stability and vergence control. This activity was performed in-office only as preparation for activity number 5.
- Prism reading. Base up prism was placed over the right eye for 2 minutes while the patient read appropriate reading material. Initial power was the most that he could tolerate without having diplopia during the 2 minute interval. Five cycles of 2 minutes on, 2 minutes off were completed. Initially 2 prism diopters base up was used and the patient was progressed to 4 prism diopters over 2 weeks of in-office training. A temporary training Rx was given for home therapy of 4 base up prism OD. See Figure 2 below.



FIGURE 2



FIGURE 3

- Lifesaver card/concentric circles. Starting with habitual left head tilt, patient was instructed to fuse, then clear closer targets and work his way up to further spaced targets. When he achieved fusion and clarity on the top target, he was to straighten his head posture and perform the activity again until he could achieve the highest target. When he was able to that, he was instructed to tilt his head to the right and repeat the progression. See Figure 3 above.

Physical Therapy

Patient was evaluated and treated by physical therapy concurrently with his vision therapy treatment. He participated in four twice-weekly physical therapy sessions as part of his rehabilitation. The physical therapy clinic was in the same facility as the optometry and vision therapy clinic and all exercises were discussed collaboratively to look for overlap. He was assessed to have a mild left head tilt and right-sided vestibular dysfunction. Impairments were noted in both vestibulo-ocular reflex testing and vestibulospinal reflex testing. He was assigned therapy activities which supported proper head posture and to address the vestibular dysfunction. It was noted in the physical therapy examination that he was developing inappropriate tension and guarding in right scapular, upper trapezius, and cervical muscles secondary to his left head tilt. Additionally, his center of gravity had shifted slightly to the left but was still within normal limits. The physical therapist also provided soft-tissue mobilization of the affected muscles during his sessions and educated the patient on importance of correcting his head posture.

TABLE 3: SUMMARY OF PROGRESS EVALUATIONS

	OPHTHALMOLOGY CONSULT (VISIT 1)	OPHTHALMOLOGY CONSULT (VISIT 2) AND PROGRESS EVALUATION 1	PROGRESS EVALUATION 2 AND OPHTHALMOLOGY FOLLOW-UP	RETURN TO DUTY EVALUATION
Date	6 Dec 2010	20 Dec 2010	25 Jan 2011	21 April 2011
Diplopia	(+) in down gaze and in right gaze	(+) in down gaze and right head tilt resolves by tilting head to the left	Denied	Denied
Ocular Motility	Ductions Full (-) pain on eye movement Right eye lower in all superior gazes (based on Hirschberg reflexes)	Ductions Full (-) pain on eye movement	Ductions Full (-) pain on eye movement	Ductions Full (-) pain on eye movement
Eye Alignment Primary Gaze	3° Right HypoTropia	3° Right HypoTropia	Cover Test: Ortho Maddox Rod: 1° Right Hyperphoria	Cover test: Ortho in all gazes
Comitancy	Park's 3-Step: Right Gaze ortho Left Gaze ortho Right Head Tilt ortho Left Head Tilt ortho Implicated Muscle: none	Park's 3-Step: Right Gaze 2° rhypt Left Gaze 2° rhypt Right Head Tilt 12° rhypt Left Head Tilt ortho Implicated Muscle: indeterminate	Maddox Rod 9 fields of gaze (bars over right eye): Superior 2 RHP/2 RHP/1 RHP Primary 2 RHP/1 RHP/1 RHP Inferior 2 RHP/2 RHP/2 RHP	Cover test: Ortho in all gazes
Head Posture	(-) Head Tilt	Left Head Tilt		(-) Head Tilt

TABLE 4: EVALUATION OF VERTICAL DEVIATIONS AND COMITANCY⁷⁸

TEST	OPHTHALMOLOGY CONSULT (VISIT 1)	PROS	CONS
Cover test	Patient fixates on appropriate distance or near target. Determination of TROPIA with Unilateral: cover/uncover each eye while observing any movement. Determination of PHORIA/Magnitude with Alternating: switch cover from right to left and neutralize movement with prism. Eyes are DISSOCIATED	Commonly used procedure, basis for Park's 3-Step	Need to control head posture
Park's Three-Step	Cover test in various positions: 1. Primary Gaze 2. Right Gaze and Left Gaze 3. Right Head Tilt and Left Head Tilt Eyes are DISSOCIATED	Accepted method (for Vertical Tropia) to demonstrate changes in comitancy across gaze positions Multiple "apps" are available to analyze results	Inconclusive if other than Superior Oblique Palsy
Hirschberg	Observation of the corneal light reflex; usually performed using a penlight or transilluminator Can be done based on observation without introducing specific light source if observer can see corneal light reflex without addition of point source of light.	Limited equipment, patient does not need to respond other than fixating on lighted target	Observer error
Extra-Ocular Motility	Using Hirschberg technique while evaluating Physiologic Double H pattern	Limited equipment, patient does not need to respond other than fixating on lighted target	Observer Error
Maddox Rod	Red Maddox Rod lens (cylinders side by side across surface) is held over one eye Patient looks at light (transilluminator) and notices a white light and a red line. If the red line does not go through the light, prism is introduced until the two are superimposed Eyes are DISSOCIATED	Can help discriminate small deviations Hand-held Risley Prism style testers make this less awkward to test	Subjective
Hess-Lancaster	The patient wears red and green filter glasses and uses red and green lights. The clinician shines a light on a Hess-Lancaster map and the patient matches their light to the clinician's light. The clinician records the patient's responses on a score sheet to map out the muscle fields Eyes are DISSOCIATED	Trace of muscle fields Considered highly accurate in assessing comitancy	Specialized equipment Difficulty with interpretation if not performed frequently

Conclusions

The use of vision therapy in an integrated team approach allowed this patient to control his rehabilitation process and meet his primary goal of full return to duty. Key providers for this patient included neurology, optometry, ophthalmology, and physical therapy. Collaboration among providers allowed for a focused approach to therapeutic interventions. The patient was able to return to his full work demands faster than anticipated by medical providers. He met his goals and was pleased with his final outcome.

Bibliography

- Huang RH, Van Sicliet JE, Jenkins WS. Demographics and Treatment Options for Orbital Roof Fractures. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002 Mar; 93(3):238-45.
- Futcher TP, Sullivan TJ. Orbital Roof Fractures: Management of Ophthalmic Complications. *Ophthalm Plast Reconstr Surg* 2003 Sep;19(3):359-63.
- Chen CT, Chen YR. Update on Orbital Reconstruction. *Curr Opin Otolaryngol Head Neck Surg* 2010 Aug;10(4):311-6.
- Kim JW, Baek TH, Kim WS, Kim HK. Early Reconstruction of Orbital Roof Fractures: Clinical Features and Treatment Outcomes. *Arch Plast Surg* 2012 Jun;39(1):31-5.
- Intrenga T, Lamba GF, MacKinnon C, Agr H. Spontaneously Reduced Isolated Orbital Roof Fracture. *J Craniofac Surg* 2012 Jul;25(4):1020.
- Scheiman M, Wick B. *Clinical Management of Binocular Vision: Heterophoria, Accommodative, and Eye Movement Disorders*. Second Edition 2002. Philadelphia, PA: Lippincott, Williams & Wilkins.
- Caloroso EE, Rouse MW. *Clinical Management of Strabismus*. 1993. Newton, MA: Butterworth-Heinemann.
- London R. An Alternative Approach to Interpretation of the Vertically Acting Extraocular Muscles: Excerpts from the Writings of Arthur Janzinsky. *Problems in Optometry* 1992 Dec; 4(4):556-64.