**Title**

Evidence Based Care Pathway for Isolated Adult Orbital Blowout Fractures

**Authors/ Affiliations**

Jessica Wood, BSc (Hons)

Joanne Adeoye BSc, MMedSci

Department of Orthoptics, University of Liverpool

**Key Words** mechanical, incomitant, motility, surgery, imaging

**Abstract**

**Aim:** This review aims to develop an evidence-based pathway for isolated adult orbital blowout fractures. Evaluation of assessment methods, outcome measures, imaging modalities and crucially, the optimal timing of surgical intervention was critically examined to develop a clinically applicable care pathway.

**Methods**: A literature search was carried out using Scopus, PubMed and Web of Knowledge.

**Results:** The literature favours the use of HAR% ratio, Field of BSV and exophthalmometer as the core tests that should form part of the standardised assessment for BOF. CT imaging demonstrates adequate sensitivity, but ideal timing and frequency is yet to be determined. There was some disagreement in relation to timing of intervention in adult fractures with persistent diplopia, EOM entrapment and enophthalmos >3mm (2 weeks vs 4 weeks). There was a lack of evidence-base for adult patients who are asymptomatic with enophthalmos and diplopia, however the literature available agreed that successful functional and radiological outcomes can be achieved with conservative or late surgical management beyond 4 weeks.

**Conclusions:** An evidence-based care pathway has been created, confidently including the initial assessment methods, imaging modality and the criteria for observation. A 4-week observational period has been advocated due to evidence suggesting that there is no significant difference in outcomes from 2 weeks.

**Introduction –**

There is lack of standardised care for adult BOFs, with the assessment methods, frequency and choice of imaging and management approach varying for each patient. In recent literature, the idea of extending the 2-week observation period in favour of avoiding unnecessary surgery has been proposed and consequently this review builds upon these findings whilst questioning whether a larger proportion of BOF patients can benefit from conservative management and therefore including this option within the care-pathway.

The aim of this review is to develop a care pathway (CP) for the assessment and management of adult BOFs not in combination with facial or systemic injury.

**Methods**

ALiterature search was carried out using Scopus, PubMed and Web of Knowledge; search terms included ‘orbital fracture’, ‘early surgery’, ‘late surgery’ ‘conservative’ and ‘blow-out fracture’. Due to the absence of prospective studies and randomised controlled trials, the literature reviewed was all of retrospective design. The inclusion criteria in terms of classification, aetiology and systemic injuries were not strictly defined, providing the study included data for early, late or conservative outcomes. The literature included is from an international radius, due to the absence of quantifiable UK-based literature.

**Results**

**Assessment Methods**

From the evidence, the Hess Chart should be used in conjunction with HAR% and the FOBSV: combining these methods provides functional and mechanical information to make an informed surgical decision.1-4. The place of OM assessment within the CP is debatable as there is lack of robust data which correlates OM deficit to actual entrapment on CT imaging. OM assessment was frequently modified in the literature to include a quantitative grading of restriction.2,3,5-9 Evidence shows that diplopia in depression has a greater impact on QoL than diplopia in elevation.5,9 Self-reporting questionnaires were found to be useful to determine the QOL of the patient in adjunct to the objective measurement of deficit; although the questionnaires were original to each study design, preventing comparison of outcomes.2,5-8,10

The Exophthalmometer is essential to identify enophthalmos. This assessment is crucial for all BOF patients since enophthalmos >3mm is a firm indicator for surgical intervention.2,3,8,9As demonstrated in Figure 1, the t-test was carried out comparing pre and post-operative outcomes.5,7,10,11 Enophthalmos reached significance with early (p<0.03) and delayed repair (p=0.001), confirming the reliability of the Exophthalmometer to warrant surgery at any point during the care-pathway and quantify improvement.

**Imaging**

CT imaging remains the gold-standard modality for all adult BOF patients, 100% of patients were scanned post-injury (n=1440).5-8,11-16 There was a lack of robust data to evaluate the use of CT imaging for those patients conservatively managed. However, the study by Young et al. found 93% (n=41) of patients who were conservatively managed showed neobone formation and 91.4% showed significant reduction in orbital volume at 6-month scan post-injury (p<0.01).17 Contrary to previous literature where imaging was only used at initial assessment, CT documents physiological improvement alongside subjective assessments which improves monitoring and ensures natural recovery.6,18 MRI is infrequently used as the primary imaging modality throughout the literature. MRI can, however play a role in identification of EOM entrapment where the CT scan is NAD, but the patient remains symptomatic.18 Consequently, symptomatic patients after 2-week observation may benefit from a follow-up MRI.

**Timing**

The data shown in Figure 1 and Table 1 is from 1440 participants: 8 studies focusing upon early intervention (0-14 days) and 7 studies with late intervention (14 days-1277 days). 5-8,11-16,19-23 The graph demonstrates the presence of key indicators; OM deficit, diplopia and enophthalmos pre-operatively and post-operatively with respect to early and late surgical intervention. The Shapiro Wilk test showed a normal distribution (p=0.07) which guided parametric analysis using SPSS software. The paired t-test was used to compare pre-operative and post-operative variables in Figure 1, with the Independent t-test comparing early and late post-operative outcomes as shown in Table 1. The mean and standard deviation of the percentage measure are presented. The threshold for significance was set at p<0.05 as this correlates with the value used in all included studies.5-8,11-15,19-22

As shown in Figure 1, enophthalmos was the only value to reach significance for early (p=0.024) and late intervention (p=0.001), which agrees with the evidence base that advocates enophthalmos >3mm should warrant surgical intervention.11,23,24 In contrast to diplopia and OM, enophthalmos cannot spontaneously resolve as physical re-positioning of the orbital contents is required. Consequently, this accounts for the statistical significance irrespective of surgical timing as data cannot be skewed by participants who demonstrate improvements not attributed to surgical intervention. Early enophthalmos post-injury should be a cause for concern because once herniation subsides, enophthalmos is likely to continue to worsen with no orbital swelling to proptose the globe. Even though studies show less improvement with surgery for early enophthalmos, this does not infer late intervention is superior, moreover late intervention may facilitate the worsening of the displacement.11,24 Therefore, it is recommended that enophthalmos >3mm should warrant surgical intervention, regardless of the timing.

OM did not reach significance: early surgery (p=0.47) and late surgery (p=1) compared with diplopia: early surgery (p=0.29) and late surgery (p=0.54). Neither OM or diplopia were significantly impacted by surgical intervention regardless of early or late surgery. This disagrees with the large proportion of authors who advocated surgery within 14-days if evidence of EOM entrapment and diplopia.1,6,8,19-23,25 In disagreement, the literature shows that patient outcome, regardless of early or late intervention are equitable, but the duration of recovery can be shortened with early intervention.5,6,23 Yu et al and Kwon et al showed slower diplopia recovery with intervention 2-4 weeks post-injury and a longer resolution period after intervention beyond 15-days: 100% of subjects achieved the same outcomes.5,6,9 This infers that those with CT confirmed EOM entrapment and persistent diplopia benefit from a shortened recovery period with 0-14-day intervention.

Table 1 shows that the timing of intervention did not impact the outcomes for all variables: OM (P=0.45), diplopia (p=0.51) and enophthalmos (p=0.21), inferring that timing is not the sole factor to influence patient outcomes. It is questionable if the 2-week observational period for early intervention is sufficient to allow maximum natural recovery if the outcome is not directly impacted by timing. This drives the idea of extending the observational period prior to surgery, to prevent unnecessary surgical exploration, allow herniation subsidence and consequently OM improvement.6,20,23 This also allows for spontaneous diplopia resolution. Furthermore, the QOL score was significantly greater in the non-surgical group inferring that psychological benefits alongside physiological improvement whilst preventing unnecessary surgery in a sizeable proportion of cases: reducing waiting list demand and unnecessary surgical risk. The concept of conservative management is a newly evolving theory in traumatic medicine whereby a recommendation to extend the observational period to 4-weeks is supported by several authors.5,27,28

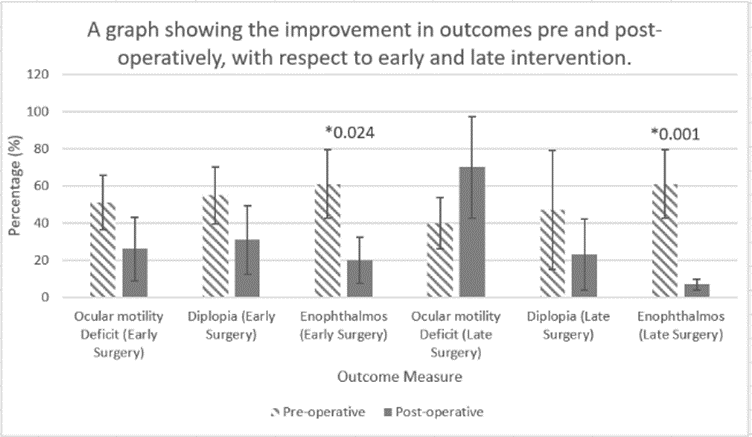
**Conclusion**

From the review of the literature, a care pathway as seen in Figure 3 has been developed. What can be gained from the literature is that BOF’s with evidence of soft tissue entrapment, persistent diplopia for more than 2-weeks and enophthalmos >3mm should be surgically managed within 4-weeks.1,5-8,12,19,25 Surgery for this group of patients would usually be advocated within 2-weeks however, the literature demonstrates that a 2-week observation period allowing for spontaneous resolution is beneficial for adults with isolated BOFs, regardless of fracture classification.5,7,11,23 The period for early intervention could potentially be extended with more robust evidence that demonstrates outcomes for intervention within 4-8-weeks post-injury.

The care pathway aims to shift management strategy toward encouraging patient choice within management decisions, when possible to do so. It is feasible for patients with no functionally limiting diplopia and enophthalmos to have extended observation, with the option of surgical management only if symptoms worsen.23 This approach could minimise the amount of surgical procedures, resulting in fewer peri-operative and post-operative complications. The extent of recovery that can take place with conservative management alone is lacking in enough robust evidence to firmly suggest that a conservative approach is safe to recommend as an option for all patients, regardless of injury features.2,11 For patients who are asymptomatic but have enophthalmos <3mm, conservative management is a viable option.2,11,23 Further research in this area should aim to retrospectively analyse outcomes from patients whose presenting features warrant surgery but decline treatment. More robust data for delaying intervention beyond 4-weeks is required to fully justify extension of the observational period.

**Reference List**

1. Yamanaka Y, Wantanbe A, Sotozono C, Kinoshita S. Impact of surgical timing of postoperative ocular motility in blowout fractures. *Br J Ophthalmol* 2018; **102**: 398-403.
2. Beigi B, Khawanda M, Gupta D. Management of pure orbital floor fractures: A proposed protocol to prevent unnecessary or early surgery. Orbit 2014; 33(5): 336-342.
3. Charteris DG, Chan HC, Whitehouse RW, Noble LJ. Orbital volume measurement in the management of pure blowout fractures of the orbital floor. Br J Ophthalmol 1993; 77: 100-102.
4. Pagnoni M et al. Late treatment of orbital fractures: a new analysis for surgical planning. Acta Otorhinolaryngologia Italica 2014; 34: 439-445.
5. Dal Canto A, Linberg VJ. Comparison of orbital fracture repair performed within 14 days versus 15 to 29 days after trauma. *Ophthalmic Plast Reconstr Surg* 2008; **24** (6): 437-443.
6. Yu D et al. Surgical timing and fracture type of the outcome of diplopia after orbital fracture repair. Ann Plast Surg 2016; 76: 91-95.
7. Alinasab B, Qureshi RA, Stjarne P. Prospective study on ocular motility limitation due to orbital muscle entrapment or impingement associated with orbital wall fracture. Int J Care Injured 2017; 48: 1408-1416.
8. Steinegger K, Haller DH, Courvoiser D, Scolozzi MD. Orthoptic sequalae following conservative management of pure blowout orbital fractures: anecdotal or clinically relevant? *J Craniofac Surg* 2015; **26**(5): 433-437.
9. Kwon HJ, Moon HJ, Kwon SM, Cho HJ. The differences of blowout fracture of the inferior orbital wall between children and adults. Arch Otolaryngol Head Neck Surg 2005; 131: 723-727.
10. Kunz C, Sigron RG, Jaquirery C. Functional outcome after non-surgical management of orbital fractures- the bias of decision making according to size of defect: critical review of 48 patients. Br J Oral Maxillifacial Surg 2013; 51: 486-492.
11. Furuta M, Yago K, Iida T. Correlation between ocular motility and evaluation of computed tomography in orbital blowout fractures. Am J Ophthalmol 2006; 142: 1019-1025.
12. Egbert JE, May K, Kersten RC, Kulwin RD. Paediatric orbital floor fracture. Ophthalmology 2000; 107(10): 1875-1879.
13. Jung H et al. Prognostic CT findings of diplopia after surgical repair of pure orbital blowout fracture. J Craniomaxillofac Surg 2016; 44: 1479-1484.
14. Jin H, Lee H, Yeon J, Suh W. Residual diplopia after repair of pure orbital blowout fracture: The importance of extraocular muscle injury. Am J Rhinol 2007; 21: 276-280.
15. Matteini C, Renzi G, Becelli R, Belli E, Lannetti G. Surgical timing in orbital fracture treatment: experience with 108 consecutive cases. J Craniofac Surg 2004; 15(1): 145-150.
16. Silverman N et al. Orbital floor fracture with entrapment: Imaging and clinical correlations in 45 cases. Orbit 2017; 36(5): 331-336.
17. Young T et al. Conservatively treated orbital blowout fractures: spontaneous radiologic improvement. Trans Am Acad Ophthalmol Otolaryngol 2018; 125: 938-944.
18. Caranci F et al. Orbital fractures: Role of imaging. Semin Ultrasound CT MRI 2014; 33: 385-391.
19. Bansagi CZ, Meyer RD. Internal orbital fractures in the paediatric age group: characterization and management. Ophthalmology 2002; 107: 829-836.
20. Liao JC, Elmalen IV, Wells ST, Harris JG. Surgical timing and postoperative ocular motility in type B orbital blowout fractures. Ophthalm Plast Reconstr Surg 2015; 31(1): 29-33.
21. Shah AH et al. Use of fracture size and soft tissue herniation on computed tomography to predict diplopia in isolated orbital floor fractures. JAMA Otolaryngol Head Neck Surg 2013; 34: 695-698.
22. Jung H et al. Prognostic CT findings of diplopia after surgical repair of pure orbital blowout fracture. J Craniomaxillofac Surg 2016; 44: 1479-1484.
23. Dubois L, Steenen A, Goonis JJP, Mourits MP, Becking GA. Controversies in orbital reconstruction. Timing of post-traumatic orbital reconstruction: A systematic Review. Int J Oral Maxillo 2015; 44: 433-440
24. Guy J, Simon B, Hassan MS, McCann DJ, Goldberg AR. Early versus late repair of orbital blowout fractures. Ophthalmic Surg Lasers Imaging 2009; 40: 141-148.
25. Damgaard OE, Larsen GC, Felding AU, Toft BP, Buckwald VC. Surgical Timing of the Orbital ‘‘Blowout’’ Fracture: A Systematic Review and Meta-analysis. Otolaryngol Head Neck Surg 2016; 155(3): 387-390.
26. Jemella MH et al. Objective and subjective outcomes of strabismus surgery in Graves’ Orbitopathy: a prospective multicentre study. Acta Ophthalmol 2017; 95: 386-391.
27. Jansen et al. A nonsurgical approach with repeated orthoptic evaluation is justified for most blow-out fractures. J Craniomaxillofac Surg 2020; 48: 560-568.
28. Lofrese et al. Spontaneous Repositioning of Isolated Blow-In Orbital Roof Fracture: Could Wait and See Be a Strategy in Asymptomatic Cases? Craniofac Surg 2020; 31(3): 263-266.



**Figure 1**: Presence of OM, diplopia and OM deficits pre-operatively and post-operatively. 5-8,11-16,19-23

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**Table 1**: Data comparing early versus late outcomes.