Effect of Time to Operative Repair Within Twenty-Four Hours on Visual Acuity Outcomes for Open Globe Injuries

Kevin Makhoul (kevin.makhoul@umassmed.edu)
University of Massachusetts Chan Medical School
Racquel Bitar
Grayson Armstrong
Massachusetts Eye and Ear https://orcid.org/0000-0001-9102-5868
Marguerite Weinert
Alexander Ivanov
Francesca Kahale
Thong Ta
https://orcid.org/0000-0002-9538-083X
Alice Lorch

Article

Keywords:

Posted Date: October 10th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2074036/v1

Version of Record: A version of this preprint was published at Eye on December 21st, 2022. See the published version at https://doi.org/10.1038/s41433-022-02350-6.

Abstract

Background/Objectives

Convention is to perform open globe injury (OGI) repair within 24 hours to minimize risk of endophthalmitis. However, there is limited data assessing how time to operative repair (OR) within 24 hours impacts postoperative visual acuity (VA).

Subjects/Methods

Manual retrospective chart review of 633 eyes at Massachusetts Eye and Ear (MEE) with a diagnosis of OGI between 2012–2022. Inclusion criteria were primary repair ≤ 24 hours after injury and ≥ one month up. Multivariate regression analysis was conducted with postoperative VA as primary outcome.

Results

Of the subjects, 489 (77.3%) were male and 496 (78.4%) were white. Demographics of OGI wounds included 320 (50.6%) rupture and 313 (49.4%) laceration; 126 (19.9%) with rAPD, 189 (29.9%) zone 3 injuries, 449 (71.2%) uveal prolapse, and 110 (17.4%) intraocular foreign body. Final postoperative LogMAR VAs consisted of 31% with a VA < 1.7, 9% with a VA of 1.9, 18% with a VA of 2.3, 27% with a VA of 2.7, and 11% with a VA of 3.0. Multivariate analysis showed no significant correlation between time to OR and postoperative VA ($p = 0.800$) [95%CI:-0.01,0.01]. Older age ($p < 0.001$) [95%CI:0.00,0.01], worse presenting VA ($p < 0.001$) [95%CI:0.17,0.32], rAPD ($p < 0.001$) [95%CI:0.65,1.0], mechanism of rupture ($p < 0.001$) [95%CI:0.19,0.54], higher zone of injury ($p < 0.001$) [95%CI:0.25,0.45], and uveal prolapse ($p = 0.003$) [95%CI:0.09,0.42] were significantly associated with worse final VA.

Conclusions

Time to repair of OGIs within 24 hours does not influence final VA. Optimization of surgical and patient factors may contribute more significantly to final VA than prioritizing more rapid time to OR.

Introduction

Open globe injury (OGI), defined as a full thickness wound of the wall of the eye, is a severe form of ocular trauma that has a high risk of ocular and visual morbidity.[1] Given the potential for severe vision loss, identification of factors that may improve visual function following OGI is critical. Prior studies have demonstrated that final visual acuity is influenced by injury-related factors, including presenting visual acuity, mechanism of rupture, retinal detachment, and relative afferent pupillary defect (rAPD), as well as patient factors including older age.[2,3,4,5,6,7,8] Moreover, endophthalmitis, a vision-threatening complication of OGI, has been found to be associated with injury-specific factors including presence of intraocular foreign body (IOFB), soil exposure, and, importantly, delayed primary wound closure greater than 24 hours.[9,10,11,12] For this reason, the standard of care for ruptured globes is to perform primary closure within 24 hours to minimize the risk of endophthalmitis.

Ultimately, a myriad of factors influences visual outcome in the pre-operative, intraoperative, and postoperative period of OGI repair, most beyond the surgeon's control. Factors that can be influenced by the ophthalmologist include early intervention, antibiotic prophylaxis, and longitudinal follow-up.[13,14] The relationship between length of time from OGI injury to surgical repair on OGI outcomes is multifaceted.[4,13,14,15] To date, there have been limited well-powered studies of the impact of time to operative repair within 24 hours on visual acuity outcome for patients with OGI. We therefore aimed to evaluate whether a surgeon's time to the operating room for primary repair of an OGI results in any difference in final visual acuity.

Materials (Subjects) And Methods

This study was approved by the Mass General Brigham institutional review board and adhered to the tenets of the declaration of Helsinki in accordance with HIPAA regulations. The requirement for informed consent was waived because of the retrospective nature of the study.

Data Extraction

A retrospective chart review of 633 pediatric and adult OGIs operated on at Mass Eye and Ear (MEE) between January 1st, 2012, and January 31st, 2022. All patients presented to MEE with an OGI for primary repair and were treated according to our standardized open globe repair protocol.[14] Inclusion criteria included primary OGI repair within 24 hours of injury and at least one month of follow-up with a documented visual acuity.

Clinical data were manually collected from the electronic medical record. Demographic variables collected included date of birth, age at time of injury, sex, race, ethnicity, and eye laterality. Clinical variables included time from injury to operating room (OR), presenting VA, mechanism of injury (laceration vs. rupture), maximal zone of injury (Zone 1 as the cornea, Zone 2 as the limbus to 5 mm onto the sclera, and Zone 3 as the rest of the posterior sclera), presence of an IOFB, presence of rAPD, presence of uveal prolapse on presentation, whether lensectomy was performed, whether post-op sight-improving surgery was performed after the initial repair (including pars plana vitrectomy, anterior vitrectomy, lensectomy +/- IOL insertion, pupilloplasty, keratoplasty, cyclophotocoagulation, retinectomy, scleral buckle insertion, lateral canthotomy, wound revision, and endolaser), and the final post-op VA recorded in the patient's chart.[13,16] All Snellen VAs were converted to LogMAR scale: Snellen VAs < 20/1000 correspond to a LogMAR of < 1.7, and counting fingers (CF), hand motion (HM), light perception (LP), and no light perception (NLP) correspond to values of 1.9, 2.3, 2.7, and 3.0, respectively.[17,18,19] The types of trauma were categorized according to the Birmingham Eye Trauma Terminology (BETT) and Ocular

Trauma Classification (OTC) guidelines.[1,20] Final VA at last follow up was the primary outcome of the study.

Statistical Analysis

Data were analyzed using R statistical programming software (version 4.1.2). Descriptive statistics and frequencies were calculated for all demographic and clinical variables of interest utilizing Chi-squared tests of independence and Kruskal-Wallis tests. A p-value < 0.05 was considered to be statistically significant. Time to OR was analyzed as a continuous variable. Univariate and multivariate models were constructed to observe the effects of time to OR and demographic data on final VA at last follow-up.

Results

A total of 633 eyes from 628 individual patients met inclusion criteria. The average patient age was 44.8 years at the time of injury (*Table 1*). Males constituted a majority of the cases at 486 (77.3%). A majority of patients were white (78.4%), followed by other (10.7%) and black (7.0%). In addition, 65 (10.3%) patients identified their ethnicity as Hispanic (Table 1). A rAPD was present in 126 (19.9%) eyes, and an IOFB was present in 110 (17.4%) eyes. A similar proportion of patients sustained rupture vs laceration mechanisms of injury, with 320 (50.6%) being rupture injuries. Uveal prolapse occurred in 451 (71.2%) eyes. Primary or secondary lensectomy was performed in 234 (37.0%) eyes, and other post-op sight-improving surgery was performed in 347 (54.8%) eyes.

Variables that were not distributed equally included those that were significantly associated with either laceration or rupture as a mechanism of injury. rAPD occurred in 32 (10.2%) eyes that sustained a laceration injury and 94 (29.4%) eyes that sustained a rupture injury ($p < 0.001$). An IOFB was found in 93 (29.7%) eyes with a laceration injury and 17 (5.3%) eyes with a rupture injury ($p < 0.001$). Uveal prolapse occurred in 187 (59.7%) eyes with a laceration injury and 264 (82.5%) eyes with a rupture injury ($p < 0.001$). On average, the time to OR was 13.8 hours for eyes that sustained laceration injuries and was 15.3 hours for eyes that sustained a rupture injury ($p = 0.002$).

Time to OR significantly correlated with post op VA in univariate analyses ($p = 0.014$) [95% CI: 0.00, 0.04]. However, when using a multivariate analysis that included 21 covariates, time to OR was no longer a significant variable ($p = 0.800$) [95% CI: -0.01, 0.01] (*Table 2*). Analysis demonstrated that presenting VA ($p < 0.001$) [95% CI: 0.17, 0.32], higher age at time of injury ($p < 0.001$) [95% CI: 0.00, 0.01], rupture as a mechanism ($p < 0.001$) [95% CI: 0.19, 0.54], presence of rAPD ($p < 0.001$) [95% CI: 0.65, 1.0], higher maximal zone of injury ($p < 0.001$) [95% CI: 0.25, 0.45], and uveal prolapse ($p = 0.003$) [95% CI: 0.09, 0.42] were all significantly associated with the change in LogMAR VAs (Fig. 1).

Discussion

In this study, we evaluated the effect of time to primary repair on visual acuity outcomes of OGI injuries repaired within 24 hours who presented to a single academic institution. Our results indicated that there was no significant correlation between time to OR and final visual acuity within the 24-hour window. This study also supports previous data that found significant association of other factors with visual acuity outcomes.

The finding that time to primary operative repair within the 24-hour window does not have a discernible impact on visual outcomes is a clinically important finding. While situations will arise that call for an ophthalmologist to use their judgment and take an OGI for primary repair immediately, there are many reasons why an ophthalmologist may wish to instead delay an OGI repair with a goal of repair within the 24-hour period, including patient hemodynamic stabilization after trauma, or insufficient OR and anesthesia staffing overnight or on weekends. In addition, there are factors outside of a surgeon's control that may delay primary OGI repair, such as delays in transfer of the patient from an outside hospital. Given the results of our findings, we can conclude that delay in primary repair within the 24-hour post-injury window does not appear to have a statistically significant impact on final visual acuity on average and optimizing the patient and surgical environment is warranted to improve operative success and patient outcomes.

It is worth noting that variables other than time to operative repair influenced final visual outcome of patients with OGIs repaired within 24 hours, namely: presence of rAPD, rupture as mechanism of injury, presenting VA, higher zone of injury, uveal prolapse, and age at time of injury. This is consistent with prior literature where many of these factors were found to influence final visual acuity and were included in the Ocular Trauma Score, which can be used to prognosticate final visual acuity.[2,3,4,5,6,7,8,20] Notably, in our study, presence of rAPD was the strongest predictor of poor final visual acuity, followed by rupture as a mechanism of injury. Mechanism of injury was also highly correlated with visual outcomes, with only 8.6% of laceration injuries resulting in LP or worse vision, versus 38% of rupture injuries resulting in LP or worse vision. Notably, all of these factors are intrinsic to the patient or the nature of the injury, and none are able to be controlled by the ophthalmologist. In addition, while presence of IOFB has been shown previously to be a risk factor for endophthalmitis,[10] presence of IOFB did not correlate significantly with worse final visual acuity in our study.

While time to primary repair of OGI did not correlate with visual outcomes, we did identify interesting trends in the practice patterns of OGI repair at our institution. We found that eyes with Zone 3 injuries were treated 1.67 hours later on average than those with Zone 1 or 2 injuries ($p = 0.005$). Meanwhile, eyes with rupture as a mechanism were treated 1.5 hours later on average than those with laceration injuries ($p = 0.002$). This may be due to either patient factors such as more severe comorbid trauma occurring with blunt ruptures, or physicians' understanding of the poorer prognosis associated with blunt rupture and Zone 3 injuries.

Limitations of this study include its retrospective nature and single-center design. However, inclusion of consecutive patients over a ten-year period who were treated by multiple surgeons increases the generalizability. Selection bias may also exist, as MEE is a major referral center that may see and treat more advanced ocular trauma. While we only evaluated patients treated within the 24-hour window, we see this as a critical strength of our study design, as the general practice pattern of ophthalmologists is to treat OGIs within the 24-hour window for endophthalmitis risk reduction.[14] Therefore, OGIs repaired outside of the 24-hour window were purposely excluded. The predominance of white, non-Hispanic patients is representative of the population served at Massachusetts Eye and Ear but is not representative of the U.S. and global population of those who sustain OGIs. Lastly, data analyzed included only initial and final vision, which did not take into account changes in vision in the interim, as some final follow-up visits were many months or years after the primary OGI repair.

In conclusion, while OGIs have the potential to inflict severe ocular and visual morbidity, our findings suggest that time to primary operative repair of OGIs does not influence final VA if repaired within the 24-hour window. Other variables which impact final VA include rAPD, rupture as a mechanism, presenting VA, higher zone of injury, uveal prolapse, and age at time of injury, as is consistent with prior literature. Ultimately, optimization of patient and surgical factors, as well as individualized, longitudinal treatment plans for patients with OGI, likely has a more meaningful impact on patient visual acuity outcomes than time to primary repair.

Declarations

ACKNOWLEDGEMENTS

We acknowledge the support of the Ophthalmology Department at Mass Eye and Ear and all those who contributed to the care of our patients with open globe injuries.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

FUNDING

The authors did not request or contribute any funding for this project.

AUTHOR CONTRIBUTION STATEMENT

KGM was responsible for leading the investigation, screening potentially eligible studies, conducting the search, extracting and analyzing data, interpreting results, updating reference lists, and writing the original draft. RAB was responsible for conducting the search, screening potentially eligible studies, extracting and analyzing data, interpreting results, updating reference lists, and writing the original draft. GWA was responsible for designing the review protocol, conceptualizing the project, interpreting results, outlining research goals and methodology, and editing the draft. MCW was responsible for designing the review protocol, conceptualizing the project, interpreting results, outlining research goals and methodology, and editing the draft. AI was responsible for conducting the meta-regression analyses and developing the figures. FK was responsible for conducting the search and extracting data. TT was responsible for project administration, submitting the IRB, and supervision. ACL was responsible for conceptualizing the project, submitting the IRB, designing the review protocol, interpreting results, outlining research goals and methodology, supervision, and editing the draft.

References

1. Kuhn F, Morris R, Witherspoon C, Mester V. The Birmingham Eye Trauma Terminology system (BETT). Journal Français d'Ophtalmologie. 2004 Feb;**27**(2):206–10.
2. Chee YE, Patel MM, Vavvas DG. Retinal Detachment After Open-globe Injury. International Ophthalmology Clinics. 2013;**53**(4):79–92.
3. Kloek CE, Andreoli MT, Andreoli CM. Characteristics of Traumatic Cataract Wound Dehiscence. American Journal of Ophthalmology. 2011 Aug;**152**(2):229–33.
4. Nishide T, Hayakawa N, Nakanishi M, Ishii M, Kimura I, Shibuya E, et al. Preoperative Factors Associated with Improvement in Visual Acuity after Globe Rupture Treatment. European Journal of Ophthalmology. 2013 Sep;**23**(5):718–22.
5. Matthews GP, Das A, Brown S. Visual outcome and ocular survival in patients with retinal detachments secondary to open- or closed-globe injuries. Ophthalmic Surg Lasers. 1998;**29**(1):48–54.
6. Morikawa S, Okamoto F, Okamoto Y, Mitamura Y, Ishikawa H, Harimoto K, et al. Clinical characteristics and visual outcomes of work-related open globe injuries in Japanese patients. Sci Rep. 2020 Dec;**10**(1):1208.
7. Mayer CS, Reznicek L, Baur ID, Khoramnia R. Open Globe Injuries: Classifications and Prognostic Factors for Functional Outcome. Diagnostics. 2021 Oct 8;**11**(10):1851.
8. Li EY, Chan TC, Liu AT, Yuen HK. Epidemiology of Open-Globe Injuries in Hong Kong. APJO. 2017 Jan;**6**(1):54–8.
9. Lieb DF, Scott IU, Flynn HW, Miller D, Feuer WJ. Open globe injuries with positive intraocular cultures. Ophthalmology. 2003 Aug;**110**(8):1560–6.
10. Mieler WF, Ellis MK, Williams DF, Han DP. Retained Intraocular Foreign Bodies and Endophthalmitis. Ophthalmology. 1990 Nov;**97**(11):1532–8.
11. Thompson WS, Rubsamen PE, Flynn HW, Schiffman J, Cousins SW. Endophthalmitis after Penetrating Trauma. Ophthalmology. 1995 Nov;**102**(11):1696–701.
12. Thompson JT, Parver LM, Enger CL, Mieler WF, Liggett PE. Infectious Endophthalmitis after Penetrating Injuries with Retained Intraocular Foreign Bodies. Ophthalmology. 1993 Oct;**100**(10):1468–74.
13. Tieger MG, Kloek C, Lorch AC. Controversies in open globe injury management. In: Grob S, Kloek C. Management of Open Globe Injuries. (Springer International Publishing, 2018) 47–58.
14. Andreoli CM, Andreoli MT, Kloek CE, Ahuero AE, Vavvas D, Durand ML. Low Rate of Endophthalmitis in a Large Series of Open Globe Injuries. American Journal of Ophthalmology. 2009 Apr;**147**(4):601–608.e2.

15. Blanch RJ, Bishop J, Javidi H, Murray PI. Effect of time to primary repair on final visual outcome after open globe injury. Br J Ophthalmol. 2019 Oct;**103**(10):1491–4.
16. Savar A, Andreoli MT, Kloek CE, Andreoli CM. Enucleation for Open Globe Injury. American Journal of Ophthalmology. 2009 Apr;**147**(4):595–600.e1.
17. Tiew S, Lim C, Sivagnanasithiyar T. Using an excel spreadsheet to convert Snellen visual acuity to LogMAR visual acuity. Eye. 2020 Nov;**34**(11):2148–9.
18. Schulze-Bonsel K, Feltgen N, Burau H, Hansen L, Bach M. Visual Acuities “Hand Motion” and “Counting Fingers” Can Be Quantified with the Freiburg Visual Acuity Test. Invest Ophthalmol Vis Sci. 2006 Mar 1;**47**(3):1236.
19. Bach M, Feltgen N, Burau H, Hansen L, Schulze-Bonsel K. Author Response: Numerical Imputation for Low Vision States. Invest Ophthalmol Vis Sci. 2007;eLetter.
20. Kuhn F, Maisiak R, Mann L, Mester V, Morris R, Witherspoon C. The Ocular Trauma Score (OTS). *Ophthalmololgy Clinics of North America*. 2002 Jun;**15**(2):163-5

Tables

Tables 1 and 2 are available in the Supplementary Files section.

Figures

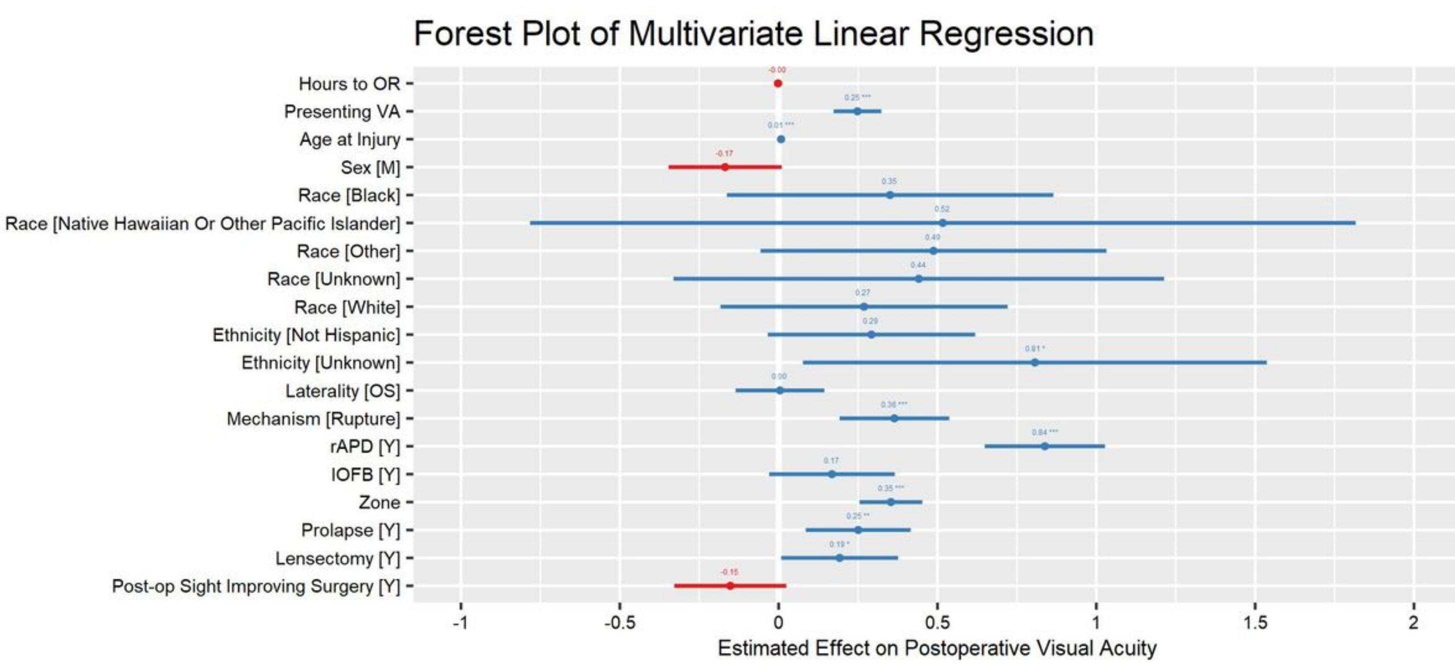

Figure 1

Title: Forest Plot. Legend: Forest plot demonstrating factors influencing final visual acuity outcomes for open globe injuries repaired within 24 hours.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1.jpg
- Table2.jpg