Diagnosis of Traumatic Eye Injuries With Point-of-Care Ocular Ultrasonography in the Emergency Department

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Study objective: Traumatic eye injuries are common emergency department presentations worldwide, and diagnosis may be delayed because of concurrent injuries and lack of guidelines in regard to the utility of clinical examination, computed tomography (CT), and point-of-care ultrasonography. In this study, we compare point-of-care ultrasonography with ophthalmologist clinical examination and CT for 6 types of traumatic eye injury.

Methods: We conducted a prospective cohort study evaluating patients with suspected traumatic eye injury who were recruited at an academic medical center in Tabriz, Iran. Each patient was evaluated by an emergency physician with point-of-care ultrasonography using a 7- to 15-MHz linear transducer, by a radiologist with orbital CT imaging, and by an ophthalmologist with a complete bedside ocular examination. Obtained results were tabulated. Sensitivity, specificity, and likelihood ratios were subsequently calculated. Cohen's κ was assessed to evaluate the agreement between ocular point-of-care ultrasonography with orbital CT and point-of-care ultrasonography with complete bedside ocular examination.

Results: Two hundred thirty-two patients (351 eyes) with suspected traumatic eye injury were included. In all measures of accuracy, diagnosis by point-of-care ultrasonography compared favorably with CT and a complete bedside ocular examination by an ophthalmologist in the 6 ocular injury patterns included in this study. Compared with CT imaging, point-of-care ultrasonography provided a specificity of 99.4% (95% confidence interval [CI] 97.8% to 99.9%) and a sensitivity of 96.8% (95% CI 83.3% to 99.9%) in the diagnosis of lens dislocation, and a specificity of 99.7% (95% CI 98.3% to 100.0%) and sensitivity of 95.7% (95% CI 78.1% to 99.9%) in the diagnosis of retrobulbar hematoma. Compared with complete bedside ocular examination by an ophthalmologist, point-of-care ultrasonography provided a specificity of 98.7% (95% CI 96.7% to 99.6%) and sensitivity of 97.8% (95% CI 88.2% to 99.9%) in the diagnosis of vitreous hemorrhage. In all injury types, positive likelihood ratios were high and negative ones were low.

Conclusion: Point-of-care ultrasonography demonstrates high sensitivity and specificity in the diagnosis of traumatic eye injury, and represents a valuable diagnostic tool in addition to orbital CT and complete beside ocular examination by an ophthalmologist in the diagnosis of traumatic eye injury. [Ann Emerg Med. 2019;74:365-371.]

Please see page 366 for the Editor's Capsule Summary of this article.

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INTRODUCTION

Background

Traumatic eye injuries are associated with high morbidity and mortality, account for a significant portion of health care costs worldwide,[1,2] and are a significant cause of disability in both developed and developing countries.[3-5] In the United States, research using national survey data has suggested that traumatic eye injuries are present in approximately 1.5% of all emergency department (ED) visits,[6] with approximately 3% of all traumatic eye injuries treated in EDs resulting in hospital admission.[7] Studies vary in regard to the burden of traumatic eye injuries in developing countries, but current research suggests that they are present in up to 40% of ED trauma visits.[8,9] Data in both developed and developing countries indicate that patients with traumatic eye injury are disproportionately young, male individuals, even compared with those with other traumatic injuries.[7,10-13]

Ocular injuries can be diagnosed by computed tomography (CT) and magnetic resonance imaging, both of which are resource intensive and may require patient cooperation, and by slit lamp biomicroscopy and ophthalmologic examination. None of these modalities may be available in resource-poor settings.

Editor's Capsule Summary

What is already known on this topic

Ultrasonography can be used to diagnose ocular trauma.

What question this study addressed

What are the test characteristics of bedside ocular ultrasonography compared with computed tomography and formal ophthalmologic examination for 6 common ocular injuries?

What this study adds to our knowledge

In this prospective study of 242 patients (351 eyes), the sensitivity and specificity of bedside ocular ultrasonography were very high compared with criterion standard testing.

How this is relevant to clinical practice

Although needing further validation, this study provides support for the utility of bedside ocular ultrasonography as a rapid method of evaluating ocular trauma.

Importance

Point-of-care ultrasonography is a tool that has potential for more extensive use in the ED to identify and assess traumatic eye injury. When performed by trained ED clinicians, it can rapidly and effectively diagnose retinal detachment, vitreous hemorrhage, lens dislocation, and retrobulbar hematoma.[14,15] Compared with standard imaging techniques, point-of-care ultrasonography offers cost-effective, real-time examination of cross-sectional images of the eye and orbit, even in the presence of optically opaque interposed structures.[16] Its major limitation is interoperator variability and the absence of defined prerequisite clinical training and experience.[17]

Previous small studies have investigated point-of-care ultrasonography in the diagnosis of a single type of traumatic eye injury.[18-25] Other studies have reported on radiologist-performed sonography in traumatic eye injury.[9] We wished to prospectively study various types of traumatic eye injury with emergency physician–performed point-of-care ultrasonography and compare each with accepted imaging criterion standards.

MATERIALS AND METHODS

Study Design and Setting

A prospective cohort study examining the use of point-of-care ultrasonography in traumatic eye injury was performed by emergency physicians at the Imam Reza academic medical center in Tabriz, Iran, from November 2015 to December 2016. Patients were included in this study according to mechanism of injury and clinical signs and symptoms suggestive of serious facial trauma that warranted diagnostic evaluation of at least one eye. This included patients presenting with significant facial or periorbital edema or ecchymosis, orbital edema, or eyelid laceration. Included patients underwent point-of-care ultrasonographic examination by a trained emergency physician ("study sonographer"), followed by orbital CT evaluated by trained radiologists and full bedside ophthalmoscopy and slit lamp biomicroscopy performed by an ophthalmologist ("study ophthalmologist"). After alert by the on-site trauma team in regard to any injury concerning for potential ocular trauma, 1 of 2 study sonographers on an alternating on-call schedule completed patient enrollment and ocular point-of-care ultrasonographic examination. In all cases, the study sonographer and study ophthalmologist were not members of the primary treatment team and had no role in any aspects of patient care. Images and evaluations obtained by the study sonographer and study ophthalmologist were not made available to the primary treatment team. Ophthalmologic consultation deemed necessary for patient care was performed solely by nonstudy ophthalmologists blinded to study results. Ocular point-of-care ultrasonography deemed necessary for patient care was performed solely by nonstudy physician members of the primary treatment team, who were blinded to study results. Study sonographers and study ophthalmologists recorded examination findings without access to patient data beyond gross physical appearance. All study participants were blinded to one another's findings. At no point did the study protocol delay time-sensitive care from the primary treatment team. This study protocol was reviewed and approved by the institutional review board. All researchers adhered to the Helsinki Declaration during this study.

Selection of Participants

Patients were excluded from study participation if informed consent could not be obtained directly or by a legal medical representative. Patients unable to undergo orbital CT imaging or bedside ocular examination were also excluded. Consent for included patients with a Glasgow Coma Scale (GCS) score less than 15 was obtained by a legal medical representative. Patients with gross globe deformity consistent with globe rupture were excluded because of the limited diagnostic yield of point-of-care ultrasonography in clinically overt cases, and a theoretic risk of compressive injury from the ultrasonography in such cases. All patients received standard trauma care by a trauma team. Demographic data, injury type, and clinical symptoms of all patients were recorded.

For purposes of this study, 2 emergency physicians (study sonographers) received 16 hours of point-of-care ultrasonographic in-class training, which included review of protocols for the identification of various orbital injuries and used emergency medicine textbook materials and online modules. These physicians also completed 48 hours of hands-on training on ocular point-of-care ultrasonography before initiation of the study. On completion of training, each physician demonstrated proficiency in diagnostic ocular point-of-care ultrasonography for acute traumatic injuries, obtaining images within 2 to 5 minutes. All point-of-care ultrasonographic imaging in this study was performed with a SonoSite M-Turbo machine (SonoSite, Bothell, WA) with a 7- to 15-MHz linear transducer. Scanning was performed in sagittal and transverse plane, using closed-eye technique with water-soluble gel. Transparent adhesive films were applied to protect the injured eye. After point-of-care ultrasonography was completed, CT imaging was performed with a SOMATOM Emotion (Siemens, Munich, Germany) 16-slice scanner with 1-mm slices. A complete bedside ocular examination was then performed by a board-certified ophthalmologist (study ophthalmologist).

Outcome Measures

We identified 6 ocular injuries for inclusion in this study: retinal detachment, lens dislocation, intraocular foreign body, globe rupture, retrobulbar hematoma, and vitreous hemorrhage. For each unique ocular injury type, the accepted diagnostic criterion standard was based on review of the literature and best practice guidelines. Lens dislocation was compared with both orbital CT and complete bedside clinical examination by an ophthalmologist because of lack of consensus about a criterion standard,[26] although past research has used orbital CT for this purpose.[19] In cases of intraocular foreign body, orbital CT was selected as the criterion standard. Previous research has identified orbital CT as the most accurate diagnostic modality for detection of glass intraocular foreign bodies[20] and has reported moderate to high sensitivity and high specificity in studies that included multiple intraocular foreign body composition types.[21,26,27] Orbital CT is most effective in the detection of stone and plastic foreign bodies, with less accuracy in detecting wood.[21,28] In cases of globe rupture, orbital CT was used as the diagnostic criterion standard. It has been shown to provide moderate to high sensitivity and specificity in the detection of globe rupture compared with intraoperative findings.[26,29] As in previously published studies, we evaluated diagnosis of retinal detachment by point-of-care ultrasonography, using complete bedside ocular examination by an ophthalmologist as the criterion standard.[22-24]

Primary Data Analysis

Statistical analysis of quantitative data was performed with mean and SD for all variables with normal distribution. Median and interquartile ranges were used

Table 1. Ocular injuries in the ED: participant details.

Characteristics	No. (%), Average
Total patients	232 (100)
Eyes tested	464 (100)
Eyes included	351 (75.6)
Age, y	34.3
Sex	
Men	171 (73.7)
Women	61 (26.3)
GCS score	
<9	50 (21.6)
9–13	76 (32.8)
>13	106 (45.7)
Facial trauma mechanism	
Total patients	232 (100)
Car vs pedestrian	32 (13.8)
Car vs car	87 (37.5)
Motorcycle	58 (25.0)
Fall onto hard surface	9 (3.87)
Sport-related injury	9 (3.87)
Fall from height	21 (9.1)
Assault	12 (5.2)
Other	4 (1.72)
Visual acuity	
Total patients	232 (100)
Normal	73 (31.5)
Abnormal	20 (8.6)
Unable to cooperate	139 (59.9)
External ocular trauma*	
Total eyes	351 (100)
Eyelid laceration	103 (29.3)
Periorbital ecchymosis	187 (53.3)
Cutaneous orbital-area bleeding	6 (1.7)
Periorbital edema	156 (44.4)
Nonorbital facial trauma†	55 (14.2)

*Patients may have had more than one injury type.
†Includes suspected midface, orbital, and nasal fractures.

for nonparametric variables. Qualitative variables were reported as frequency and percentage. One-way ANOVA and Mann-Whitney's test were used to compare parametric and nonparametric variables, respectively. χ^2 Or Fischer's exact test was used for categoric data. Sensitivity and specificity, and positive and negative likelihood ratios, were calculated. $P<.05$ was considered statistically significant. All analyses were performed with Stata (version 15.0; StataCorp, College Station, TX).

RESULTS

Characteristics of Study Subjects

Of 246 patients with head or facial trauma who were approached for enrollment, 14 were excluded because of clinically evident globe rupture (4), clinical deterioration and death before orbital CT (8), or failure to obtain ophthalmologist consultation (2). Two hundred thirty-two patients met criteria for inclusion, representing 351 eyes. Demographics and injury patterns of enrolled patients are shown in Table 1. Fifty patients (21.6%) had a GCS score of less than 9. Visual acuity was normal in 31.5% of patients, abnormal in 8.6%, and not reported because of noncooperation with examination in 59.9%. The most common clinical findings associated with ocular injury were periorbital ecchymosis (53.3%), followed by periorbital edema (44.4%) and eyelid laceration (29.3%) (Table 1, Figure).

Main Results

For globe foreign body, sensitivity and specificity for point-of-care ultrasonography were 100% (95%

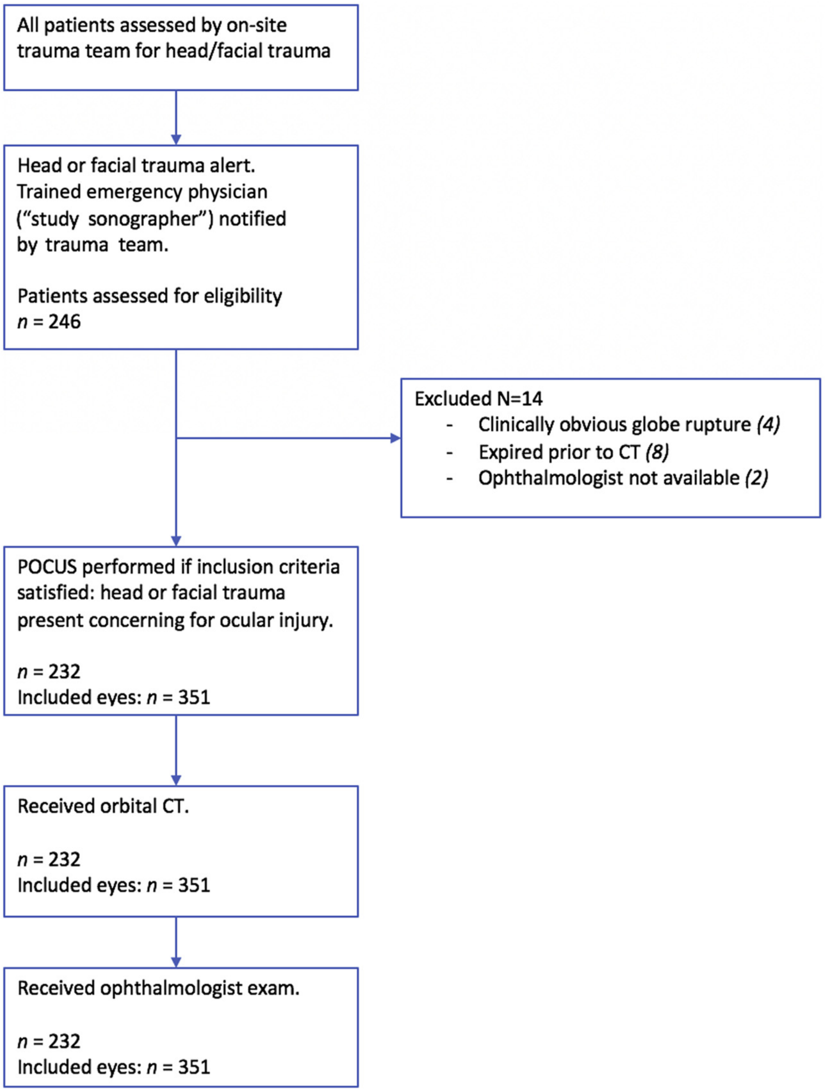

Figure. CONSORT diagram. *POCUS*, Point-of-care ultrasonography.

confidence interval [CI] 79.4% to 100%) and 99.7% (95% CI 98.3% to 100%), respectively, compared with orbital CT. For lens dislocation, sensitivity and specificity for point-of-care ultrasonography were 96.8% (95% CI 83.3% to 99.9%) and 99.4% (95% CI 97.8% to 99.9%), respectively, compared with orbital CT. For globe rupture, sensitivity and specificity for point-of-care ultrasonography were 100% (95% CI 39.7% to 100%) and 99.7% (95% CI 98.4% to 100%), respectively, compared with orbital CT. For retrobulbar hematoma, sensitivity and specificity for point-of-care ultrasonography were 95.7% (95% CI 78.1% to 99.9%) and 99.7% (95% CI 98.3% to 100%), respectively, compared with orbital CT. A wide CI for sensitivity of point-of-care ultrasonography for globe rupture correlated with a low incidence within the study population (4 true-positive results) (Appendix E1 to E4, available online at http://www.annemergmed.com).

For vitreous hemorrhage, sensitivity and specificity of point-of-care ultrasonography were 97.8% (95% CI 88.2% to 99.9%) and 98.7% (95% CI 96.7% to 99.6%), respectively, compared with ophthalmologist bedside examination. For retinal detachment, sensitivity and specificity of point-of-care ultrasonography were 88.9% (95% CI 70.8% to 97.6%) and 100% (95% CI 98.9% to 100%), respectively, compared with ophthalmologist bedside examination. In all injury types, positive likelihood ratios were extremely high and negative likelihood ratios were close to zero, indicating a high probability that positive results with point-of-care ultrasonography were associated with the presence of injury and that negative results were associated with its absence (Table 2 and Appendix E5 to E7 [available online at http://www.annemergmed.com]).

LIMITATIONS

This study design presented certain limitations. This was a single-center study performed with trauma patients from a single geographic area. Furthermore, a small number of providers (2 emergency physicians, 1 ophthalmologist, and 1 radiologist) were involved in the evaluation of patients in this study and the emergency physician sonographers received extensive training before the study, limiting the external validity of our findings. Additionally, data were not recorded in regard to which sonographer performed each point-of-care ultrasonographic examination, thus precluding determination of interrater reliability. Because of study design, data were not collected on the total number of patients evaluated by the trauma service during the study period; we were thus unable to report the incidence of traumatic eye injury in the population studied. For patients with intraocular foreign bodies, our study did not report on the composition of the identified foreign body, a variable known to influence diagnostic sensitivity with all imaging modalities.[21,26,28] Additionally, the young mean age of patients in this study reduced the likelihood of false-positive ocular ultrasonographic findings, which are known to complicate point-of-care ultrasonography assessment in older patients. Clinicians may wish to note the lower confidence boundary of some of the test sensitivities, which arose because of the sample size. A final limitation of point-of-care ultrasonography as a diagnostic tool is its dependence on operator clinical training and experience, which may introduce variability in the diagnostic accuracy of traumatic eye injury. There is also little evidence available that quantifies the degree of interrater reliability in ocular point-of-care ultrasonography, although limited research has indicated that it may be greater than previously proposed.[17]

Table 2. Comparison of diagnostic criterion standard in selected ocular injuries with diagnosis by point-of-care ultrasonography in the ED.

Diagnosis	Sensitivity (95% CI)	Specificity (95% CI)	LR+ (95% CI)	LR– (95% CI)
Diagnosis of ocular injuries by ultrasonography compared with CT examination				
Lens dislocation	96.8 (83.3–99.9)	99.4 (97.8–99.9)	154.8 (38.8–617.0)	0.032 (0.005–0.22)
Globe foreign body	100.0 (79.4–100.0)	99.7 (98.3–100.0)	335.0 (47.3–2,371.0)	0.0 (0.0–0.0)
Globe rupture	100.0 (39.7–100.0)	99.7 (98.4–100.0)	347.0 (49.0–2,456.0)	0.0 (0.0–0.0)
Retrobulbar hematoma	95.7 (78.1–99.9)	99.7 (98.3–100.0)	313.7 (44.2–2,225.0)	0.044 (0.0064–0.30)
Diagnosis of ocular injuries by ultrasonography compared with complete ophthalmologist clinical examination				
Lens dislocation	96.6 (82.2–99.9)	98.8 (96.9–99.7)	77.7 (29.3–206.0)	0.035 (0.0051–0.24)
Vitreous hemorrhage	97.8 (88.2–99.9)	98.7 (96.7–99.6)	74.8 (28.2–198.0)	0.023 (0.032–0.16)
Retinal detachment	88.9 (70.8–97.6)	100.0 (98.9–100.0)	Infinite	0.11 (0.038–0.32)

LR+, Positive likelihood ratio; *LR–*, negative likelihood ratio.
Disagreement was observed between different standards in regard to the number of lens dislocations.

DISCUSSION

There are few studies describing the accuracy of emergency physician–performed point-of-care ultrasonography compared with accepted criterion standards. Ojaghi Haghighi et al[19] compared point-of-care ultrasonography with CT to diagnose lens dislocation and reported a diagnostic accuracy similar to ours. Shazlee et al[9] compared radiologist-performed sonography with operative reports or ophthalmology clinic follow-up in the diagnosis of traumatic eye injury, with reported sensitivities and specificities comparable to our findings. For retinal detachment, previous studies have shown sensitivities of 89% to 100% and specificities of 83% to 100% when comparing emergency physician–performed point-of-care ultrasonography with ophthalmologist-performed complete bedside ocular examination,[22-24] whereas Sandinha et al[25] reported 100% sensitivity and specificity for ophthalmologist-performed point-of-care ultrasonography for retinal detachment; in this study, emergency physician–performed point-of-care ultrasonography again yielded comparable results. To our knowledge, ours is the first published prospective study to report sensitivity and specificity of emergency physician–performed point-of-care ultrasonography in the diagnosis of vitreous hemorrhage, globe rupture, and retrobulbar hematoma, all critical injuries.

Comprehensive ultrasonographic training is currently a mandatory component of emergency medicine residency in North America.[30,31] Despite this, recent research suggests that only minimal training is required for emergency physicians to identify certain ocular injuries with a high degree of sensitivity and specificity[14,22] and that point-of-care ultrasonography performed by nonphysicians trained to identify certain types of ocular injuries demonstrates high sensitivity and specificity in the diagnosis of traumatic eye injury.[32] This study suggests that, with limited sonographic training for clinicians, emergency physician–performed point-of-care ultrasonography provides diagnostic accuracy comparable to that of CT and ophthalmologist-performed bedside examination in the clinical diagnosis of traumatic eye injury.

When performed by trained emergency physicians, point-of-care ultrasonography may allow accurate diagnosis of traumatic eye injury in patients with head and facial trauma. It offers an accessible and portable alternative to CT imaging and ophthalmologic consultation, and may offer a unique diagnostic advantage in resource-poor settings. Although further validation is needed, point-of-care ultrasonography represents a potentially rapid, accurate diagnostic tool when ocular trauma is managed.

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Author contributions: SOH conceived the study, designed the trial, and obtained institutional review board approval. SOH and SSV supervised the conduct of the trial and data collection. SOH and SSV undertook recruitment of participating centers and patients and managed the data, including quality control. RS was the ophthalmologist consultant on the study, AP, KML, and SD provided statistical advice on study design and analyzed the data. SOH, AP, KML, SD drafted the manuscript, and all authors contributed substantially to its revision. SOH takes responsibility for the paper as a whole.

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REFERENCES

1. Murray CJL, Lopez AD; World Health Organization; World Bank; Harvard School of Public Health. *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability From Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020: Summary*. Geneva, Switzerland: World Health Organization; 1996. Available at: http://www.who.int/iris/handle/10665/41864. Accessed June 29, 2018.
2. Peden M, McGee K, Sharma G. *The Injury Chart Book: A Graphical Overview of the Global Burden of Injuries*. Geneva, Switzerland: World Health Organization; 2002:6-76. Available at: http://www.who.int/iris/handle/10665/42566. Accessed June 29, 2018.
3. Kuhn F, Morris R, Witherspoon CD, et al. Epidemiology of blinding trauma in the United States Eye Injury Registry. *Ophthalmic Epidemiol*. 2006;13:209-216.

4. Abraham D, Vitale S, West S, et al. Epidemiology of eye injuries in rural Tanzania. *Ophthalmic Epidemiol*. 1999;6:85-94.
5. Cao H, Li L, Zhang M, et al. Epidemiology of pediatric ocular trauma in the Chaoshan Region, China, 2001-2010. *PLoS One*. 2013;8:2001-2010.
6. Vaziri K, Schwartz SG, Flynn HW, et al. Eye-related emergency department visits in the United States, 2010. *Ophthalmology*. 2016;123:917-919.
7. Owens PL, Mutter R. Statistical brief related to eye injuries, 2008. 2011; Available at: https://www.hcup-us.ahrq.gov/reports/statbriefs/sb112.pdf. Accessed March 12, 2019.
8. Négrel AD, Thylefors B. The global impact of eye injuries. *Ophthalmic Epidemiol*. 1998;5:143-169.
9. Shazlee MK, Ali M, Ahmed MS, et al. Diagnostic accuracy of ultrasound B scan using 10 MHz linear probe in ocular trauma: results from a high burden country. *Pakistan J Med Sci*. 2016;32:385-388.
10. May DR, Kuhn FP, Morris RE, et al. The epidemiology of serious eye injuries from the United States Eye Injury Registry. *Graefes Arch Clin Exp Ophthalmol*. 2000;238:153-157.
11. Koo L, Kapadia MK, Singh RP, et al. Gender differences in etiology and outcome of open globe injuries. *J Trauma*. 2005;59:175-178.
12. Pandita A, Merriman M. Ocular trauma epidemiology: 10-year retrospective study. *N Z Med J*. 2012;125:61-69.
13. Nelson-Imoru J, Mowatt L, Walters C. Patterns of ocular trauma presenting to the University Hospital of the West Indies in Jamaica. *WIMJ Open*. 2014;1:45-50.
14. Blaivas M, Theodoro D, Sierzenski PR. A study of bedside ocular ultrasonography in the emergency department. *Acad Emerg Med*. 2002;9:791-799.
15. Kilker BA, Holst JM, Hoffmann B. Bedside ocular ultrasound in the emergency department. *Eur J Emerg Med*. 2014;21:246-253.
16. Silverman RH. High-resolution ultrasound imaging of the eye: a review. *Clin Exp Ophthalmol*. 2009;37:54-67.
17. Oberfoell S, Murphy D, French A, et al. Inter-rater reliability of sonographic optic nerve sheath diameter measurements by emergency medicine physicians. *J Ultrasound Med*. 2017;36:1579-1584.
18. Vrablik ME, Snead GR, Minnigan HJ, et al. The diagnostic accuracy of bedside ocular ultrasonography for the diagnosis of retinal detachment: a systematic review and meta-analysis. *Ann Emerg Med*. 2015;65:199-203.e1.
19. Ojaghi Haghighi SH, Morteza Begi HR, Sorkhabi R, et al. Diagnostic accuracy of ultrasound in detection of traumatic lens dislocation. *Emerg (Tehran)*. 2014;2:121-124.
20. Gor DM, Kirsch CF, Leen J, et al. Radiologic differentiation of intraocular glass: evaluation of imaging techniques, glass types, size, and effect of intraocular hemorrhage. *AJR Am J Roentgenol*. 2001;177:1199-1203.
21. Patel SN, Langer PD, Zarbvin MA, et al. Diagnostic value of clinical examination and radiographic imaging in identification of intraocular foreign bodies in open globe injury. *Eur J Ophthalmol*. 2012;22:259-268.
22. Shinar Z, Chan L, Orlinsky M. Use of ocular ultrasound for the evaluation of retinal detachment. *J Emerg Med*. 2011;40:53-57.
23. Yoonessi R, Hussain A, Jang TB. Bedside ocular ultrasound for the detection of retinal detachment in the emergency department. *Acad Emerg Med*. 2010;17:913-917.
24. Jacobsen B, Lahham S, Lahham S, et al. Retrospective review of ocular point-of-care ultrasound for detection of retinal detachment. *West J Emerg Med*. 2016;17:196-200.
25. Sandinha MT, Kotagiri AK, Owen RI, et al. Accuracy of B-scan ultrasonography in acute fundus obscuring vitreous hemorrhage using a standardized scanning protocol and a dedicated ophthalmic ultrasonographer. *Clin Ophthalmol*. 2017;11:1365-1370.
26. Gad K, Singman EL, Nadgir RN, et al. CT in the evaluation of acute injuries of the anterior eye segment. *AJR Am J Roentgenol*. 2017;209:1353-1359.
27. Lakits AL, Prokesch R, Scholda C, et al. Orbital helical computed tomography in the diagnosis and management of eye trauma. *Ophthalmology*. 1999;106:2330-2335.
28. Desai A, Parihar R, Mathews J, et al. Occult wooden posterior segment intraocular foreign body. *Ophthalmic Surg Lasers Imaging Retina*. 2014;45:58-61.
29. Yuan WH, Hsu HC, Cheng HC, et al. CT of globe rupture: analysis and frequency of findings. *AJR Am J Roentgenol*. 2014;202:1100-1107.
30. Whitson MR, Mayo PH. Ultrasonography in the emergency department. *Crit Care*. 2016;20:1-8.
31. Akhtar S, Theodoro D, Gaspari R, et al. Resident training in emergency ultrasound: consensus recommendations from the 2008 Council of Emergency Medicine Residency Directors conference. *Acad Emerg Med*. 2009;16(suppl 2):S32-S36.
32. Sargsyan AE, Dulchavsky AG, Adams J, et al. Ultrasound detection of simulated intra-ocular foreign bodies by minimally trained personnel. *Aviat Space Environ Med*. 2008;79:58-61.

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