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Diagnostic performance of isolated orbital CT scan for assessment of globe rupture in acute blunt facial trauma

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ABSTRACT

Objectives: We determine the diagnostic performance of emergent orbital computed tomography (CT) scans for assessing globe rupture in patients with blunt facial trauma.
Methods: We performed a retrospective cohort study based on prospectively collected trauma registry and acute care surveillance data in a tertiary-care hospital. Patients aged at least 18 years who underwent isolated orbital CT scanning for assessing potential ocular trauma were examined. Analyses were performed to evaluate the magnitude of agreement between diagnosis by CT scanning and ophthalmic assessment, including globe rupture.
Results: Our study cohort comprised 136 patients, 30% of whom (41 patients) sustained orbital wall fractures. Concordance for orbital CT diagnosis and the ophthalmic assessment of globe rupture was substantial ($k = 0.708$). The relative risk of globe rupture was 0.692 (95% confidence interval (CI): 0.054–8.849) for superior wall fractures, 0.459 (95% CI: 0.152–1.389) for inferior wall fractures, 2.286 (95% CI: 1.062–4.919) for lateral wall fractures, and 0.637 (95% CI: 0.215–1.886) for medial wall fractures. According to multivariate analysis, lateral wall fractures were an independent risk factor for globe ruptures (adjusted odds ratio (OR) = 12.01, $P = 0.011$), and medial or inferior wall fracture was a protective factor (adjusted OR = 0.14, $P = 0.012$). In the stratified analysis of diagnostic performance of CT scan, specificity was highest among patients with orbital wall fractures (97.2%), followed by negative predictive volume (NPV, 97%), and accuracy (95.1%).
Conclusion: Among patients with blunt facial trauma who underwent isolated orbital CT scanning as part of ocular trauma assessment, the diagnostic performance of CT in detecting globe rupture is more accurate in patients with orbital wall fractures. Nevertheless, isolated orbital CT alone does not have a sufficiently high diagnostic performance to be reliable to rule out all globe ruptures. Lateral orbital wall fractures in blunt facial trauma patients, in particular, should prompt thorough evaluation by an ophthalmologist.

Introduction

Diagnosing and treating globe rupture from blunt craniofacial trauma is usually challenging for clinicians, particularly in acute care settings with a limited workup. These trauma-related injuries have a high risk of causing permanent blindness, thus highlighting the importance of studying these injuries in such settings [1]. The reported incidence of midfacial injuries with coexisting ocular

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injuries ranges widely from 2.7 to 90.6% [2–5]. The inconsistent results of previous studies can be attributed to differences in study cohorts, treatment strategies, definitions of reported ocular injuries, diagnostic device selection, and the nature of study data [2–12].

Although the epidemiology of globe rupture injuries from facial trauma may not be well elucidated, the primary approach to ocular trauma is relatively conclusive. The primary survey principle (airway, breathing, circulation, disability, and exposure) in trauma management takes precedence over eye injuries, and treating ocular injuries usually takes priority over midfacial or periorbital trauma management [13]. Early clinical assessment and prompt management are pivotal to achieving a favourable outcome in such cases [2,5,12,13].

In clinical practice, penetrating ocular injuries usually warrant immediate ophthalmological consultation. However, this is not the case in blunt ocular trauma. Periocular swelling, the uncooperative behaviour of patients, decreased levels of consciousness, or the coexistence of other critical injuries further complicate the accurate diagnosis of ocular injuries in patients with blunt ocular trauma. Because ocular sonography or magnetic resonance imaging are usually not indicated in such trauma situations, an orbital computed tomography (CT) scan with or without a cranial CT scan is usually the primary modality for diagnosing ocular trauma in a modern, fast-paced emergency department (ED) [14–16]. Although clinicians in acute care settings rely heavily on CT-based surveys, the diagnostic performance of CT scans in detecting globe ruptures is not satisfactory in identifying all missed globe ruptures [17–19]. Not all ED services have 24-haccess to ophthalmology specialists. The major challenge for ED staff is identifying cases with negative CT findings of globe rupture that indeed require ophthalmic intervention.

Highlighting the problems associated with a CT-based approach to diagnosing ocular injuries facilitates the development of collaborative strategies among emergency physicians (EP), surgeons, and ophthalmologists for optimising the management of acute ocular trauma. At our study hospital, nearly all patients with potential globe ruptures undergo a CT survey in addition to routine ophthalmic assessment. Thus, this routine led us to examine the clinical value of a CT-based approach in diagnosing global rupture. Accordingly, we explored the diagnostic performance of emergent orbital CT scans for assessing globe rupture in patients with blunt facial trauma.

Materials and methods

Study design

This was a retrospective cohort study based on prospectively collected trauma registry and acute care surveillance data in a tertiary-care hospital. The study was approved by the Institutional Review Board of the hospital.

Acute care settings

The investigation was performed in the ED of Kaohsiung Medical University hospital. The hospital is a tertiary-care and academic medical centre in Southern Taiwan and provides medical care to an urban population of approximately 1.5 million people. Annually, 85,000 patients visit the ED seeking three types of service (internal medicine, trauma or surgical emergency, and paediatric emergency medicine). Patients presenting with trauma are routinely assessed by EPs or trauma surgeons and examined using a primary and secondary trauma survey in a trauma bay. Because of the diversity of the staff in the trauma bays, craniofacial, orbital CT, or both may be performed for a patient experiencing a craniofacial trauma along with potential ocular involvement, according to the preference of the physician in charge. In addition, according to the institutional policy and requests of the ophthalmic consultants, all patients with potential globe rupture undergo an orbital CT survey, and the ophthalmology specialists may be consulted with depending on clinical suspicion or imaging findings.

Selection of participants

For clearly determining the diagnostic value of isolated orbital CT scanning for assessment of globe rupture, we tried to eliminate some potential influences on making diagnosis of globe rupture, such as multiple CT scans over injured eyes or available diagnosis of globe rupture from transfer documents. Inclusion criteria for the study participants were as follows: adult nontransfer patients (aged $\geq$18 years) with acute blunt facial trauma who presented to our ED, those who underwent isolated orbital CT scanning in an axial and coronal projection because of clinical suspicion of an ocular injury, and those who received an emergency ophthalmology consultation, and for whom final diagnosis information relating to their ocular emergencies was available. All study participants were identified and selected from the electronic medical records and the trauma registry of the study hospital.

Methods of measurement

Orbital CT administration and interpretation

In the ED of the study hospital, patients underwent isolated orbital CT or orbital CT scanning as part of a craniofacial CT scanning on the basis of the severity of their craniofacial injury. We selected only patients who underwent isolated orbital CT scanning to minimise other confounding effects on the diagnostic performance, such as different imaging planes, window settings, and coexisting distracting injuries. All orbital CT scans were obtained using a 16-channel multidetector row CT scanner (Lightspeed 16; General Electric Medical Systems, Milwaukee, WI, USA). Axial CT and reconstructed coronal views were obtained for all patients during the study period using a narrow-field technique utilising a slice of thickness of $\leq$3 mm. The formal radiology reports could be acquired immediately by direct requests from EPs. Globe rupture was diagnosed by the board-certified radiologist on duty. Both CT images and formal reports were recorded and entered into the medical record system. These records could be checked and reviewed using the picture archiving and communication system of the hospital.

Ophthalmologic examinations and records

In the present study, a qualified ophthalmologic examination was conducted by trained ophthalmology residents and approved by the attending ophthalmologists. Data included assessments of ocular motility, visual acuity, and pupillary reactivity, and anterior and posterior segment examinations. Ophthalmic consultants were expected to perform initial examinations within 30 min of consultation. If the patient condition prohibited a complete survey, the survey was completed after resolving complications, such as uncooperative behaviour, a decreased level of consciousness, coexisting distractive injuries, and severe periorbital swelling. Pre- and postoperative findings were included if the patient underwent surgery. In addition, during the follow-up period, the clinical status of the patient was reevaluated and recorded in our electronic medical records. All the aforementioned data were reviewed to determine the final diagnosis of each patient.

Measurement of outcomes

The primary outcome measure was based on the comparison of the globe ruptures determined using orbital CT scans with those