Journal of Neuroradiology (2016) 43, 25—30

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

ORIGINAL ARTICLE

Radiological prognostication in patients with head trauma requiring decompressive craniectomy: Analysis of optic nerve sheath diameter and Rotterdam CT Scoring System

Muhammad Waqas[a], Saqib Kamran Bakhshi[a], Muhammad Shahzad Shamim[a,*], Saleha Anwar[b]

[a] *Section of Neurosurgery, The Aga Khan University Hospital, Stadium Road, Karachi 74800, Pakistan*
[b] *Department of Radiology, Liaquat National Hospital Karachi, Karachi, Pakistan*

Available online 20 October 2015

KEYWORDS
Decompressive craniectomy;
Optic nerve sheath diameter;
Rotterdam Computed Tomography Score;
Outcomes;
Traumatic brain injury

Summary
Introduction: Optic nerve sheath diameter (ONSD) measured on CT scan has been shown to predict outcomes of patients with severe traumatic brain injury. No such relation has been studied in patients undergoing decompressive craniectomy (DC). We evaluated ONSD on admission CT scan to predict outcomes of patients undergoing DC along with Rotterdam CT Score (RCTS).
Materials and methods: This retrospective cohort study was approved by the institutional ethics committee. All the consecutive patients undergoing DC with available images and records were included. We measured ONSD 3 mm behind the eyeball and calculated RCTS. Glasgow Outcome Scale (GOS) was measured at last follow-up. We analyzed the data on SPSS v 19. Receiver operator curve analysis (ROC) was done to measure the predictive values of ONSD and RCTS for mortality and unfavorable outcomes.
Results: One hundred and seventeen patients were included. Twenty patients had bilateral DC. Mean GCS at presentation was 8.5 ± 3.5. Mean follow-up was 7.5 ± 1.2 months. Thirty-day mortality was 19%. Mean ONSD of both eyes was 6.73 ± 0.89 mm. Area under the curve (AUC) for bilateral mean ONSD as predictor of mortality was 0.49 [95%CI: 0.36—0.62]. AUC for RCTS was as a predictor of 30-day mortality was significant, i.e. 0.67 [95%CI: 0.572—0.820]. The difference of mean ONSD was also not significantly different between survivor and non-survivors.
Conclusion: Admission ONSD in DC patients is high but does not predict mortality and unfavorable outcomes. RCTS has a better prognostic value for predicting mortality and unfavorable outcomes in DC patients.

* Corresponding author.
E-mail addresses: shaiq_waqas@hotmail.com (M. Waqas), saqib_dmc@hotmail.com (S.K. Bakhshi), shahzad.shamim@aku.edu (M.S. Shamim), salehaanwar@hotmail.com (S. Anwar).

http://dx.doi.org/10.1016/j.neurad.2015.07.003
0150-9861/

Introduction

Decompressive craniectomy (DC) is a surgical procedure performed for raised and medically refractory intracranial pressure (ICP) usually caused by head trauma leading to diffuse cerebral edema or mass lesion such as intracerebral, subdural and/or extradural hematoma [1]. It significantly decreases mean ICP and has now become a standard option for raised ICP not responding to non-surgical treatment [2,3]. It is perhaps due to the nature of underlying pathology that the outcome of patients undergoing DC remains poor, with most studies reporting a rate of mortality and unfavorable outcomes exceeding 50% [3—6]. Several predictors of outcome following DC have been analyzed with little practical application [7,8].

Neuroradiology since inception has been at the center of the evolution of imaging techniques [9]. Exploring different radiological markers of injury has attracted a lot of interest and includes advanced modalities such as diffusion tensor imaging [10]. Measurement of optic nerve sheath diameter (ONSD) has recently emerged as an alternative non-invasive method of monitoring ICP [11]. Although ultrasound is the preferred method for serial recording of ONSD, it can also be done using thin-cut axial CT brain scans, which has the advantage of objectivity and simplicity, and most importantly, remains the only existing tool for objective, retrospective measurement of ICP for patients for whom real time ICP observations are not available. Rotterdam Computed Tomography Score (RCTS), which has numerical values from one to six, has also been evaluated as a potential radiological tool for predicting outcomes in patients undergoing DC [12]. The published work shows RCTS to have a significant correlation with outcomes [12].

Through this study, we aimed to assess the predictive value of ONSD compared with RCTS on thin-cut CT scan in patients undergoing DC for traumatic brain injury, by correlating them with the eventual clinical outcome of these patients.

Material and methods

This was a retrospective cohort study conducted after ethical approval from our institutional Ethical Review Committee. The study duration was three and half years (July 2010 to December 2013) and the review period was from January to March 2014. The study was conducted at the Aga Khan University Hospital (AKUH) in Karachi, Pakistan. AKUH is a JCIA accredited, ISO certified tertiary care hospital with level-1 trauma facilities and a neurosurgical referral center.

Sample size was calculated using EPI version 6. For a prevalence of 66% and expected sensitivity and specificity of 86 and 75%, a sample of 98 was obtained. Desired precision for this calculation was 0.15. However as consecutive convenient sampling was performed we achieved a sample of 117. All patients with traumatic brain injury (TBI) who underwent DC, regardless of age and gender, were included. Patients with incomplete data, unavailable pre-operative CT scans and those with unilateral or bilateral orbital injury precluding ONSD measurements were excluded from the study. Data were retrieved from our medical records and the collection was carried out on a standardized pro forma. All files were reviewed by the same co-investigator. Data pertaining to patient demographics, mechanism of injury, emergency room (ER) parameters including Revised Trauma Score (RTS), post-resuscitation Glasgow Coma Score (GCS), CT scan findings, various aspects of in-hospital management, outcome including Glasgow Outcome Score (GOS) at discharge and follow-ups were obtained from the medical records.

Indications and technique of surgery

As an institutional protocol, all patients with severe TBI (GCS 8 or less) are managed with immediate intubation and admission in ICU. Intracranial pressure monitoring is not routinely employed. Patients with mass lesions such as extradural or subdural hematoma, fulfilling Brain Trauma Foundation guidelines, are taken to the operating room for emergency decompressive surgery and in case of persistent diffuse brain swelling despite evacuation of mass lesion, the bone flap is not replaced. All the decompressive surgeries are performed by senior residents under direct supervision of one of six consultant neurosurgeons. In a standard decompressive craniectomy, a bone flap of at least 12-cm diameter is removed along with expansile duraplasty.

Measurements of ONSD and RCTS

Immediate pre-operative CT scan brain of all the patients was reviewed on Picture Archiving and Communication Software (PACS) and the individual diameter of each optic nerve exactly 3 mm behind the posterior limit of eyeball was measured on 3-mm thick slices. Diameter for both optic nerves was measured and a mean was obtained for each patient. Mean of the larger of the two diameters was also calculated. The pre-operative CT brain scan of each patient was also scored according to Rotterdam CT Scoring (RCTS) as described by the original authors [8,13]. The indications and method of DC employed at our institution were previously published [14,15].

Analysis

Data were analyzed on SPSS v 19. Percentage and proportions were calculated for categorical variables such as gender, mechanism of injury, surgical procedures, and mortality. Mean and standard deviations were calculated for continuous variables with normal distribution. Patients were divided into two groups, i.e., survivors and non-survivors. Patient characteristics were described for each of the groups. Mean follow-up was expressed in months. Glasgow Outcome Score (GOS) for individual patients was divided into two categories, i.e. favorable outcome (GOS $\geq$4) and unfavorable outcome (GOS $\leq$3). Mean ONSD and mean of larger ONSD were plotted against GOS to calculate Pearson's correlation. Correlation of RCTS, RTS and presenting GCS with GOS were also calculated. Receiver operator curve (ROC) analysis was performed to estimate the predictive value of mean ONSD and mean of the larger ONSD for unfavorable outcomes and 30-day mortality. An ROC was also plotted for RCTS and unfavorable outcomes and 30-day mortality. A *P*-value of 0.05 was considered significant.