



Validation of a New Clinico-Radiological Grading for Compound Head Injury: Implications on the Prognosis and the Need for Surgical Intervention

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■ **BACKGROUND:** Lack of risk stratification among patients with varying severities of compound head injury has resulted in too-inconsistent and conflicting results to support any management strategy over another. The purpose of this study was to validate a new clinico-radiological grading scheme with implications on outcome and the need for surgical debridement.

■ **METHODS:** Patients who sustained an external compound head injury with no serious systemic injury and no pre-established infection and who continued the entire treatment were studied prospectively for their proposed grade of compound injury in relation to infective complications, unfavorable Glasgow Outcome Scale (GOS), delayed seizures, mortality, and hospital stay for 3 months. Appropriate univariate and multivariate analyses were performed.

■ **RESULTS:** Among a total of 344 patients, 182 (53%) had no dural violation or midline shift (Grade 1), 56 (16%) had cerebrospinal fluid leak or pneumocephalus (Grade 2), 34 (10%) had exposed brain (Grade 3), 47 (14%) had midline shift (Grade 4), and 25 (7%) had both exposed brain and midline shift (Grade 5). Each successive grade of compound injury had significant incremental impact on all the outcome measures studied. Infective complications in Grades 1 to 5 were noted among 7%, 9%, 27%, 28%, and 36% of patients, respectively ($P < 0.001$). There was a significant difference in unfavorable GOS (23% vs. 56%, odds ratio [OR] 4.3, $P < 0.001$) and mortality (17% vs. 42%, OR 3.5, $P < 0.001$) between Grades 1–2 and Grades 3–5. Delayed seizures were noted in 4%, 4%, 9%, 13%, and 16%

of patients in Grades 1–5 ($P = 0.04$). The median hospital stay was 1, 3, 6, 6, and 8 days, respectively ($P < 0.001$). All patients in Grades 4–5 (72) underwent surgery. Only 32 of 182 (18%) patients in Grade 1, 9 of 56 (16%) patients in Grade 2, and 23 of 34 (68%) patients in Grade 3 underwent surgical debridement, whereas the rest were managed conservatively. Patients who were managed conservatively had significantly lower infective complications (3% vs. 25%, OR 9.67, $P < 0.001$) in Grade 1, and (2% vs. 44%, OR 36.8, $P = 0.002$) in Grade 2, compared with those who underwent surgical debridement. In multivariate analysis, the proposed grade had significant independent association with infection ($P < 0.001$), unfavorable GOS ($P = 0.01$), delayed seizures ($P = 0.001$), and hospital stay ($P < 0.001$), and each successive grade had significant incremental impact on both infective complications and unfavourable GOS, independent of GCS and other prognostic factors.

■ **CONCLUSION:** The new grading scheme appears to be of practical clinical significance. It shows significant statistical associations with the rates of infection, unfavorable neurologic outcome, delayed seizures, mortality, and duration of hospital stay. The incremental impact of each successive grade on infective complications and unfavorable GOS was independent of GCS and other prognostic factors. Conservative management had significantly lower infection compared to surgical debridement, at least in patients with Grades 1 and 2.

Key words

- Compound head injury
- Grading
- Infective complications
- Outcome
- Surgical debridement
- Unfavourable GOS

Abbreviations and Acronyms

- CSF:** Cerebrospinal fluid
CT: Computed tomography
GCS: Glasgow Coma Scale
GOS: Glasgow Outcome Scale
IQR: Interquartile range

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INTRODUCTION

Cranial fracture is an important indicator of the severity of head injury, probability of intracranial hematoma, and poorer outcome (3). Overlying scalp laceration and galeal disruption in continuity with a cranial fracture constitutes “compound head injury,” comprising 90% of all depressed fractures (2, 6, 27). It has been associated with a greatly varied rate of infection, from 1.9% to 44%, with meningitis and intracranial sepsis being the imminent threat driving the management policies (18-23). Furthermore, it carries an average neurologic morbidity of 11%, an incidence of late epilepsy of up to 15%, and a mortality rate of 1.4%–19% in various studies (5, 6, 14-17). This finding assumes even more significance when one considers the nature of multiple brain and systemic injuries suffered by these patients that add to their poor initial presentation and the final outcome.

Studies on compound head injury have focused either on infection or occasionally on neurologic outcome, with no clear risk stratification among patients of differing severities (3, 14-17, 24-26). If at all there was categorization, it was in relation to dural violation (5, 14-17, 24-26). Because of this blanket inclusion of all patients and the retrospective nature of most of the studies with only univariate analysis, results varied greatly with respect to various outcome measures to support any one management strategy over another (3). In our previous experience, it was serendipitously observed that those who could not undergo operation as the result of various reasons often were noted to have lesser rates of infective complications. This warranted us to propose a new clinicoradiological grading scheme for compound head injury and this study was to validate this grading for its prognostic relevance and the need for surgical management.

METHODS

All patients with external compound head injury (open calvarial fractures) managed at the Neurosurgery Department of the Post Graduate Institute of Medical Education and Research, Chandigarh, India, from 2010 to 2011 were enrolled prospectively for the study after we received approval from the ethics committee. Patients with a solely internal compound head injury (skull base fractures), those with serious systemic injury, missile injuries, established infection before admission, or those who did not continue the entire treatment were excluded.

After initial resuscitation, the patients underwent evaluation with noncontrast computed tomography (CT) of the head and other relevant radiologic and laboratory investigations. All patients with midline shift of at least 5 mm in CT underwent surgical management as a policy. The management strategy of other patients was decided by the consultant neurosurgeon in charge on a case-to-case basis and in consideration with the patient/guardian's expectations. Nonsurgical management consisted of thorough irrigation of the wound, removal of foreign bodies, and suturing of the scalp defect with nonabsorbable monofilament sutures either bedside or in treatment room under local anesthesia. Many patients already had undergone cleansing and suturing in other centers before they presented and were continued on conservative management. Surgical management additionally involved

elevation of depressed bone fragments, debridement and, if necessary, duraplasty in operation theater under general anesthesia.

The proposed grading (Table 1) was partly based on previous literature (3, 14, 26), and based partly on intuitive experience, in external compound head injury. Simple compound injuries were considered as grade 1, whereas the next tier of dural violation was categorized as grade 2. Exposed brain can be assumed to be the result of a more severe dural violation and was grouped as grade 3. The most decisive factor of midline shift (3) for surgical intervention was naturally classified as grade 4. Those with both exposed brain and midline shift were sorted under grade 5.

Standard care provided to patients consisted of intubation and ventilation (whenever Glasgow Coma Scale [GCS] < 9), fluid and electrolyte homeostasis, seizure prophylaxis with phenytoin, and routine tetanus prophylaxis as a policy. Two doses of prophylactic antibiotics were given as a routine. Baseline demographic characteristics of patients, mechanism of injury, time to admission, GCS, proposed grade, clinicoradiologic evidence of internal compounding (cerebrospinal fluid [CSF] rhinorrhea/otorrhea or skull base fractures), treatment details and adverse events were noted in a prospective database and followed up. Those developing clinical features of infection or neurologic deficit underwent appropriate microbiological and other laboratory and radiologic investigations including contrast CT. Development of any infective complication was managed with culture-based antibiotics for 3–6 weeks. Follow-up at regular intervals was carried out to assess various outcome parameters.

Outcome

Any occurrence of severe wound infection, meningitis, subdural empyema, brain abscess, or systemic sepsis was noted as an “Infective complication.” The Glasgow Outcome Scale (GOS) (16) was used to assess neurologic outcome at least 3 months after injury. Good recovery (GOS 5) or moderate disability (GOS 4) was considered as favorable GOS, and severe disability (GOS 3), persistent vegetative state (GOS 2), or death (GOS 1) was considered under unfavorable GOS (12, 13). Infective complications and unfavorable GOS were considered as primary outcome measures. Patients who had died because of any cause were considered as GOS 1 or mortality. In addition, delayed seizures and duration of in-hospital treatment also were assessed. Patients whose outcome could not be ascertained were excluded from all analyses. Cosmetic issues were not considered in our study.

Table 1. Grading of External Compound Head Injury

Grade 1	Open wound overlying skull fracture
Grade 2	CT evidence of a) pneumocephalus, b) CSF leak from the wound, or c) both
Grade 3	Exposed brain
Grade 4	CT evidence of at least 5 mm midline shift
Grade 5	Presence of both 3 and 4
CT, computed tomography; CSF, cerebrospinal fluid.	

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