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Maxillofacial Injury Severity Score: proposal of a new scoring system

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Abstract. In this study a new injury severity score system, the Maxillofacial Injury Severity Score (MFISS), was developed to evaluate the characteristics of injury from maxillofacial trauma. Nine hundred and two cases of maxillofacial trauma were included in this study to evaluate injury severity using the MFISS, which was designed on the basis of Abbreviated Injury Scale, 1990 revision (AIS-90), and defined as the product of the sum of the three highest maxillofacial AIS scores and the sum of the injury severity scores for three maxillofacial functional parameters, malocclusion (MO), limited mouth opening (LMO), and facial deformity (FD). The correlation analysis was undertaken with the dependent factor of cost and number of days of stay in hospital. The results demonstrated a significant difference ($P < 0.01$) between bone and soft-tissue injuries and among various regional fractures. There was correlation ($P < 0.01$) between the MFISS and the cost of treatment and days of stay in hospital. The newly established MFISS thus characterizes maxillofacial injury severity while reflecting the management costs and treatment complexity.

Key words: maxillofacial trauma; injury severity score.

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In order to assess injury severity and its probable outcome, various trauma scoring systems have been developed over the past decades. The Abbreviated Injury Scale (AIS) was put forward in 1971 and revised repeatedly by The American Association for Automotive Medicine[2]. AIS is a summary of all values from 1 to 9 for each injured organ and body part that has became the groundwork of subsequent scoring standards. Although the AIS can be used to evaluate trauma severity itself, it cannot be employed to predict outcome due to its limitation to only an anatomical description of injury. The Injury Severity Score (ISS), proposed by Baker et al.[3] in 1974, is defined as the sum of the squares of the highest AIS grade in each of the three most severely injured body areas. It has been playing the role of 'standard summary' in trauma measurement for more than 20 years. The Trauma and Injury Severity Score (TRISS)[4] is a trauma score method using a combination of anatomical and physiological criteria, the age of patients, and the mechanism of injury. As well as quantifying injury severity, it can be used to calculate the survival probability of the injured victims and evaluate the emergency management of the hospital[9]. This scoring system obviated the ISS shortcomings.

The New Injury Severity Score (NISS), a modified version of ISS[17], simplified the complexity of ISS calculation and improved its predictive power. The Severity Characterization of Trauma (ASCOT)[8] is actually an upgraded version of TRISS in which the Glasgow Coma Score, systolic blood pressure, and respiratory rate were indexed. A few scoring models were designed for special trauma issues[24], such as Acute Physiology and Chronic Health Evaluation (APACHE) for intensive care, Mortality Probability Models (MPA) for

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the prediction of trauma death, and the Mathematical Model of Hemorrhagic Shock (MMHS) for triage decisions on hemorrhagic shock[7]. The Pediatric Trauma Score (PTS) was designed for evaluation of the response of pediatric patients to trauma[25].

All these scoring systems are available for the assessment of general trauma, and mainly focus on the prediction of survival or death; they rarely enable the measurement of impairment and disability of the injured organs. In fact, such impairment or disability is very frequent, especially as the outcome secondary to motional organ injury, which can often cause deterioration in quality of life. In hand surgery, the hand injury severity scoring system (HISS)[16] has been developed, taking into consideration the prognostic outcome. Maxillofacial trauma, to some extent, is similar to motional organ injury in the correlation between injury severity and prognosis, rarely leading to a direct threat to life, but often resulting in functional disability. The current scoring models have proved insensitive and inaccurate in judging maxillofacial injury severity for the prediction of prognosis, because the parameters and score indices that they contain are insufficient to reflect the peculiarities of this type of trauma and its outcome. Therefore, the aim of this study was to establish a new scoring system especially designed for maxillofacial trauma.

Materials and methods

The study population consisted of 902 maxillofacial trauma patients treated between 1996 and 2002, 739 (81.9%) male and 163 (18.1%) female, aged 1–87 years with a mean age of 31 years. Of them, 706 (78.2%) were from the Department of Oral and Maxillofacial Surgery, Peking University School of Stomatology, and 196 (21.8%) from another nine oral and maxillofacial units of state general hospitals distributed in four provinces.

All patients included in this retrospective study fulfilled the following criteria: (1) there was a definite diagnosis of maxillofacial trauma and detailed description of the physical examination; (2) treatment was available within 2 weeks of the trauma incident. Of the 902 patients, 613 (68.0%) underwent surgical treatment and 289 (32.0%) were treated by conservative methods. Their documents containing the records of trauma cause, injury sites, and severity description, associated body injuries, treatment cost, and hospitalization days were collected and stored using specially designed analysis software. The initial diagnosis of maxillofacial injury was confirmed by the authors with reference to the 9th edition of the International Classification of Diseases[13]. The injured areas of soft tissue included mucosa, skin, muscle, cartilage, facial nerve, and salivary gland. Bone-tissue injuries included mandibular (symphysis/parasymphysis, body, angle, and condyle) fracture, maxillary (Lefort I, II, and III types) fracture, and zygomatic arch fracture. The case distribution of soft-tissue injuries and facial fractures is shown in Table 1.

Table 1. Case distribution of 902 maxillofacial injuries

Injury types	Number of cases
Soft-tissue injuries	118 (13.1%)
Bone-tissue injuries	784 (86.9%)
Simple fractures	606 (67.2%)
Mandible	449 (49.8%)
Maxillary	54 (6.0%)
Zygomatic arch	103 (11.4%)
Compound fractures	178 (19.7%)
Multiple injuries	268 (29.8%)

Simple fracture: limited to isolated area (mandible, maxilla or zygomatic arch). Compound fracture: involving two or three anatomical areas. Multiple injuries: concomitant injuries in other parts of the body.

Maxillofacial Injury Severity Score method

The injury evaluation was limited to the maxillofacial region regardless of any other body injuries. The Maxillofacial Injury Severity Score (MFISS) method was designed to pick up the three highest Maxillofacial Injury Severity Scores according to the AIS-90 standard (Table 2), and then combine them with the injury severity scores for three maxillofacial functional parameters, malocclusion (MO), limited mouth opening (LMO), and facial deformity (FD) (Table 3). The MFISS could be calculated according to the following formula :

$$\mathrm{MFISS} = (A_1 + A_2 + A_3) \times (\mathrm{MO} + \mathrm{LMO} + \mathrm{FD})$$

where A_1, A_2, A_3 are the three highest maxillofacial AIS scores, and MO, LMO, FD are the maxillofacial functional parameter scores.

MO represents a possible outcome of dentition disarrangement resulting from fracture displacement and/or a segment defect. The malocclusion pattern (such as open bite, unilateral cross bite, excessive overjet, and so on) was difficult to assess by using scores, so the number of teeth and jaw involved was used instead. LMO indicates mandible motion disability resulting from bone, muscle, and joint injury, which could be assessed and given scores by measuring the interincisal opening distance. FD stands for facial disfigurement subsequent to fracture displacement, bone and/or soft-tissue defect, and other soft-tissue injury, which in the early stage of injury was frequently masked by swelling and hematoma. Therefore, assessment of facial disfigurement had to be made by a scaled description of anatomical injuries instead of facial deformity presentation.

Table 2. AIS-90 standard for facial injury scale (exclusion of eye and ear)

AIS-90	Description of injury
1	Contusion, lacerations, and avulsions <25 cm^2 of skin, subcutaneous and muscle (including lip, lid, auricle, and forehead) Rupture of external carotid arterial branches Superficial injuries of oral mucosa and tongue Ramus fracture, nasal fracture Teeth fracture, teeth displacement; teeth luxation Temporomandibular joint contusion
2	Lacerations >10 cm and avulsions >25 m^2 of skin, subcutaneous and muscle (including lip, lid, auricle, and forehead) Deeper and extensive tongue laceration Alveolar fracture, condylar fracture, mandibular body fracture Maxillary fracture (LeFort I, II) Open, displaced, comminuted nasal fracture Close orbital fracture Temporomandibular joint luxation Zygomatic fracture Facial nerve injury
3	Maxillary LeFort III fracture with loss of $<20\%$ blood Open, displaced, comminuted orbital fracture
4	Maxillary fracture with loss of $>20\%$ blood