Original Research

Role of Maxillofacial Trauma Scoring Systems in Determining the Economic Burden to Maxillofacial Trauma Patients in India

Sundar Ramalingam

Contributor:
Lecturer, Department of Maxillofacial Surgery, College of Dentistry, King Saud University, Riyadh, Kingdom of Saudi Arabia.
Correspondence:
Dr. Ramalingam S. Department of Maxillofacial Surgery, College of Dentistry, King Saud University, P.O. Box: 60169, Riyadh 11545, Kingdom of Saudi Arabia. Phone: +966-532092386. Email: sundar. ksu@gmail.com

Abstract:

Background: The objective of this study was to evaluate the association between severity of maxillofacial injuries determined by trauma scoring systems and its economic burden to patients in terms of cost and duration of hospitalization.

Materials and Methods: Following ethical approval a retrospective chart review was undertaken at Meenakshi Ammal Dental College and Hospital to identify patients admitted with maxillofacial injuries between January 2006 and December 2008. Patients with incomplete records, associated injuries, debilitating systemic diseases and patients treated under local anesthesia were excluded. Details regarding the nature and severity of injury and treatment were recorded in addition to the total treatment cost and duration of hospitalization. Maxillofacial injury severity was scored using maxillofacial injury severity score (MFISS) and facial injury severity scale (FISS). The MFISS and FISS scores were correlated with two surrogate markers of the economic burden namely cost and duration of hospitalization.

Results: A total of 162 patients with maxillofacial injuries were identified (108 males, 54 females; mean age = 32.4 years). Road traffic accidents were the cause of injury in 114 patients (70.4%) and only 29 patients (17.9%) had medical insurance coverage. The mean MFISS and FISS scores were 14.04 (standard deviation [SD] = 9.19; range = 3-42) and 4.40 (SD = 3.17; range = 1-14), respectively. The mean cost and duration of hospitalization of the patients were Indian rupees (INR) 13877.28 (SD = 8252.59; range = INR 5250-42960) and 4.12 days (SD = 1.5; range = 2-8 days) respectively. Pearson's correlation between the MFISS and FISS scores and the cost and duration of hospitalization, revealed statistically significant correlations (MFISS vs. cost - $R = 0.862$, $P < 0.001$; MFISS vs. duration - $R = 0.828$, $P < 0.01$; FISS vs. cost - $R = 0.845$, $P < 0.01$; FISS vs. duration - $R = 0.819$, $P < 0.01$).

Conclusion: Based on the results of this study, maxillofacial injury severity measured by MFISS and FISS scores are predictable indicators of the economic burden to the patients.

Key Words: Cost of treatment, duration of hospitalization, injury severity, maxillofacial trauma, trauma scoring

Introduction

Trauma is a major health care problem in present day society. In spite of the high rates of morbidity and mortality associated with trauma, it is still not regarded as a major disease.[1] Oral and maxillofacial (OMF) trauma has become a major point in focus, owing to its increasing incidence and the multispecialty management, which it dictates. OMF injuries, either with or without associated systemic injuries, account for a large number of hospital admissions, especially through the emergency department.[2-4] While the specialty of OMF surgery is most commonly involved in diagnosis and treatment of maxillofacial traumatic injuries, comprehensive management often involves several other specialties.[3] A clear understanding of the maxillofacial anatomy and pattern of injuries is required not only to diagnose, but also to assess injury severity following maxillofacial trauma.[3] Injury severity is regarded as an indicator of the nature and intensity of treatment required by the patient, and helps predict treatment outcomes when quantified.[2,3,5]

Several statistical models to predict treatment outcomes through injury severity scoring have been reported in the literature.[3,5] The Glasgow Coma Scale (GCS) is a universally accepted scoring system used to assess the level of consciousness among trauma patients.[6,7] The Abbreviated Injury Scale (AIS) designed by American Association of Automotive Medicine classifies more than 2000 injury scenarios based on nine anatomic regions. It was first introduced in 1971 and underwent subsequent modifications in 1980, 1985, and 1990 (AIS-90).[5] Another anatomically based scoring system is the Injury Severity Score (ISS) proposed by Baker *et al.* in 1974.[8] The Trauma Injury Severity Score (TRISS) is a more comprehensive scoring system utilizing anatomic, physiological and demographic data in addition to the mechanism of injury.[9] Other trauma scoring methods include New Injury Severity Score (NISS), Acute Physiology and Chronic Health Evaluation (APACHE), Pediatric Trauma Score (PTS) and Assessment and Severity Characterization of Trauma (ASCOT).[3,5] While trauma scoring enables injury severity assessment and effective communication between physicians, it would be desirable of them to aid in standardizing treatment delivery and studying the economic impact of trauma.[2,4]

Injury scoring systems for maxillofacial trauma have to overcome the complexities of the maxillofacial anatomy, which

involves three dimensional bony articulations and functional complexes.[2,3] Current maxillofacial fracture classifications are commonly based on anatomic regions, and so are the maxillofacial trauma scoring systems. The oldest proposed maxillofacial trauma coding system, the Cooter and David Score (CDS),[10] was based on alpha-numeric codes wherein the alphabet depicted the anatomic site and the number subjectively described injury severity on a scale of 0-3.[10] The Maxillofacial Injury Severity Score (MFISS) conceived by Zhang *et al.*[5] in 2005 was based on the AIS-90 standards for facial injury and, maxillofacial functional variables like malocclusion (MO), limited mouth opening (LMO) and facial deformity (FD). Bagheri *et al.*[3] in 2006 proposed the Facial Injury Severity Score (FISS), which assigned predefined values with variable weighting for different facial fractures. The Facial Fracture Severity Scale (FFSS) put forth by Catapano *et al.*[11] in 2010 was derived from numerical grades assigned for injuries at 41 different maxillofacial anatomic sites. In 2012, Ahmad *et al.*[2] proposed a system for scoring complex craniofacial fractures (ZS) encompassing the previous scoring systems. Nevertheless, all the above mentioned scoring systems are focused only on measuring injury severity as a basis for assessing treatment needs and predict outcomes.

The economic burden of maxillofacial trauma and its management has been reported in several studies abroad.[12-14] India with its growing urban population has witnessed a sharp rise in the incidence of traumatic injuries in general and maxillofacial injuries in particular.[15,16] Furthermore, due to the lack of awareness regarding medical insurance and the absence of social health insurance, a major portion of health care expenditure is borne by the patients themselves.[15] Based on evidences available in the literature, there are no reports evaluating the economic and financial impact of maxillofacial traumatic injuries on the patients in India. The aim of this study was to evaluate the association between injury severity determined by maxillofacial trauma scoring systems and their ability to predict the economic burden to the patients in terms of cost and duration of hospitalization.

Materials and Methods
Ethical approval
Ethical approval for this study was obtained from the Ethical Committee at Meenakshi Ammal Dental College and Hospital, Chennai, India. Being a retrospective chart review, patient consent was waived off.

Patient selection
A retrospective chart review was undertaken to identify patients admitted with maxillofacial trauma to the oral and maxillofacial surgery department at Meenakshi Ammal Dental College and Hospital, Chennai, India between January 2006 and December 2008. Patients were identified and included based on the following criteria:

- Evidence of maxillofacial injury diagnosed by means of clinical and radiographic examination (plain radiographs and CT).
- Availability of complete peri-operative records including case history, description of injury with photographic and/ or radiographic evidence, treatment and hospitalization summaries.
- No evidence of associated systemic injuries
- No evidence of pre-existing systemic illnesses which could delay treatment and recovery. E.g. uncontrolled diabetes mellitus, uncontrolled hypertension and respiratory, cardiac or renal diseases.
- Treatment of maxillofacial injuries done at the same center within the 1st week since diagnosis.
- All surgical treatments done under general anesthesia, and maxillofacial fractures treated by open reduction and internal fixation.

Demographic and clinical data of the patients were extracted using a standardized extraction tool. Data related to nature and cause of maxillofacial injury was sourced from the primary history of the patient. Clinical information pertaining to the maxillofacial injury of the patient in the form of photographs, radiographs, and dental casts were also obtained from the patient records section of the institution. Furthermore, details of hospitalization and treatment procedures, including the nature of treatment, treatment cost (in Indian Rupees [INR]), duration of hospitalization (in days) and medical insurance coverage were obtained from the financial department of the hospital. All the collected data were tabulated using spreadsheet software (Microsoft Excel 2010) and other patient records (photographs, radiographs and dental casts) were converted to digital photographs.

Trauma scoring
Based on a literature search five different maxillofacial trauma scoring systems[2,3,5,10,11] were identified. The alpha-numeric coding system proposed by Cooter and David[10] was excluded as it could not be used for statistical comparisons. The remaining four scoring systems were ranked based on the number of citations as evidenced from PubMed (Medline) and Google SCHOLAR. Severity of maxillofacial injuries were measured using two of the most highly cited maxillofacial trauma scoring systems, namely "FISS" (57 citations)[3] and "MFISS" (24 citations).[5] Patients were scored depending on the nature of their maxillofacial injuries using the criteria enumerated in Tables 1 and 2. In the case of MFISS, the final score was obtained by multiplying the sum of the three highest AIS-90 scores (A1+A2+A3) by the sum of the three functional injury scale scores (MO+FD+LMO). The final FISS score was the sum of all the individual scores. In order to standardize the individual scores for a given patient, the patient records were evaluated and scored by 5 independent oral and maxillofacial surgeons using MFISS (Table 1) and FISS (Table 2). All

Table 1: MFISS – scoring criteria.[5]					
AIS-90 for facial injury			**Maxillofacial functional injury scale**		
Description of injury	**AIS-90 score**	**Functional deficit**	**Description of injury**		**Score**
Facial soft tissue lacerations <10 cm and avulsions <25 cm^2	1	MO	Involving less than 6 teeth in one jaw		1
Rupture of external carotid artery branches			Involving more than 6 teeth in one jaw		2
Oral mucosa and tongue - superficial injuries			Involving both jaws		3
Dento-alveolar - fracture, sub-luxation or displacement of teeth					
Facial skeleton - fracture of mandibular ramus or nasal bone					
Temporo-mandibular joint contusion					
Facial soft tissue lacerations >10 cm and avulsions >25 cm^2	2	FD	Soft tissue injury<4 cm		1
Oral mucosa and tongue – deep or extensive laceration			Non-displaced facial bone fracture		
Dento-alveolar fracture			Soft tissue injury >4 cm with tissue defect <2 cm^2		2
Facial skeleton – Mandibular body, coronoid and condylar fracture/ Mid-facial Lefort I and II fracture/Zygomatico-maxillary complex fracture/Nasal bone fracture - open, displaced or comminuted/Orbital fracture - closed			Injury to facial nerve branches		
			Unilateral fracture of a single jaw		
			Soft tissue injury >4 cm with tissue defect >2 cm^2		3
Temporo-mandibular joint luxation			Injury to facial nerve trunk		
Injury to the facial nerve			Bilateral fracture of a single jaw or fracture involving both jaws		
Mid-facial Lefort III fracture with blood loss <20%	3	LMO	Mouth opening between 2 cm and 3.7 cm		1
Orbital fracture - open, displaced or comminuted					
Mid-facial Lefort III fracture with blood loss >20%	4		Mouth opening <2 cm		2
MFISS: Maxillofacial Injury Severity Score, MO: Malocclusion, AIS: Abbreviated Injury Scale, FD: Facial deformity, LMO: Limited mouth opening					

Table 2: FISS – scoring criteria.[3]		
Anatomic region	**Fracture type**	**Score**
Mandible	Dento-alveolar	1
	Body/ramus/symphysis	2
	Condyle/coronoid	1
Mid-face	Dento-alveolar	1
	Lefort I	2
	Lefort II	4
	Lefort III	6
	NOE complex	3
	ZMC	1
	Nasal	1
Upper-face	Orbital roof/rim	1
	Frontal sinus – displaced	5
	Frontal sinus – undisplaced	1
Combined length of all facial lacerations>10 cm		1
FISS: Facial injury severity scale, NOE: Nasal orbital ethmoid, ZMC: Zygomatico-maxillary complex		

personal identification data in the patient records were blinded prior to scoring. Moreover, the clinicians involved in scoring were explained about the two maxillofacial trauma scoring systems and trained for using them on a pilot sample of 15 patients. Based on the outcomes of the pilot study, there was an inter-observer agreement (Fleiss' Kappa) of 84% (K = 0.84). The final MFISS and FISS scores for each patient were calculated by averaging the scores given by the 5 independent observed.

Economic burden of maxillofacial trauma
In order to ascertain the individual economic burden of maxillofacial trauma to each patient, the cost and duration of hospitalization were obtained from the hospital summaries of the patients. The "cost of hospitalization" was calculated as the total expenditure incurred in INR by the patient for treatment of the maxillofacial injury including pre-treatment investigations, surgical procedures and consumables, and post-treatment medication and therapy. The number of days from admission until discharge of the patient was considered as the "duration of hospitalization."

Statistical analysis
All the collected data were statistically analyzed using statistical software (IBM SPSS Statistics Version 20). The statistical analysis was focused on descriptive analysis of demographic data, trauma scores, hospitalization cost and duration of hospitalization. Pearson's correlation and paired samples *t*-test were done to identify statistical association between the different variables. $P < 0.05$ was considered as statistically significant.

Results
A total of 162 patients fulfilling the inclusion criteria were identified from the retrospective chart review. There were 108 male patients and 54 female patients with a mean age of 32.4 years (range = 21-48 years). Road traffic accidents (RTA) were the largest cause of maxillofacial injuries (114 cases, 70.4%), followed by falls (28 cases, 17.3%), interpersonal assaults and sports injuries (17 cases, 10.5%) and industrial accidents (3 cases, 1.8%). The mean MFISS and FISS scores were 14.04 (standard deviation [SD] = 9.19; range = 3-42) and 4.40 (SD = 3.17; range 1-14) respectively. While the mean cost of hospitalization of the patients was INR 13877.28 (SD = 8252.59; range INR 5250-42960), the mean duration of hospitalization was 4.12 days (SD = 1.5; range 2-8 days). With only 29 patients (17.9%) under medical insurance coverage, all remaining patients paid for their medical expenditure by themselves.

Statistical analysis using Pearson's correlation between the MFISS and FISS scores and the independent variables of cost and duration of hospitalization revealed statistically significant correlations. The MFISS scores of the patients showed a positive correlation with the cost of hospitalization ($R = 0.862$, $P < 0.001$) and duration of hospitalization ($R = 0.828$, $P < 0.01$). Similarly, the FISS scores of the patients showed a positive correlation with the cost ($R = 0.845$, $P < 0.01$) and duration ($R = 0.819$, $P < 0.01$) of hospitalization. Moreover, within the independent variables, a weak positive correlation was observed between the cost and duration of hospitalization ($R = 0.716$, $P < 0.05$). Results of the t-test indicated no significant differences between the MFISS and FISS scores obtained by the patients ($t = 19.57$, df = 161, $P < 0.05$).

Discussion

The use of scoring systems to assess injury severity has become a norm rather than the exception in contemporary trauma management protocols. The use of GCS to stratify patients with suspected head injuries and its value in deciding treatment strategy and judging prognosis is testimony to the invaluable nature of such trauma scoring systems.[6,7] Majority of the injury severity scoring systems are designed based on the AIS-ISS system and concentrate on outcomes following general trauma.[17] Considering the peculiarities of the maxillofacial region and the requirements for anatomic, functional and esthetic approaches toward maxillofacial trauma management, AIS-ISS does not aid much in characterizing maxillofacial injuries.[17] This has led to the development of several exclusive maxillofacial trauma scoring systems[2,3,5,10,11] in the last three decades.

The MFISS developed by Zhang *et al.*[5] utilizes two components to predict maxillofacial injury severity. While the first component is based on the AIS-90 facial injury scale, the second component is a maxillofacial functional injury scale developed by the authors themselves.[5] Interestingly MFISS is the only maxillofacial scoring system which has been designed including components of the AIS-ISS systems. Based on the results of their multi-center study among Chinese population, Zhang *et al.*[5] reported significant positive correlations between the MFISS score and the treatment cost and number of hospitalized days. Furthermore, they suggested that the nature of treatment (surgical or non-surgical), treating hospital and associated injuries could act as co-existing independent variables which could affect the treatment cost and days of hospitalization. In the present study, we found a significant correlation between the cost and duration of hospitalization and the MFISS scores of the patients. Nature of treatment, treating hospital and associated injuries were not assessed as all patients in the present study had maxillofacial injuries only and were treated surgically in the same hospital.

The FISS was proposed by Bagheri *et al.*[3] with the aim of establishing a communicative tool, which correlates with outcomes following maxillofacial trauma. The FISS classifies and grades maxillofacial fractures solely based on their anatomic location in the upper, middle or lower thirds of the face. Based on the results of a single-center study, Bagheri *et al.*[3] reported significant correlation between the operating room expenditure and the FISS scores of the patients. However, they did not regard the FISS score as an effective predictor of the length of hospitalization. In the present study, FISS scores of the patients significantly correlated with both the cost and duration of hospitalization. The dissimilarities in correlation of the duration of hospitalization with the FISS scores, between the present study and the original study of Bagheri *et al.*[3] could be attributed to the exclusion of patients with associated injuries in the current study. Our study was specifically designed to include only patients with maxillofacial injuries, as it is an established fact that the presence of injuries involving multiple systems is directly related to increased durations of hospitalization.[15]

In the CDS coding system developed by Cooter and David[10] the maxillofacial region was anatomically divided into 20 regions, and each region was coded by an alphabet. Within each anatomic region, the injury severity was subjectively given a score from 0 to 3. While this has been the earliest reported maxillofacial trauma scoring system, it has not been widely used by OMF surgeons as evidenced from literature.[2] More recently, Catapano *et al.*[11] proposed the FFSS as a comprehensive tool to assess facial fracture severity. The FFSS divides the facial skeleton into 41 distinctive anatomic regions, which are individually graded from 0 to 3 depending on the presence of fracture, degree of displacement and bone loss. While the FFSS is to be appreciated for its use of a color coded maxillofacial skeletal map depicting individual anatomic regions, it is however an improvisation of the coding system originally proposed by Cooter and David.[2,10,11] Similar to the FFSS, Ahmed *et al.*[2] proposed a scoring system for maxillofacial fractures (ZS) based on a color coded skeletal map. Furthermore, they emphasized to have overcome shortcomings in the previously reported maxillofacial fracture scoring systems by selectively weighting fracture severity in each anatomic region.[2] A selective mandibular injury severity scoring system (MISS) has also been reported by Shetty *et al.*[18] The MISS is based upon variables related to the mandible fracture like site and type of fracture, occlusal and soft tissue derangement, infection and displacement.

Irrespective of the maxillofacial injury or fracture scoring system, all systems are based on the anatomic classifications of the injury and grade for injury severity based on fracture type and severity in individual anatomic sub-units. Although this might be easy and practical, it should be borne in mind that the maxillofacial region is also comprised of functional units and esthetic soft tissues[5,17] Among all the reviewed maxillofacial injury scoring systems the only systems to include scores for

soft tissue injuries like facial and intraoral soft tissue lacerations are the MFISS[5] and the FISS.[3] While the FFS[11] and the ZS[2] scores indirectly predicted functional deficit by selectively weighting fracture severity in individual anatomic regions, the MFISS[5] was the only scoring system to incorporate a functional injury scale. In order to determine the association between maxillofacial injury severity and its economic impacts on the patients a comprehensive and practical scoring system was required. Based on a literature search it was found that the FISS[3] and the MFISS[5] were the most cited scoring systems followed by the CDS,[10] the FFSS[11] and the ZS[2] scoring systems. The MFISS[5] and the FISS[3] scoring systems were only used to grade maxillofacial injury severity in the present study as the remaining scoring systems did not include scores for soft tissue injury and functional deficit. Although the FISS[3] scoring system had no component to grade functional deficit following maxillofacial injury, it was included in the study owing to its popularity based on citations and relative ease of use.

Although maxillofacial trauma is rarely life threatening, it is often associated with functional disability and facial disfigurement in several instances.[5] Nevertheless, maxillofacial injuries should always be considered critical owing to the risk of injury to vital sensory organs, upper airway, oro-digestive tract and facial morphology. Most of the reported studies have compared maxillofacial injury scores to surrogate markers of injury severity such as days of hospitalization, treatment cost, medical resources consumption,[5] operating room expenditure,[3] duration of surgery, numbers of plates and screws,[11] cost of implants,[2] sensori-neural deficit, indications for hospitalization, pain during follow-up and post-operative complications.[18] As the objective of the present study was to determine the association between the injury severity and its resultant economic burden to the patients, the cost and duration of hospitalization were identified as the surrogate markers for injury severity. Moreover, the cost of hospitalization included the overall cost for anesthesia and surgery, consumable expenditure and the cost of implants and medicines. Similar surrogate markers of maxillofacial injury severity, which indicate economic burden to the patients have been compared in previous studies.[3,5]

In a study reported by Kumar *et al.*[15] the treatment expenses borne by the patients as a result of traumatic injuries arising as a result of RTA was analyzed in a small subset of the Indian population. Interestingly, only 22% of the studied patients had access to medical insurance, and the remaining patients managed their medical expenses out of their personal savings (9%) or from borrowings (69%). While the authors found a direct relationship between the length of hospitalization and the burden of expenditure, they also suggested better financial assistance mechanisms to the injured patients. Although, the results of the above study[15] were based on trauma victims, in general, the rising incidence of maxillofacial injuries, especially

among RTA victims lends credibility to the present study results. Furthermore, the availability of medical insurance coverage in the present study sample was very low and similar to that reported by Kumar *et al.*[15] This could probably be attributed to the inadequate awareness regarding medical insurance and its benefits in a developing country like India. Based on a single-center review of maxillofacial injuries from Chennai, India, Subhashraj *et al.*[16] reported 2748 cases in 6 years. The authors found that RTA were the largest cause of maxillofacial injuries (62%) and the majority of the patients reviewed (68%) had associated injuries. RTA were found to be a major cause of maxillofacial injury (70.4%) in the present study too. However, patients with associated injuries were excluded to avoid skewing of results in terms of cost and duration of hospitalization.

While culture and geographic location play a significant role in the incidence and prevalence of maxillofacial injuries, socio-economic status in addition plays a major role in the way such injuries are treated.[4,12,14,16] Although the cost of treatment and hospitalization are direct sources of the economic burden to the patient, a lengthy hospitalization indirectly correlates with the duration for which a patient is financially non-productive. Social assistance by the government to cover the medical needs of the entire Indian population might not be possible. Nevertheless, patients could be graded for injury severity based on available maxillofacial trauma scoring systems in order to qualify for financial assistance for treatment. Moreover, patients should be educated about the needs and benefits of medical insurance coverage.

Conclusion
Based on the results of the present study the MFISS and the FISS are not only predictable indicators of maxillofacial injury severity, but also reliable indicators of the economic burden to the patient as a result of maxillofacial injury. The results of this study should, however, be weighted with the fact that it was only a single center study involving a small subset of urban Indian adult population without any associated systemic injuries. Nevertheless, further large scale multi-center studies would be required to extrapolate the present results to a larger population.

Clinical significance
Routine use of maxillofacial trauma scoring systems to assess patients with maxillofacial injuries would not only enable to predict injury severity and treatment planning, but would also help in forewarning trauma patients and their families about their economic liability.

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