Original Article

Comprehensive facial injury (CFI) score as a predictor of surgical time, length of hospital stay, and head injury? Our experience at level I trauma center

ABSTRACT

Purpose: The present study aimed to evaluate the statistical significance of comprehensive facial injury (CFI) score concerning total surgical time (ST), length of hospital stay (LHS), and head injury in maxillofacial trauma patients.

Methods: This retrospective observational study included 288 patients having maxillofacial injuries with or without associated head injury. CFI score was calculated for each of them. One-way ANOVA and Kruskal–Wallis H-test were used to compare ST (minutes), LHS (days), and Glasgow Coma Scale (GCS) score among the CFI score clusters. Head injury among the CFI score clusters was compared using Fisher's exact test. The level of statistical significance was set at $P < 0.05$.

Results: Of total 288 cases (males: 83.68%, females: 16.31%, mean age: 30 ± 15.92 years), road traffic accidents accounted for 76.0% of admissions. A definitive approach (open reduction and internal fixation) was used in 26.38% of cases. Statistically significant association of CFI score was obtained with ST and LHS in high-dependency unit ($P < 0.001$). Posttraumatic head injury was seen in 21.25% of cases. A significant association of CFI score with GCS score ($P = 0.032$) and with head injury ($P = 0.019$) was found.

Conclusion: CFI score is a comprehensive yet simple scale to assess ST and LHS. A strong correlation established between CFI score and these variables further validate its reliability as a perfect tool for communication of the maxillofacial morbidity and in making a treatment protocol, although its predictive ability for associated head injuries needs to be studied further.

Keywords: Comprehensive facial injury score, Glasgow Coma Scale, head injury, length of stay, maxillofacial, surgical time, trauma

INTRODUCTION

Maxillofacial injuries in isolation or along with concomitant injuries account for a considerable percentage of the emergency room and hospital admissions. These injuries are serious public health and economic setback, as required treatment, length of hospital stay (LHS), and time spent off work are expensive. The severity of the injuries in the facial area affects the surgical planning, timing, and length of surgical procedures, length of stay in the intensive care unit (ICU), and the recovery of the patient. Canzi *et al*. proposed a comprehensive facial injury (CFI) score to measure the severity of facial injuries that can effectively review these factors.[1] CFI score is a simple tool that expresses the relationship to the overall surgical time (ST) required for definitive treatment of a certain facial fracture classification. Surgical duration and

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Saurabh Kumar Rawat, Kuldeep Vishwakarma, Bharat Shukla, Ritesh Kumar

Apex Trauma Centre, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India

Address for correspondence: Dr. Kuldeep Vishwakarma, Apex Trauma Centre, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow - 226 029, Uttar Pradesh, India. E-mail: drkuldeep12@rediffmail.com

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LHS are relevant outcomes in terms of trauma team efficiency and hospital management requirements.[2-4]

The facial skeleton is composed of multiple bones interdigitating with each other at suture lines. It is designed to perform several functions, but in the context of trauma, they act as a crumple zone to absorb the energy transferred to the face, thus minimizing damage to the skull and brain.[5,6] However, recent investigations have suggested that the face may actually transmit forces directly to the neurocranium, resulting in more serious brain injuries.[7-10] A low Glasgow Coma Scale (GCS) score is an important finding for suspicion of a cranial injury.[11]

Therefore, we conducted this unicentric retrospective observational study to evaluate the statistical significance of CFI score in maxillofacial injury patients managed at our Level I trauma center between July 2018 and March 2020.

METHODS

Design and setting

This was a single-center retrospective observational study involving all the patients with maxillofacial injuries who reported at the emergency department of the trauma center. The study was conducted after prior ethical approval from the bioethics cell of our institute (IEC code: 2020-225-IP-EXP-26).

Study population

This study included a total of 288 patients having maxillofacial injuries (hard tissue/soft tissue or both) with or without an associated head injury that reported and got admitted to the emergency department of our trauma center during July 2018 and March 2020. All cases were operated on by the same team of surgeons using a definitive approach, i.e., open reduction and internal fixation (ORIF), complicated laceration suturing or a conservative one (uncomplicated suturing/closed reduction intermaxillary fixation, cap splinting, and zygomaticomaxillary fracture reduction/or no intervention). Management of associated head injuries was done by the concerned specialty accordingly.

Patients who reported with a history of the previous injury, readmission, and with the pathological cause of the maxillofacial fracture and missing and incomplete records were excluded from the study.

Variables

The total ST and LHS in high-dependency unit (HDU)/ICU were the primary outcomes studied in relation to CFI score. LHS in ICU (a minimum of one day) was studied between two groups: (1) cases with facial injury only and (2) cases with facial and head injury both. We further tried to observe the association of facial injury with GCS score and head injury.

Variables such as demographic data (age, sex, injury mechanism, type of maxillofacial injury, and association with traumatic brain injury and GCS score), type of treatment given, ST, LHS in HDU, and ICU were obtained from medical records of these patients.

Data source and measurement

CFI score[1] was calculated for each of them after evaluating their case record file and computed tomography scan images stored in PACS (Picture Archiving and Communication System). This required summing up the designated score for each injury classification and the treatment given [Figure 1].

The CFI scale is a checklist that offers an anatomical and functional classification of facial injuries [Figure 1]. The anatomical classification divides the face into three horizontal thirds: the upper third (consisting of the frontal bone and orbital roof including the frontal sinus and its drainage system), the middle third (including the upper maxilla and upper dentoalveolar arch, zygoma, lateral and medial wall and floor of orbits, and nasal bones), and the lower third (including the lower dentoalveolar arch, the mandibular symphysis, the body, angles, vertical branches, and condyles).

Functional classification results in two alternative scores for each fractured site: a lesser score for compound fractures, generally treated conservatively, and a higher score for displaced fractures, where an open reduction and internal osteosynthesis (ORIF) is needed, consuming a longer overall treatment time.

The overall sample was then divided into six clusters according to the range of CFI scores:

- Cluster 1: CFI $\leq$5
- Cluster 2: CFI between 6 and 10
- Cluster 3: CFI between 11 and 15
- Cluster 4: CFI between 16 and 20
- Cluster 5: CFI between 21 and 25
- Cluster 6: CFI $>$25.

All the above-mentioned information was used to fill a preorganized datasheet by the investigator. Only patient records were reviewed and no patient was called for data collection. All personal identifiable information such as registration number and patient's name were not used in the datasheet.

Statistical analysis

Normality of data was examined and continuous data were represented by mean ± standard deviation. or median (q1-q3)

COMPREHENSIVE FACIAL INJURY(CFI) score

Mandible	**c**	**d**
Dentoalveolar	1	2
Body/Angle/Symphysis	1	3
Ramus/Condyle	1*	5*
Tot		
Mid-Face		
Dentoalveolar	1	2
LeFort I	1	4
LeFort II	2	5
LeFort III	4	6
NOE	2	6
Zygoma	2	4
Nasal	1	3
Orbital floor	2	5
Medial wall	1	4
Tot		
Upper face		
Frontal sinus Anterior wall	2	4
Posterior wall/Frontonasal duct	2	6
Orbital roof/rim	2	4
Tot		
Soft tissues	1**	5**
Tot		

Unilateral Le Fort fractures are assigned half the numeric value
Each bone atrophy or fragments comminution upgrade Total Score +3 points

"c" = Not displaced fractures or indication to *Non-Operative Management*
"d" = Displaced fractures that need *Open Reduction and Internal Fixation*
*** Condyle "c"** = intra-articular (displaced or not)
"d" = extra-articular displaced fractures
**** Soft tissue "c"** = Simple laceration, not complicated
"d" = Complicated (i.e. Facial or trigeminal nerve/salivary duct involvement, loss of tissues, human/animal bite, gunshot wound, lachrymal drainage system, retrobulbar hematoma)

Incomplete or greenstick fractures do not increase Total Score

Figure 1: The comprehensive facial injury scale for estimating the severity of facial trauma

and categorical data as frequency (percentage). The parametric test compared the normally distributed data, whereas the nonparametric test was used to compare the skewed data. One-way ANOVA and Kruskal–Wallis H-test were used to compare ST (Minutes), LHS (days), and GCS score among the clusters of CFI scores. Fisher's exact test compared head injury among the CFI score clusters. The inference was drawn for the different categories of the CFI score at $P < 0.05$. Statistical Package for the Social Sciences version 23 (SPSS-23, IBM, Chicago, USA) was used for data analysis.

RESULTS

The study group comprised 241 males (83.68%) and 47 females (16.31%) of all ages (mean age 30 ± 15.92, range: 1–87 years). Road traffic accident (76.0%) was the leading etiology for the hospitalization. Of the total, 26.38% of cases were managed with a definitive approach (ORIF), and the rest 73.62% were managed conservatively [Figure 2].

The mean CFI score was 3.34 ± 4 and the median CFI score assigned was 1(1–5). The median CFI score of cases managed conservatively was 1 (0–9) and 7 (1–31) for those which required definitive management.

Tables 1 and 2 summarize the distribution of studied variables among 6 clusters of CFI scores. We found no cases in Cluster 4 (CFI score: 16–20).

The following outcomes were studied:

Total surgical time

The box plot representation [Figure 3] highlights the obtained results: A concurrent increase in median ST values when the CFI score increased up to 25 and pronounced conservation of the interquartile distance amplitude. Figure 4 shows a simple linear regression model on 288 patients, with CFI score as the independent variable and total ST (minutes) as the dependent variable.

Total ST was statistically significant among the clusters of CFI score ($P < 0.001$). Further pair-wise comparison indicated that the ≤5 CFI score is statistically significant from 6 to 10 score ($P < 0.001$), 11–15 score ($P < 0.001$), and 21–25 score ($P < 0.001$) in terms of duration of surgery [Table 1].

Length of hospital stay in the high-dependency unit

Box plot representation shows an increasing trend for LHS in HDU values (days) with an increase in CFI cluster number up to CFI score 25 [Figure 5]. Duration of HDU stay was also statistically significant among the clusters ($P < 0.001$). On pair-wise comparison, we found that the ≤5 CFI score is statistically significant from 6 to 10 score ($P < 0.001$), 11–15 score ($P < 0.001$), and 21–25 score ($P < 0.009$) [Table 1]. We confirmed the existence of a positive linear regression between these two variables [Figure 6].

Length of hospital stay in the intensive care unit

The data were classified based on exclusive facial and those with facial and head injuries both, among the CFI score clusters, but subgroup analysis could not be carried further due to lack of samples in each group. Only 27 (9.4%) patients had ICU stay. Among these, 9 had an exclusive facial injury and 18 had associated head injuries. The highest ICU admissions ($n = 10$) belonged to the CFI ≤5 cluster having both facial and head injuries [Table 2].

Association with Glasgow Coma Scale score and head injury

GCS score at arrival was also statistically significant among the clusters ($P = 0.032$). CFI scores 6–10 ($P = 0.020$) and 11–15 ($P = 0.017$) were statistically significant from up to 5 CFI score group [Table 1]. Linear regression analysis confirmed a negative correlation between GCS score and CFI score [Figure 7]. Cases having a fall in GCS score (<15) increased from Cluster 1 (8.2%) to Cluster 3 (28.6%). A total of 61 patients (21.25%) had associated posttraumatic head injury, and we found that percentage of head injury cases within a cluster increased with increasing CFI score and the association was significant ($P = 0.019$) [Table 1].

DISCUSSION

CFI score was introduced as a simple, comprehensive, and reproducible tool for facial trauma, in which its severity is expressed with the total surgical duration needed for definitive treatment. This is the most significant parameter

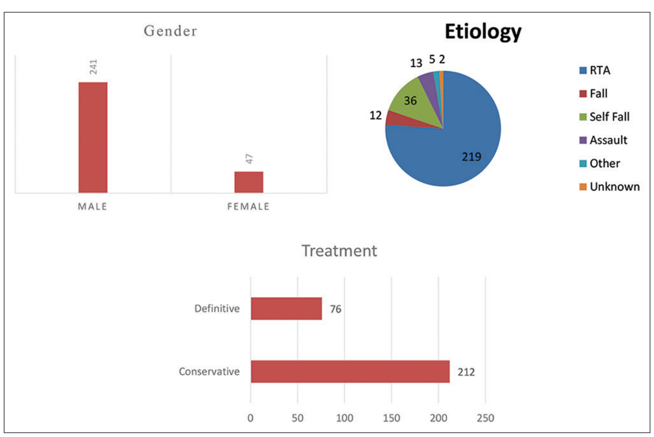

Figure 2: Demographic analysis

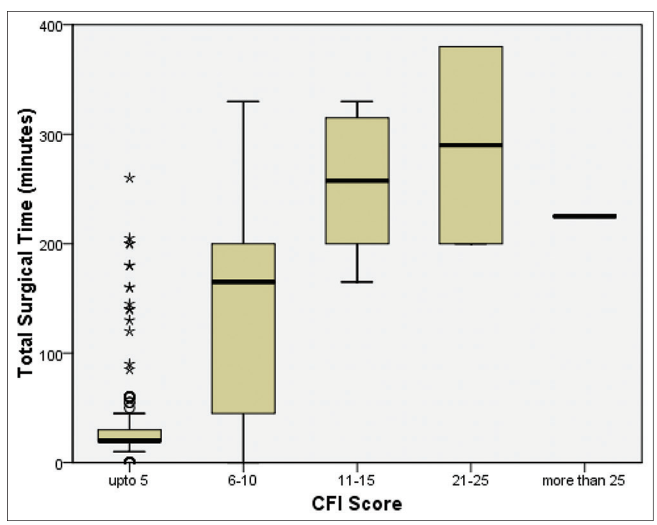

Figure 3: Box-plot representation for total surgical time in minutes among the comprehensive facial injury score clusters

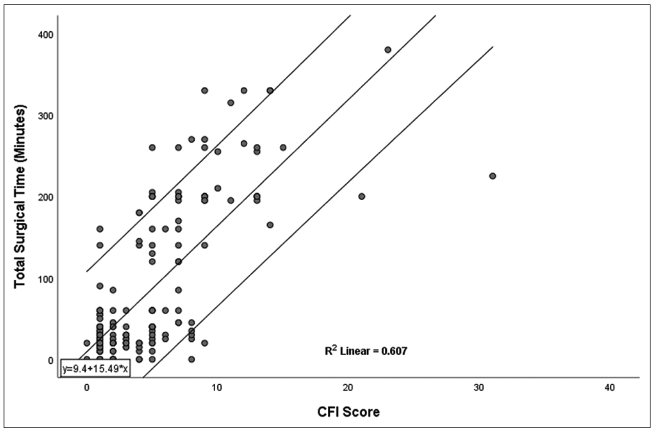

Figure 4: Scatter dot plot diagram representing total surgical time (minutes) among the comprehensive facial injury score clusters. (ang. coeff. 15.49, R-squared 0.607, 95% CI 14.04– 16.94, $P < 0.001$)

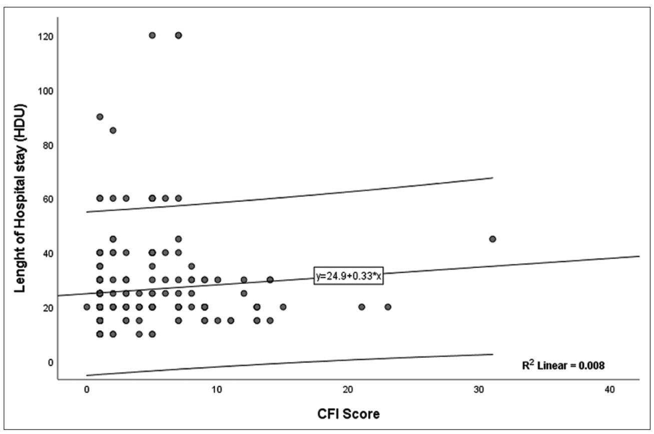

Figure 6: Scatter dot plot diagram for length of hospital stay in high-dependency unit among the comprehensive facial injury score. (ang. coeff. 15.49, R-squared 0.607, 95% CI 14.04–16.94, $P < 0.001$)

to express the commitment of care required and its statistical validation is already proven.[1] We also observed a corresponding increment in median ST with increasing CFI score cluster, at least up to CFI scores above 20 [Table 1] and a positive correlation on linear regression analysis [Figure 4]. Hence, we state that the CFI scale is capable of correlating with the duration of surgical treatment for each type of facial injury classification and its clinical severity.

Previous facial injury severity systems such as Cooter and David Score,[12] Maxillofacial injury severity score (MFISS),[13] (MISS),[14] Facial fracture severity score,[15] and facial injury severity scale (FISS)[16] existed but had characteristic drawbacks.

CFI score mitigated the weakness of the FISS model, where the results were correlated with the specific surgical strategy used and sociopolitical–economic context (operating room charges) rather than the duration of surgery and it also lacked full classification of the different kinds of fracture.[1]

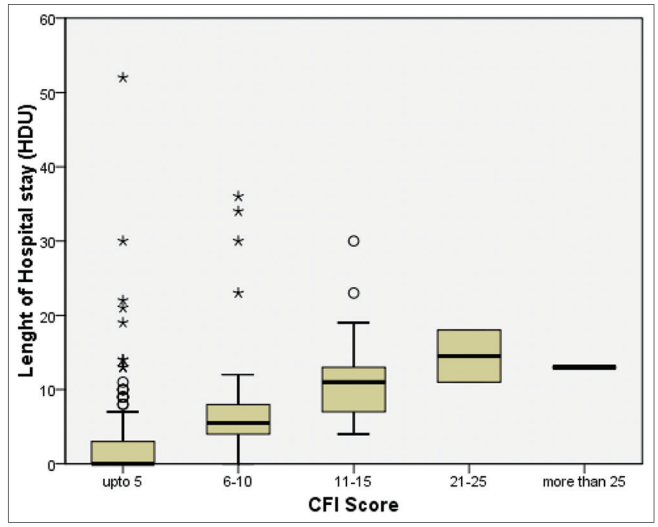

Figure 5: Box-plot representation of length of hospital stay in high-dependency unit (days) among the comprehensive facial injury score clusters ($P < 0.001$)

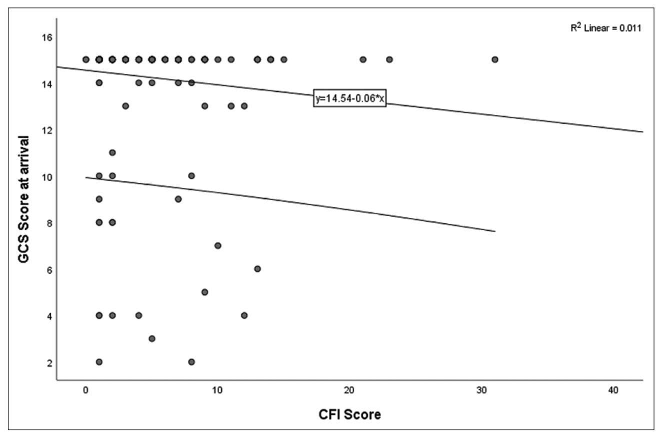

Figure 7: Scatter dot plot diagram representing Glasgow Coma Scale score at arrival and comprehensive facial injury score. (ang. coeff. 0.06, R-squared 0.011, 95% CI -0.131– 0.005, $P = 0.032$)

In continuation of our study, we believe LHS is another valuable outcome in terms of the economic burden to the patients, in-patient care by hospital staff, and total patient turnover rate. Recently, Alta *et al.*, 2018,[2] studied the predictive ability of FISS for the length of stay but found it rather simplistic and less predictable as higher scores are needed to reach positive predictive values.

MFISS was also validated as a model to be able to correlate with treatment costs and hospital stay, but the results were bound to be noncomparable and nonreproducible in different socioeconomic/healthcare systems.[13,14] Nishimoto *et al.*, 2019,[17] and Shetty *et al.*, 2007,[18] found a positive correlation between MISS value, overall ST, and length of stay while quantifying mandibular trauma severity.

We studied the LHS of all patients in the HDU and separated the study group into two groups for ICU stay. It was found that there was a statistically significant rise in LHS in HDU up to CFI scores 25 ($P < 0.001$) [Table 1]. Our study also demonstrated the existence of linear regression between LHS in HDU and CFI score, with high statistical significance [Figure 6]. This positive outcome helps validate the importance of the CFI scale in expressing the severity of facial injury and the requirement of hospital resources.

We further tried to study the impact of CFI score on LHS in ICU in exclusive facial injury cases but failed to establish a significant statistical association due to the insufficient sample size in each sub groups. However, ICU admissions were found more frequent in the group of patients having associated head injury [Table 2].

Historically, the facial architecture has been perceived to be a cushion against impact, protecting the neurocranium from severe injury.[19-21] However, some recent investigations have suggested that the face may transmit forces directly to the neurocranium, resulting in more serious brain injuries.[8-10]

Does the face protect the brain? Keenan *et al*.[7] in 1999 studied this question on 3388 bicyclists to examine the association between facial fractures and traumatic brain injuries. This study demonstrated no evidence that facial fractures help prevent traumatic brain injury and their data suggested facial fractures as markers for increased risk of brain injury.

Woriax *et al*.[22] in 2018 found that severe midface fractures are associated with lower rates of hemorrhagic brain injuries, spine fractures, pneumothorax, abdominal, and pelvic injuries. Deceleration effect was considered one potential mechanism where midface impact dissipates the energy from the trauma resulting in decreased brain, neck, and torso trauma.

Joshi *et al*.[23] found that the risk of head injury increased significantly as the GCS score decreased and with an increase in the number of facial fractures. They suggested that more research into the mechanism of force transduction, additional risk factors for minor brain injury and long-term functional consequences is needed.

Traumatic brain injury has been reported as associated with a facial fracture in 5.4%–87% of patients.[23] In our study, 21.25% of patients had associated posttraumatic head injury. A low GCS score is an important finding for suspicion of a cranial injury, which is a frequent cause of death and disability and post a substantial demand on health services. This outcome was studied on comparatively much lesser patients in our study although a significant association was established [Table 1]. Consecutive fall in GCS was seen up to CFI score of 15, confirmed by negative linear correlation [Figure 7]. Frequency of fall in GCS score (<15) in a cluster increased with increasing CFI score up to 15. Associated head injuries were more frequent in increasing CFI score clusters up to CFI score 15 [Table 1], but we also believe that this outcome is affected by multiple factors such as the age of the patient, type and mechanism of injury, comorbidities, and anticoagulant/antiplatelet therapy.

Table 1: Distribution of total surgical time, length of hospital stay in high-dependency unit, Glasgow Coma Scale score on arrival, and head injury among the comprehensive facial injury score clusters

Outcome	Cluster 1 (*n*=233)	Cluster 2 (*n*=38)	Cluster 3 (*n*=14)	Cluster 4 (*n*=0)	Cluster 5 (*n*=2)	Cluster 6 (*n*=1)	$P^{\#}$
ST (min)*	33±40	146±89	250±59	-	290±127	225±0	<0.001
	20 (20-30)	165 (45-200)	258 (200-315)	-	290 (200-380)	225 (225-225)	
LHS in HDU (days)*	2±5	8±9	12±7	-	15±5	13±0	<0.001
	0 (0-3)	6 (4-8)	11 (7-13)	-	15 (11-18)	13 (13-13)	
GCS score on arrival*	14±2	14±3	13±4	-	15±0	15±0	0.032
	15 (15-15)	15 (15-15)	15 (13-15)	-	15 (15-15)	15 (15-15)	
GCS <15$	19 (8.2)	8 (21.1)	4 (28.6)	-	0	0	0.024
Head injury$	43 (18.5)	12 (31.6)	6 (42.9)	-	0	1 (100)	0.019

*Data expressed in mean±SD and median results (IQR) for each CFI score cluster, #Significant at $P<0.05$, $Data expressed as frequency (%). ST: Surgical time, LHS: Length of hospital stay, HDU: High-dependency unit, GCS: Glasgow Coma Scale, CFI: Comprehensive facial injury, SD: Standard deviation, IQR: Interquartile range

Table 2: Distribution of length of hospital stay in intensive care unit of Group 1 and 2* among comprehensive facial injury score clusters

Outcome	CFI score ≤5		CFI score 6-10		CFI score 11-15		CFI score 16-20		CFI score 21-25		CFI score >25	
Length of hospital stay in ICU (days)$	1 (2)#	2 (10)	1 (4)	2 (5)	1 (1)	2 (3)	1 (0)	2 (0)	1 (2)	2 (0)	1 (0)	2 (0)
	8±3.5	5±7.5	7±9.3	9±10.4	-	5±4	-	-	3±0	-	-	-

*Group 1: Cases with facial injury only, Group 2: Cases with facial and head injury both, #Number of cases in each group, $Mean±SD. CFI: Comprehensive facial injury, SD: Standard deviation, ICU: Intensive care unit

Limitations

The main statistical limitation of this study was the small sample size and its distribution among different CFI score clusters. Scarcity in the number of patients having a head injury and ICU stay questions the validity of the outcome.

CONCLUSION

CFI score is the culmination of anatomical classification of the maxillofacial injuries and the treatment provided, therefore guides in the communication of the morbidity and in making a protocol for patients having comparable injury severity scores.

The results obtained validate the ability of the CFI scoring system to predict the total ST and hospital resources in terms of LHS for surgical treatment of maxillofacial injuries. This new scoring system is simple to use yet descriptive and can be a perfect tool for a widespread application within trauma centers, facilitating communication skills among various disciplines. Therefore, the data obtained from primary and secondary surveys of a trauma patient will lay down a road map for the therapeutic strategies, timing and treatment sequences, surgical duration, hospitalization, and overall outcome.

We opine that a higher CFI score can be a risk factor for an associated head injury, but its predictive ability has to be further studied on a larger scale to draw a more significant association.

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Conflicts of interest

There are no conflicts of interest.

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