Journal of Cranio-Maxillo-Facial Surgery 47 (2019) 377–382

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

The CFI score: Validation of a new comprehensive severity scoring system for facial injuries

Gabriele Canzi [a, *], Elena De Ponti [b], Giorgio Novelli [c], Fabio Mazzoleni [c], Osvaldo Chiara [d], Alberto Bozzetti [c], Davide Sozzi [c]

[a] Maxillofacial Surgery Unit, Emergency Department, ASST-GOM Niguarda, Niguarda Hospital, Piazza Ospedale Maggiore 3, 20162, Milan, Italy
[b] Department of Physical Medicine, ASST-Monza, San Gerardo Hospital, University of Milano-Bicocca, Via Pergolesi 33, 20900, Monza, Italy
[c] O.U. Maxillofacial Surgery, Department of Medicine and Surgery, School of Medicine, ASST-Monza, San Gerardo Hospital, University of Milano-Bicocca, Via Pergolesi 33, 20900, Monza, Italy
[d] O.U. General Surgery, Trauma Team, Emergency Department, ASST-GOM Niguarda, Niguarda Hospital, State University of Milan, Piazza Ospedale Maggiore 3, 20162, Milan, Italy

ARTICLE INFO

Article history:
Paper received 4 September 2018
Accepted 4 January 2019
Available online 18 January 2019

Keywords:
Facial injury severity score
Facial trauma scale
Facial fracture classification

ABSTRACT

At the time of writing there is no measuring scale for the severity of facial trauma that can effectively summarize its clinical relevance, and can therefore be proposed as a definitive tool in trauma center decision making.

This paper introduces a new, simple, comprehensive, and reproducible score for facial trauma, in which its severity is expressed in relation to the surgical duration necessary for definitive treatment. This parameter is identified as the most significant in expressing the commitment of care required. Statistical validation of this comprehensive facial injury (CFI) score involved a sample of 1050 patients, treated by the same team in two highly specialized trauma centers. It demonstrated a linear regression between CFI score and surgical duration, and a high degree of accuracy in forecasting overall surgical time for each type of facial injury.

The descriptive capacity of CFI score, and its extremely simple use, make it a perfect tool for widespread application and for facilitating communication inside trauma centers. It also allows the classification of homogeneous groups of patients — a prerequisite for benchmarking and effective analysis of results.

The CFI model is definitively proposed for the classification of facial injuries, and therefore for the integration of maxillofacial skills, within the trauma team.

1. Introduction

The complex management of patients with multidistrectual trauma requires the use of simple, comprehensive, measurable, validated, and reproducible communication tools within the multidisciplinary trauma team.

The classification of injuries reported for patients with major trauma, in terms of site distribution and anatomical impairment, helps understanding of their impact on mortality and morbidity, as well as the analysis of outcomes and the effectiveness of clinical and organisational decision making for groups of patients with comparable injury severity (Champion, 2002; Sanson, 2012).

Facial trauma is rarely associated with an increase in patient mortality (Cannel et al., 1996). Current classification standards are therefore limited in their description of real severity in this kind of trauma, which usually occurs in patients with multiple concomitant injuries, because additional commitment of resources is needed.

The surgical strategy, length of stay in the intensive care unit, timing and length of procedures, and how the treatment affects the

* Corresponding author. Maxillofacial Surgery Unit, Emergency Department, ASST Grande Ospedale Metropolitano Niguarda, Niguarda Hospital, Piazza Ospedale Maggiore 3, 20162, Milan, Italy. Fax: +39 0264447019.
E-mail addresses: gabriele.canzi@ospedaleniguarda.it (G. Canzi), e.deponti@asst-monza.it (E. De Ponti), g.novelli@asst-monza.it (G. Novelli), f.mazzoleni@asst-monza.it (F. Mazzoleni), osvaldo.chiara@unimi.it (O. Chiara), alberto.bozzetti@unimib.it (A. Bozzetti), davide.sozzi@unimib.it (D. Sozzi).

https://doi.org/10.1016/j.jcms.2019.01.004
1010-5182/

recovery of the patient, all change according to the severity of the injuries in the facial area.

There is currently no measuring scale for severity of facial trauma that can effectively summarize these factors, and which can therefore be proposed as a definitive standard among the maxillofacial tools of the trauma team.

The aim of this study is to offer a new, simple, and complete injury severity score scale for facial trauma, in relation to the commitment of care necessary for the definitive treatment of the different injuries. The study also validates the statistical significance of the scale, using a sample of 1050 patients treated by the same team in two highly specialized trauma centers.

2. Materials and methods

This study used a case series treated by a team of five surgeons, who were experts in the treatment of traumatological maxillofacial injuries, shared by two Level I trauma centers in Italy (Niguarda Hospital in Milan and San Gerardo Hospital in Monza). It included 1050 patients — 793 male (75.6%) and 257 female (24.4%) — of all ages (mean 38 ± 19 years; range 1–90) undergoing surgical treatment for traumatic facial injuries. Patients without thorough radiological documentation (traditional or CT), with soft tissue lesions treated under local anesthesia or on an outpatient basis, and those who died before undergoing maxillofacial surgery or with concomitant non-traumatic specialist pathologies, were not included.

The data were collected using retrospective sampling from January 2008 (date of formation of the inter-hospital specialist team) to October 2015 (data collection starting date), and prospective sampling from October 2015 to August 2016 (date of sampling completion).

Analysis of computerized clinical documentation made it possible to record, in a specific database, the duration of the surgical intervention performed by the specialist team for the definitive treatment of the traumatic injuries of each patient. At the same time, the estimated individual score on the comprehensive facial injury (CFI) scale of facial trauma severity (Fig. 1) was calculated and recorded, along with the radiological diagnostic images stored on specific hospital servers (for skeletal injuries) and the clinical or photographic evaluation that had been systematically collected and filed (for soft tissue injuries).

The scale displays as a kind of 'check-list', which offers an anatomical and functional classification of the lesions. In terms of anatomical classification, the facial area is divided into three horizontal thirds:

- the lower third (consisting of the mandibular symphysis, body, angles, vertical branches, and condyles, as well as the lower dentoalveolar arch);
- the middle third (consisting of the upper maxilla and upper dentoalveolar arch, zygoma, lateral and medial wall and floor of orbits, and the nasal bones);
- the upper third (consisting of the orbital roof and frontal bone, specifically for the involvement of the frontal sinus and its drainage system).

The functional distinction requires two different estimated scores for each anatomical area: a lower score for compound fractures, generally needing conservative treatment or nonoperative management; and a higher score for displaced fractures, for which open reduction and internal osteosynthesis are usually required, and thus more relevant treatments in terms of resource commitment.

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

Fig. 1. The CFI scale for estimating the severity of facial trauma.

Each score (1–6) is reciprocally proportioned according to the estimated a-priori duration of the procedure required for the treatment of fractures in each area. The database compiler scrolls through the list and gives a partial score based on the combination of injuries reported by each patient. Soft tissue injuries are evaluated separately and added to the score obtained for the three-thirds skeletal injuries. Additional factors of severity are proposed for comminuted fractures or loss of substances, including bone atrophy, which can increase the complexity and duration of corrective surgery. The individual final score is obtained by collating the partial results, according to the personal injury characteristics.

In this study, each score obtained was calculated by a specialist at the time of the first evaluation of the patient or, if retrospectively calculated by the database officer, was verified by comparison with the score individually attributed by at least two of the five members of the surgical team. The overall sample was then divided into six clusters according to the range of the CFI score:

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.

The sample of 1050 patients was also divided into two groups:

- Model group — 500 patients undergoing surgery from January 2008 to November 2011.

- Test group — 550 patients undergoing surgery from November 2011 to August 2016.

2.1. Statistical analysis

The continuous data for the two groups were compared using the Kruskal–Wallis test, while the distribution of patients according to the CFI categories was compared using Fisher's exact test. For all comparisons, a p-value less than 0.05 was considered significant.

A statistical inference analysis was performed for the model group, assessing the trend in mean and median values for the dependent variable 'surgical duration', with respect to the independent variable 'CFI score'. The association between two continuous variables was studied using the linear regression model, evaluating the correlation coefficient and the R-squared coefficient of determination.

The linear regression model obtained for the model group data was then used in the test group to verify the predictability of the dependent variable 'surgical duration', according to the CFI score obtained by each patient for specific traumatic injuries. These data were then compared with the actual scores, recorded in the database, for duration of final surgery for the test group.

Finally, the degree of accuracy of CFI score categories was calculated in order to predict the maximum duration of surgery (average + 1 SD for the model group in each category) and minimum duration of surgery (average − 1 SD for the model group in each category) when applied to the test group.

3. Results

Patient age and gender, sample size for each group and for each cluster, and the absence of statistically significant differences between these characteristics, are shown in Table 1.

As in other published studies, patients of all ages and both genders were studied (Bagheri et al., 2006; Zhang et al., 2006; Zhaohui et al., 2008; Catapano et al., 2010). A specific score for the pediatric population was deemed unnecessary because overall surgical time (when surgical indication is given) is expected to be the same for child and adult patients.

A box plot representation helped to highlight overlapping of obtained results, in term of medians and the relative interquartile ranges for overall surgical time, for each of model group and test group cluster (Fig. 2). The rank test carried on each cluster was irrelevant.

A corresponding increase in median surgical time with increasing cluster number and pronounced conservation of interquartile amplitude (relating to 50% of the patients belonging to each cluster in each group) were observed, at least for CFI scores up to 20, corresponding to extremely serious and often heterogeneous lesions. It was therefore possible to demonstrate linear regression between the independent variable 'totalized CFI score' and the dependent variable 'surgical duration' necessary for the definitive treatment of the lesions described (considered a significant parameter for expressing injury severity) in the model group, with excellent correlation and R-squared determination (98.4%; $p < 0.0001$) (Fig. 3).

This result was considered the reference for predicting the independent variable 'surgical duration' for each CFI cluster in the test group. The results were then overlapped on the actual data recorded for this second group, and the linear regression calculated. The test group also confirmed linear regression between the two variables, with highly significant correlation and R-squared coefficients (98.3%; $p < 0.0001$), adhering strictly to that obtained for the model group (Fig. 3).

The significant matching of the two lines (confidence interval, CI = 95%), characterized by an identical slope, helps to further demonstrate how results obtained in the model group can be reproduced in the test group (Fig. 3). To further confirm this validation, the study aimed to determine the degree of accuracy for the CFI score, based on the results obtained in the model group, in forecasting the maximum and minimum surgical durations for each cluster of scores in the test group (with cut-off equal to average ± SD) (Table 2). The percentage of correctly classified cases was extremely satisfactory (88.7% and 90.2%, respectively), with a great degree of homogeneity of results for all score clusters (Table 2).

4. Discussion

This study proposes a new model for classifying the clinical severity of traumatic facial lesions, and validates it statistically. The design phase established the fundamental requirements of a perfect model: simple to use (making its application available even to non-specialistic team members); complete (classifying all types of commonly observed facial trauma); highly informative (offering a useful classification from a clinical and management point of view); reproducible (being valid in different places and at different times). The simplicity of the CFI model, in describing a continuum of all facial injuries found in daily clinical practice, makes it suitable even for an already complex system like that of a trauma center.

Statistical validation showed the CFI score to be 88.7% accurate in its ability to predict the maximum surgical duration necessary for the specific injuries reported, and 90.2% accurate in its ability to predict the minimum duration. This means that, starting from a given CFI cluster, it is possible to predict the duration of surgery

Table 1
Patient characteristics (*sum rank test, °Fisher's exact test).

Patient characteristics	Model group ($n = 500$)	Test group ($n = 550$)	p-value
Age (y):			
mean ± SD	37 ± 18	38 ± 19	0.260*
median (range)	34 (3–88)	36 (1–90)	
Gender:			
male (%)	374 (74.8%)	419 (76.2%)	0.327°
CFI (No.)			
1	190 (38.0%)	211 (38.4%)	0.141°
2	237 (47.4%)	243 (44.2%)	
3	40 (8.0%)	62 (11.3%)	
4	12 (2.4%)	17 (3.1%)	
5	6 (1.2%)	10 (1.8%)	
6	15 (3.0%)	7 (1.3%)	

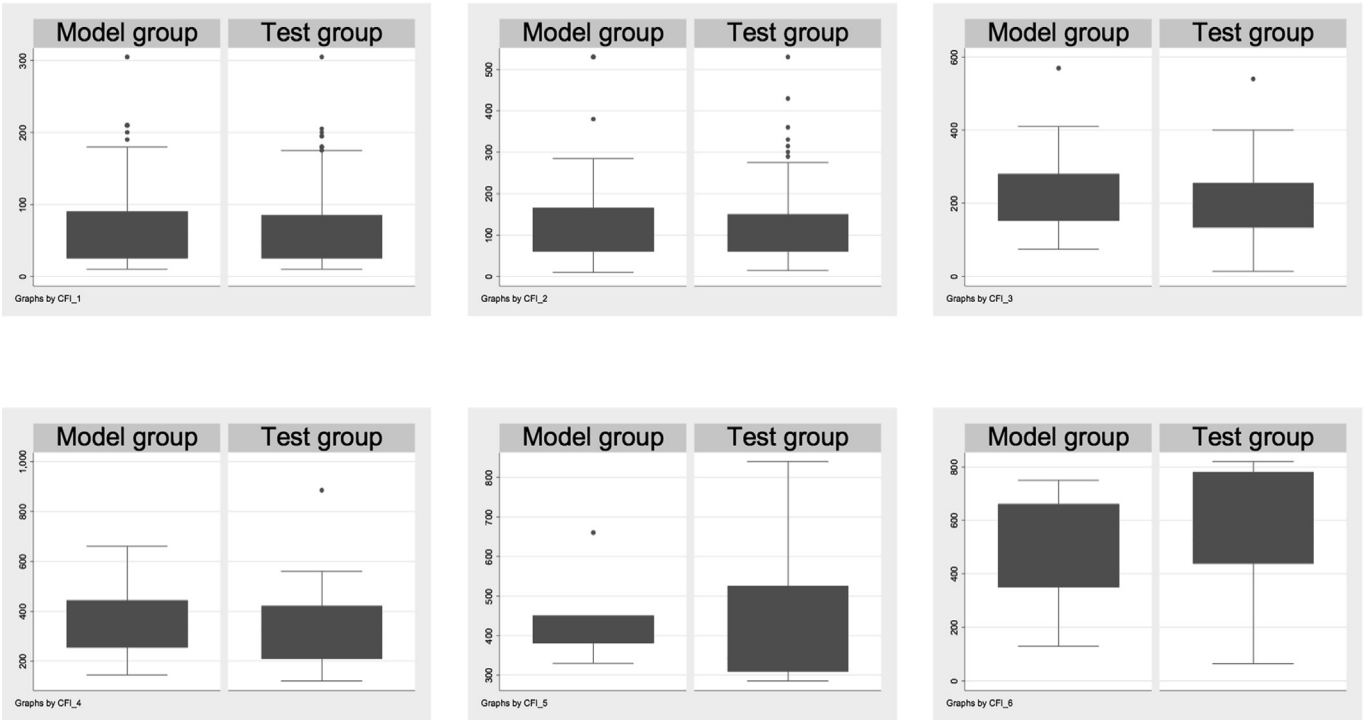

Fig. 2. Box plot comparison of the distribution, in the model group and in the test group, of surgical duration according to each CFI score cluster (1–6).

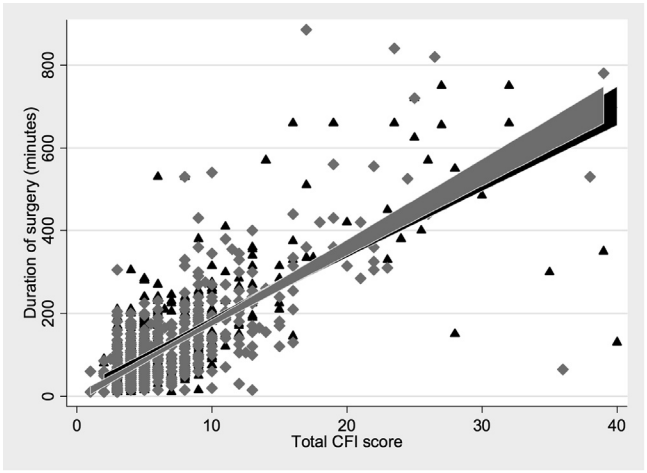

Fig. 3. Scatter plot of the duration of surgery as a function of total CFI score. The two lines demonstrate a linear regression between the independent variable 'totalized CFI score' and the dependent variable 'median surgical duration' for the model group (triangles; R-squared = 98.4%; $p < 0.0001$) and test group (rhombuses; R-squared = 98.3%; $p < 0.0001$), with a perfect match for all results in the two groups (confidence interval, CI = 95%).

needed for injuries with same scored results ($p < 0.0001$). So the CFI scale is able to correlate with the duration of surgical treatment for each type of facial injury and, ultimately, with its clinical severity.

Aside from particular emergency conditions, traumatic facial lesions rarely cause death regardless of how serious they are (Cannel et al., 1996). Their real severity often results in more integrative organizational and management requirements (especially in patients with concomitant multiple injuries), and modification of therapeutic strategies, timing and the sequence of treatment, surgical duration, length of stay, and overall outcome. Indeed, existing severity scores traditionally used for general trauma, such as AIS and its derivatives (ISS, NISS, TRISS), introduce some conceptual limitations when applied to facial trauma: insufficient classification of fractures by location, number and type; absence of correlation with the care commitment required for the treatment of classified injuries; being mainly applicable to the risk of death; and the lack of interval scale for results (Baker et al., 1974; Wang et al., 1984; Boyd et al., 1987; Copes et al., 1988; Champion et al., 1989; AAAM, 1990; Rutledge, 1996; Osler et al., 1996; Osler et al., 1997; Brenneman et al., 1998; Sacco et al., 1999; Lavoie et al., 2004; Tay et al., 2004; Bouamara et al., 2006; Di Bartolomeo et al., 2011; Rayet al., 2014).

Maxillofacial literature provides numerous anatomical classifications of facial traumatic lesions, which describe the locations

Table 2
Estimate of accuracy in predicting maximum and minimum surgical duration (cut-off = average ± SD)

CFI category	Estimated maximum duration of surgery	Correctly classified	Down-staged	Estimated minimum duration of surgery	Correctly classified	Up-staged
1	<116	183 (86.7%)	28 (13.3%)	>14	200 (94.8%)	11 (5.2%)
2	<199	222 (91.4%)	21 (8.6%)	>45	220 (90.5%)	23 (9.5%)
3	<331	56 (90.3%)	6 (9.7%)	>131	47 (75.8%)	15 (24.2%)
4	<530	15 (88.2%)	2 (11.8%)	>201	13 (76.5%)	4 (23.5%)
5	<557	9 (90.0%)	1 (10.0%)	>229	10 (100.0%)	0 (0%)
6	>557	3 (42.9%)	4 (57.1%)	>295	6 (85.7%)	1 (14.3%)
Total		488 (**88.7%**)	62 (11.3%)		496 (**90.2%**)	54 (9.8%)

involved and the types of displacement (Le Fort, 1901; Knight and North, 1961; Rowe and Killey, 1968; Markovitz et al., 1991; Dingman and Natwig, 1964; Spiessl and Schroll, 1972; Gonty et al., 1999; Echo et al., 2010). However, these descriptive classifications do not provide useful information for the organization of the multidisciplinary team.

Specific systems proposed for severity classification of facial traumas are few, and have characteristic weaknesses. The *craniofacial disruption score* or *Cooter and David Score (CDS)* does not classify each fracture and does not consider the soft tissue lesions; it is, overall, a reductive, self-limiting, and arbitrary system, and its use remains marginal today (Cooter and David, 1989). The *facial injury severity scale (FISS)* has been validated with respect to an economic outcome, meaning that the results are undermined by the specific surgical strategy used and by the different socio-political-economic context; it lacks a full classification of the different kinds of fracture (Bagheri et al., 2006). The *maxillofacial injury severity score (MFISS)*, based on the anatomical-pathological classification of AIS, has the aforementioned limits, and does not consider fractures of the upper facial third, the nose-orbit-ethmoid, and the zygomatic-orbitary area and, moreover, introduces functional variables of severity that can potentially be resolved completely with reconstructive surgery, thus nullifying its prognostic power in terms of outcome (Zhang, 2006). The *maxillofacial injury severity score (MISS)* results from the processing of the AIS-98 score, with which it shares intrinsic limits. Its calculation is extremely demanding and difficult to propose to non-specialist team members (Zhaohui, 2008). The *facial fracture severity score* (FFSS) does not consider differences in terms of commitment in the treatment of the specific sites analyzed, and is therefore excessively simplistic in terms of information capacity (Catapano, 2010). The *ZS model* (2012) was inspired by the FFSS and later by the CDS: the current proposed version fails to include the involvement of the soft tissues, vascular and nervous structures, and the upper facial third (Ahmad, 2012).

In analyzing the aforementioned pre-existing severity classification systems for facial trauma, we decided that the perfect tool is a model that mitigates the weaknesses of the FISS. This agrees with other analyses of the application of different severity facial trauma scales, in which the FISS is so far considered to be the best communication tool available within a multidisciplinary team (Ramalingam, 2015; Sahni, 2016). Recently, the use of the FISS score on a sample of 469 patients with facial trauma proved its predictive ability in terms of length of stay and the likelihood of undergoing specialist surgery (Alta et al., 2018). However, this score remains extremely simplistic, and high scores are needed to reach highly positive predictive values, for example with extensive injuries that involve multiple facial areas.

The CFI model maintains the fundamental concept of measuring severity of facial trauma in order to predict to the relevant surgery for its treatment. In contrast with the FISS score, the care commitment is expressed in terms of surgical duration in minutes. This helps to make the results comparable and reproducible, even in different socio-economic-health systems, while eliminating the inherent bias of the costs of the materials used, the specific surgical decisions, and the possible charges by the professionals involved. FISS score limits have also been improved by expanding the classification of mandibular fractures, introducing additional factors of severity for comminuted fractures and those with atrophy or loss of substance (which can therefore increase the surgical difficulty and duration), and introducing a simplified classification of soft-tissue injuries. Moreover, the CFI score differentiates lesions deserving surgical treatment from those undergoing non-operative management, thus reducing the commitment of care needed. It was initially assumed that more serious injuries require greater care, longer interventions, and longer hospitalization, but this approach has been criticized because of possible influences of operator-dependent variables (experience, surgical skill, type of treatment chosen) (Bagheri, 2006). The validation of a model in which the dependent variable is expressed in these terms therefore required a large sample and a reduced number of participating surgeons. In this case, the Maxillofacial Surgery Unit, shared by Niguarda Hospital in Milan and San Gerardo Hospital in Monza, represents the perfect context, because the analysis of data involved only five experienced surgeons, shared between two level I trauma centers, with a wide range of cases.

The main statistical limitation of this study was the heterogeneity of the sampling (retrospective analysis from January 2008 to October 2015 and subsequently prospective until August 2016). The model is based on the analysis of radiological data and the clinical analysis (or photographic documentation) of soft-tissue injuries. Thus, its development involved an overlapping of outcomes collected by different workers and at different times, limiting the effect of prospective or retrospective sampling on this observational study.

5. Conclusions

The results obtained validate, with a great statistical significance, the ability of the new CFI severity scoring system to predict the relevance of care that definitive surgical treatment of facial injuries requires. The descriptive capacity and the extreme simplicity of the CFI model make it a perfect tool for a widespread application, even by non-specialist team members within trauma centers, facilitating communication skills in the context of *hub-and-spoke* organizational models.

Within each team, the model allows numerous clinical applications, in which all the caregivers can self-predict, according to simple data obtained from the primary evaluation of the patient upon their arrival, the therapeutic strategies, timing and treatment sequences, surgical duration, hospitalization, and overall outcome.

The CFI score allows the classification of homogeneous groups of patients — a prerequisite for the effective analysis of results and *benchmarking*.

The CFI model is proposed as a definitive tool for the classification of facial injuries, and therefore for the integration of maxillofacial skills within the trauma team.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declarations of interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcms.2019.01.004.

References

Ahmad Z, Nouraei R, Holmes S: Towards a classification system for complex craniofacial fractures. Br J Oral Maxillofac Surg 50: 490–494, 2012

Alta TG, Pereira Stabile C, Dezan Garbellini CC, Vitti Stabile GA: Can a facial injury severity scale be used to predict the need for surgical intervention and time of hospitalization? J Oral Maxillofac Surg 76: 1280.e1–1280.e8, 2018

Association for the Advancement of Automotive Medice — AAAM: Abbreviated injury scale (AIS): 1990 revision. Illinois: Des Plaines, 1990

Bagheri SC, Dierks EJ, Kademani D, Holmgren E, Bell RB, Hommer L, et al: Application of a facial injury severity scale in craniomaxillofacial trauma. J Oral Maxillofac Surg 64: 408–414, 2006
Baker SP, O'Neill B, Haddon W, Long WB: The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma 14: 187–196, 1974
Bouamra O, Wrotchford A, Hollis S, Vail A, Woodford M, Lecky F: A new approach to outcome prediction in trauma: a comparison with the TRISS model. J Trauma 61: 701–710, 2006
Boyd CR, Tolson MA, Copes WS: Evaluating trauma care: the TRISS method. trauma score and the injury severity score. J Trauma 27: 370–378, 1987
Brenneman FD, Boulanger BR, McLellan BA, Redelmeier DA: Measuring injury severity: time for a change? J Trauma 44: 580–582, 1998
Cannel H, Paterson A, Loukota R: Maxillofacial injuries in multiply injured patients. Br J Oral Maxillofac Surg 34: 303–308, 1996
Catapano J, Fialkov JA, Binhammer PA, McMillan C, Antonyshyn OM: A new system for severity scoring of facial fractures: development and validation. J Craniofac Surg 21: 1098–1103, 2010
Champion HR, Sacco WJ, Copes WS, Gann DS, Gennarelli TA, Flanagan ME: A revision of the trauma score. J Trauma 29: 623–629, 1989
Champion HR: Trauma scoring. Scand J Surg 91: 12–22, 2002
Cooter RD, David DJ: Computer-based coding of fractures in the craniofacial region. Br J Plast Surg 42(17–26), 1989
Copes WS, Champion HR, Sacco WJ, Lawnick MM, Keast SL, Bain LW: The injury severity score revisited. J Trauma 28: 69–77, 1988
Di Bartolomeo S, Ventura C, Marino M, Valent F, Trombetti S, De Palma R: The counterintuitive effect of multiple injuries in severity scoring: a simple variable improves the predictive ability of NISS. Scand J Trauma Resusc Emerg Med 19: 19–26, 2011
Dingman RO, Natwig P: Surgery of facial fractures. London: W.B. Saunders, 1964
Echo A, Troy JS, Hollier LH: Frontal sinus fractures. Semin Plast Surg 24: 375–382, 2010
Gonty AA, Marciani RD, Adornato DC: Management of frontal sinus fractures: a review of 33 cases. J Oral Maxillofac Surg 57: 372–381, 1999
Knight JS, North JF: The classification of malar fractures: an analysis of displacement as a guide to treatment. Br J Plast Surg 13: 325–339, 1961
Lavoie A, Moore L, LeSage N, Liberman M, Sampalis JS: The new injury severity score: a more accurate predictor of in-hospital mortality than the injury severity score. J Trauma 56: 1312–1320, 2004
Le Fort R: Étude expirémentale sur les fracturées de la mâchoire supérieure. Revue chir de Paris 23: 208–227, 1901 360–379.479–507
Markowitz BL, Manson PN, Sargent L, Vander Kolk CA, Yaremchuk M, Glassman D, et al: Management of the medial canthal tendon in nasoethmoid orbital fractures: the importance of the central fragment in classification and treatment. Plast Reconstr Surg 87: 843–853, 1991
Osler T, Baker SP, Long W: A modification of the injury severity score that both improves accuracy and simplifies scoring. J Trauma 43: 922–925, 1997
Osler T, Rutledge R, Deis J, Bedrick E: ICISS: an international classification of disease-9 based injury severity score. J Trauma 41: 380–388, 1996
Ramalingam S: Role of maxillofacial trauma scoring systems in determining the economic burden to maxillofacial trauma patients in India. J Int Oral Health 7: 38–43, 2015
Ray CS, Wu SC, Kuo PJ, Chen YC, Chien PC, Hsieh HY, et al: Same abbreviated injury scale values may be associated with different risks to mortality in trauma patients: a cross-sectional retrospective study based on the trauma registry system in a level I trauma center. Eur J Trauma Emerg Surg 40: 287–294, 2014
Rowe NL, Killey HC. In: Fractures of the facial skeleton. General considerations and classification of mandibular fractures, 2nd ed. Edinburgh: Churchill-Livingstone, 14–24, 1968
Rutledge R: The injury severity score is unable to differentiate between poor care and severe injury. J Trauma 40: 944–950, 1996
Sacco WJ, MacKenzie EJ, Champion HR, Davis EG, Buckman RF: Comparison of alternative methods for assessing injury severity based on anatomic descriptors. J Trauma 47: 441–447, 1999
Sahni V: Maxillofacial trauma scoring systems. Injury 47: 1388–1392, 2016
Sanson G: Comprendere e studiare il fenomeno trauma. In: Chiara O, Nardi G, Gordini G, Sanson G (eds), Trauma Care: La cura definitiva del trauma maggiore, 1st ed. Milan: Elsevier, 5–9, 2012
Spiessl B, Schroll K: Spezielle Frakturen- und Luxationslehre. Ein kurzes Handbuch in fünf Bänden. Band I/1 Gesichtsschädel. Stuttgart, New York: Georg Thieme Verlag, 317, 1972
Tay SY, Sloan EP, Zun L, Zaret P: Comparison of the new injury severity score and the injury severity score. J Trauma 56: 162–164, 2004
Wang MD, Fan WH, Qiu WS, Zhang ZL, Mo YN, Qiu F: The exponential function transforms the abbreviated injury scale, which both improves accuracy and simplifies scoring. Am J Emerg Med 2: 537–549, 1984
Zhang J, Zhang Y, El-Maaytah M, Ma L, Liu L, Zhou LD: Maxillofacial injury severity score: proposal of a new scoring system. Int J Oral Maxillofac Surg 35: 109–114, 2006
Zhaohui S, Shuxia Z, Xinghua F, Shujun L, Yanpu L, Bin B, et al: The design and implementation of Chinese maxillofacial trauma registry, analysis and injury severity score system. J Trauma 64: 1024–1033, 2008