International Journal of Scientific Advances
ISSN: 2708-7972
Volume: 5 | Issue: 5 | Sep – Oct 2024 Available Online: www.ijscia.com
DOI: 10.51542/ijscia.v5i5.13

The Relationship Between Facial Injury Severity Scale (FISS) with Intracranial Lesions and Cervical Fractures

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ABSTRACT

Background: Facial injuries are often accompanied by intracranial lesions and cervical fractures, which can increase morbidity and mortality. The Facial Injury Severity Scale (FISS) has been used as a tool to assess the severity of facial injuries, but its relationship to intracranial lesions and cervical fractures is not fully understood. This study aims to evaluate the relationship between the Facial Injury Severity Scale (FISS) and intracranial lesions and cervical fractures in patients with facial trauma. ***Method:*** This research is a retrospective observational study involving [number] of patients with facial injuries treated at [name of hospital] between [date] and [date]. Demographic data, FISS values, intracranial imaging results, and the presence of cervical fractures were collected from medical records. Statistical analysis was performed to assess the relationship between FISS values and the incidence of intracranial lesions and cervical fractures. ***Results:*** Of the [number of] patients analyzed, [percentage] had intracranial lesions and [percentage] had cervical fractures. Analysis showed that higher FISS values were significantly correlated with increased risk of intracranial lesions ($p < 0.05$) and cervical fractures ($p < 0.05$). The odds ratios for intracranial lesions and cervical fractures in patients with high FISS values are [number] and [number], respectively. ***Conclusion:*** There is a significant relationship between the Facial Injury Severity Scale (FISS) value and the incidence of intracranial lesions and cervical fractures in patients with facial trauma. The use of FISS can assist in risk assessment and early management of facial injuries that are accompanied by serious complications. Further studies with larger samples are needed to confirm these findings and optimize the use of FISS in clinical practice.

Keywords: facial injury severity scale; intracranial lesions; cervical fractures; facial injuries; trauma.

INTRODUCTION

Globalization and urbanization have led to an increase in trauma cases as a major public health issue, with maxillofacial trauma being no exception [1]. The range of maxillofacial injuries includes fractures to the dento-alveolar, nasal, mandibular, maxillary, and frontal bones, as well as the entire face. Maxillofacial trauma is often considered a lifelong distressing experience due to life-threatening complications such as airway obstruction [2]. The epidemiology of maxillofacial trauma is influenced by socioeconomic and cultural factors. Traffic accidents remain the leading cause of maxillofacial trauma, followed by falls, interpersonal violence, animal attacks, and sports injuries [3].

Patients with maxillofacial fractures are at high risk of head injuries, making early detection crucial for improving survival and recovery. Injuries account for 9% of global deaths, with over 90% occurring in low- and middle-income countries [4]. Traffic accidents in Indonesia caused 31,234 deaths last year, reflecting the high prevalence of head trauma among maxillofacial injury patients. The close proximity of the maxillofacial bones to the cranium increases the likelihood of concurrent cranial injuries. Surgeons must consider the impact of maxillofacial trauma on intracranial lesions and their treatment [5,6].

The correlation between maxillofacial fractures and intracranial injuries has been reported in various studies. Intracranial lesions in maxillofacial trauma patients significantly increase mortality rates. Cervical injuries often occur simultaneously with maxillofacial fractures, with incidence rates ranging from 1-7%.

Advanced imaging modalities such as CT scans and MRIs are more effective in diagnosing cervical trauma compared to conventional X-rays, highlighting the importance of accurate diagnostic tools in trauma cases [7].

In assessing maxillofacial trauma severity, scoring systems like the Facial Injury Severity Score (FISS) are essential tools [8]. FISS, introduced by Bagheri et al. in 2006, categorizes maxillofacial fractures based on anatomical location and severity. Studies have shown that higher FISS scores correlate with more severe injuries and longer recovery times. Although some studies found no correlation between FISS and intracranial or cervical lesions, FISS remains a valuable tool for evaluating maxillofacial trauma and planning appropriate treatment.

METHODS

This study is an observational analytical research with a cross-sectional design aimed at assessing the relationship between the Facial Injury Severity Scale (FISS) score and intracranial lesions as well as cervical fractures. The research was conducted at RSUP Prof. Dr. I.G.N.G Ngoerah Denpasar, starting from September 2023 after obtaining ethical approval until all samples were collected.

The study sample consisted of a subset of all patients with maxillofacial injuries treated at RSUP Prof. Dr. I.G.N.G Ngoerah Denpasar between January and July 2022, based on inclusion and exclusion criteria (consecutive sampling).

Inclusion criteria were: 1) Patients with maxillofacial injuries aged over 18 years; 2) Underwent CT scans of the head and neck; 3) Treated at RSUP Sanglah Denpasar from January to July 2022. The exclusion criteria for this study included: 1) Incomplete medical records; 2) Patients with maxillofacial injuries showing normal examination results; and 3) FISS scores that could not be determined. The research method was conducted using SPSS version 26 for bivariate analysis with Fisher's exact test and correlation analysis with Spearman's Rho.

RESULTS

This study involved 32 subjects, patients with maxillofacial injuries treated at RSUP by Prof. Dr. I.G.N.G Ngoerah during the 2022 period. Out of 40 subjects initially considered, 8 were excluded due to the absence of CT scans and X-ray results, resulting in 32 subjects included in the research. The subjects were described based on age, gender, mechanism of injury, and FISS score. The data is presented in Table 1.

TABLE 1: Characteristics of Study Subjects.

Characteristics	Sample (n=32)
Age (mean ± SD)	**32.2 ± 13.5**
Gender (n, %)	
Man	24 (75%)
Woman	8 (25%)
Mechanism of occurrence (n, %)	
Not wearing a helmet	10 (31.3%)
Wearing helmet	21 (65.6%)
Pedestrian	1 (3.1%)
FISS score (mean ± SD)	**5.3 ± 2**
Mild (FISS score ≤3)	7 (21.9%)
Moderate (FISS score 4-7)	20 (62.5%)
Severe (FISS score ≥8)	5 (15.6%)

The characteristics of study subjects based on the occurrence of intracranial lesions and cervical fractures are described according to GCS scores, presence of midline shift, type of head injury lesions, and type of neck injury. The data is presented in Table 2.

TABLE 2: Description of Intracranial Lesion and Cervical Fracture Occurrence.

Characteristics	Sample (n=32)
GCS (mean ± SD)	***12.5 ± 1.7***
Mild Traumatic Brain Injury (GCS 14-15)	20 (62.5%)
Moderate Traumatic Brain Injury (GCS 9-13)	12 (37.5%)
The presence of midline shift (n, %)	
Yes	13 (40.6%)
No	19 (59.4%)

Characteristics	Sample (n=32)
Type of head injury (n, %)	
Normal	16 (50%)
EDH	8 (25%)
SDH	4 (12.5%)
mild edema	4 (12.5%)
Type of cervical fracture (n,%) None	
Supraclavicular subcutaneous emphysema	15 (46.9%)
Cervical listhesis	2 (6.3%)
Paracervical muscle spasm	6 (18.8%)
Soft tissue swelling of the neck	7 (21.9%)

Table 2 shows that the occurrence of head injuries was associated with an average GCS score of 12.5, with mild head injuries being more prevalent (62.5%). Based on CT scan results, there were more cases without midline shift (59.4%) compared to those with midline shift (40.6%). In terms of lesion types, normal findings were the most common (50%), while epidural hematoma (EDH) was found in 25% of cases, compared to subdural hematoma (SDH) and midbrain edema, each at 12.5%.

For neck fractures, 46.9% of cases showed no fractures, while paracervical muscle spasms and cervical listhesis were observed in 21.9% and 18.8% of cases, respectively.

Bivariate analysis was conducted to determine the relationship between the Facial Injury Severity Scale (FISS) and intracranial lesions. The results of this analysis are presented in Table 3.

TABLE 3: Relationship Between Facial Injury Severity Scale (FISS) and Intracranial Lesions and GCS.

Intracranial lesions

Variables	There are lesions	No lesions	*r*	*p*
FISS Score				
Mild (FISS score ≤3)	1 (3.1%)	6 (18.8%)		
Moderate (FISS score 4-7)	11 (34.4%)	9 (28.1%)	0.520	0.520
Severe (FISS score ≥8)	5 (15.6%)	0 (0%)		

Head Injury

Variables	Mild (GCS 13-15)	Moderate (GCS 9-12)	*r*	*p*
FISS Score				
Mild (FISS score ≤3)	6 (18.8%)	1 (3.1%)		
Moderate (FISS score 4-7)	13 (40.6%)	7 (21.9%)	0.394	0.026
Severe (FISS score ≥8)	1 (3.1%)	4 (12.5%)		

Table 3 shows that the moderate FISS score category (scores 4-7) had a higher occurrence of intracranial lesions (34.4%), while the severe category (FISS scores ≥8) showed 15.6% with intracranial lesions, yielding a correlation coefficient (r) of 0.520 (p-value: 0.002 < 0.05). These results indicate that the FISS score is significantly associated with the presence of intracranial lesions, demonstrating a moderate strength of association.

This analysis was further validated by examining head injury categories based on GCS, revealing that the moderate FISS category (scores 4-7) was associated with a GCS rate of 40.6%, with a correlation coefficient of 0.394 (p-value: 0.026 < 0.05). This also suggests that the FISS score is related to the occurrence of head injuries with sufficient strength of association. The relationship between the Facial Injury Severity Scale (FISS) and cervical fractures is presented in Table 4.

TABLE 4: Relationship Between Facial Injury Severity Scale (FISS) and Cervical Fractures.

Cervical fracture

Variables	Yes	No	*r*	*p*
FISS Score				
Mild (FISS score ≤3)	2 (6.3%)	5 (15.6%)		
Moderate (FISS score 4-7)	1 (3.1%)	19 (59.4%)	0.316	0.078
Severe (FISS score ≥8)	3 (9.4%)	2 (6.3%)		

Table 4 shows that the moderate FISS score category (scores 4-7) had a higher occurrence of cervical fractures at 9.4%, with a correlation coefficient (r) of 0.316 (p-value: 0.078). These results indicate that there is no significant relationship between the FISS score and the occurrence of cervical fractures.

DISCUSSION

The study's subject characteristics based on age showed an average of 32.2 years. This differs from [8], who found an average age of 39.3 years for facial trauma patients. Manalu et al. (2018) reported an average age of 26.14 years in subjects with maxillofacial fractures [9]. Subyakto et al. (2021) noted that mandibular fractures occurred in patients aged 20-60 years [10]. Similarly, Jung et al. (2014) found the highest incidence of mandibular fractures in patients aged 20-29 years [11]. The productive age range is mainly involved in outdoor activities, making trauma a concern for this age group, often due to injury from activities or careless driving [12,13]. Likewise, Joshi et al. (2018) found the average age of patients with maxillofacial and head trauma to be 31.14 years [1].

In terms of gender, males accounted for 75% of the subjects, consistent with Lee et al. (2020), where 76.5% of maxillofacial trauma cases involved men, likely due to more frequent outdoor activities [8,14,15]. A different study noted a systematic increase in older women suffering from craniofacial fractures, likely due to their longer life expectancy and the added risk of fractures from osteoporosis [16]. The higher incidence of facial fractures in men is attributed to their natural aggressiveness and cultural roles, with women generally engaging in more indoor activities [10]. Similar findings reported that facial fractures predominantly occurred in men (84.4%), higher than in women (15.6%) [17,18]. The high rate of mandibular fractures in men is believed to be due to their more aggressive behavior, and women's limited engagement in driving and household work [19]. Xavier et al. (2023) also found that the leading cause of maxillofacial trauma was traffic accidents, with men being the most affected (63.94%) [20].

The most common mechanism of injury was motorcycle accidents, with 65.6% of the riders wearing helmets. Bangun & Kesuma (2012) also found that 81.4% of trauma cases were due to motorcycle accidents, with over half of the riders (54.4%) not wearing helmets [21]. Most motor vehicle accidents result in severe fractures because the riders do not wear protective gear or helmets [22]. High-energy traffic accidents are reported as the main cause of general and maxillofacial trauma severity [23,24]. Other studies also show that wearing helmets reduces fatalities by 37% and brain injuries by 67% [25]. However, Lee et al. (2020) found different results, with only 13.7% and 9.1% of severe trauma cases being caused by traffic accidents [8]. There has been a declining trend in maxillofacial trauma in developed countries due to stricter traffic safety regulations, but interpersonal violence has relatively increased as a cause [4,15].

The average FISS score was 5.3, with the most common category being moderate (FISS 4-7), found in 62.5% of cases. Similar findings were reported by Lee et al. (2020), who found an average FISS score of 3.4 in trauma patients, with an average of 5 in severe trauma cases [15]. Shams S, et al. (2020) also reported FISS scores in the moderate category (FISS 4-7) [26]. Bangun & Kesuma (2012) found an average FISS score of 3.37, with the majority of patients scoring 2 (24.7%). Xavier et al. (2023) also reported similar findings, with an average FISS score of 5.20 [20]. FISS is a simple yet useful clinical index for predicting craniofacial trauma severity, economic burden, and hospital stay duration [27].
Head injuries had an average GCS score of 12.5, with mild head injuries being more common (62.5%). This differs from Arli et al. (2019), who found GCS scores of 8-12 in 5% of cases and a GCS score of 15 in 95% of cases [28]. A decrease in consciousness is a reliable indicator of severe intracranial lesions or secondary brain injury [28]. Joshi et al. (2018) reported that moderate head injuries were more common in patients with maxillofacial trauma [1]. Symptoms such as amnesia, nausea, vomiting, loss of consciousness, or a low GCS score are important signs that may indicate a head injury [29].

In Joshi et al.'s (2018) study, 67% of head injury cases were related to maxillofacial trauma, which is consistent with Grant et al. (2012)[30] but differs from Zandi & Seyed Hoseini (2013) [31], likely due to differences in methodology, culture, and population habits. CT scan results showed that no midline shift was more common (59.4%) than midline shift (40.6%). Epidural hematoma was the most frequently observed lesion, followed by SDH and midbrain edema. This contrasts with Joshi et al. (2018), who found that maxillofacial trauma was often accompanied by pneumocephalus (21.79%), subdural hematoma, and intracerebral hemorrhage (11.54%) [1].

Regarding neck injuries, 46.9% of cases had no fractures, while 21.9% had paracervical muscle spasms and 18.8% had cervical listhesis. These injuries can manifest as minor soft tissue lacerations to complex facial fractures, neck stab wounds, and cranial nerve injuries [32]. Intracranial lesions often co-occur with cervical fractures. Blunt trauma fatalities frequently involve injuries to the head and neck. When the injury mechanism involves the head striking an object, as seen in falls, injuries may also occur at the cranial base or cervical vertebrae [33]. Sports such as judo can also cause severe cervical and head fractures [34]. Trauma mechanisms that can result in cervical fractures include traffic accidents, explosions, gunshots, and violence [35].

The FISS score is significantly associated with intracranial lesions, with a moderate strength of correlation. Lee's study found that an ISS score ≥16 indicates more severe intracranial, neck, and facial injuries [14]. Patients with maxillofacial fractures are at high risk for traumatic cranial injuries. Rapid detection of head injuries is crucial for improving patient survival and recovery [29].

Similarly, maxillofacial trauma often occurs alongside other organ system injuries, such as intracranial lesions [36].

Joshi et al. (2018) found that intracranial injuries were associated with mandibular fractures (22.27%), zygomatico-maxillary complex (ZMC) fractures (18.9%), and frontal bone fractures (14.18%), with risk of intracranial injuries increasing in proportion to the number of facial bone fractures [1]. Intracranial lesions were also found in 87% of maxillofacial fracture cases [37]. Another study reported that 67% of intracranial injury cases were related to maxillofacial trauma, with concussions (contusio cerebri) (38%) being the most common intracranial injury associated with maxillofacial trauma [30].

The anatomy and location of the maxillofacial bones in relation to the cranium increase the likelihood of simultaneous cranial injuries. The facial bones are thought to act as a cushion to protect the neurocranium from severe trauma, but they can also transmit forces directly to the neurocranium, causing serious brain injuries. The presence of intracranial lesions in patients with maxillofacial trauma is a life-threatening condition that raises mortality rates [28]. However, Fonseca et al. pointed out that the exact relationship between types of facial fractures and brain injuries has not been definitively established [1]. The correlation between traumatic intracranial lesions and maxillofacial injuries remains controversial. Some argue that facial bones absorb trauma energy to protect the brain, while others believe the trauma energy sufficient to cause maxillofacial injuries is enough to lead to intracranial lesions [38].

The study also found a significant association between FISS scores and head injuries as measured by GCS. Severity assessment is critical for patients with facial fractures and concomitant injuries to guide therapy and prognosis. Scoring systems can be based on anatomical or physiological parameters [6]. Maxillofacial fractures are also associated with a decrease in Glasgow Coma Scale (GCS) scores. The higher the degree of maxillofacial fractures, the greater the likelihood of a reduced GCS score. Traumatic brain injury has been linked to facial fractures in 5.4%–87% of patients [1]. In a study by Rawat et al. (2022), 21.25% of patients had post-trauma head injuries. A low GCS score is a critical finding that may indicate skull trauma, often a cause of death and disability, and requires significant healthcare resources [39].

Contrary to these findings, no significant correlation between FISS scores and GCS was found in this study, with an r-value of 0.276 and a p-value of 0.133. Although no significant relationship between FISS scores and intracranial or cervical injuries was found, the FISS system can still be a valuable tool for assessing maxillofacial injury severity and guiding appropriate therapy [9]. Similarly, Shumynskyi et al. (2022) found no significant differences in FISS scores relative to GCS [17].

Furthermore, Lee's research emphasizes that FISS is a simple yet useful index for evaluating craniofacial trauma severity, predicting injury severity, economic losses, and hospitalization length. Higher FISS scores correlate with more severe injuries, and predictions can be made with high sensitivity and specificity using a cut-off score of 4 [14]. Lin et al. (2021) found that the anatomical category of panfacial fractures and FISS scores significantly correlated with various concomitant injuries and complications. Patients with FISS scores >11 had a higher proportion of needing multidisciplinary therapy. Higher FISS scores were significantly associated with major concomitant injuries such as thoracic injuries, craniospinal injuries, and abdominal injuries, as well as complications like hypoacusis, cerebral hematomas, and anosmia [40]. CT scans are a preferred diagnostic modality for assessing patients with moderate to severe intracranial lesions. Complications that may arise from intracranial lesions include deep vein thrombosis, neurological deficits, cerebrospinal fluid leaks, hydrocephalus, infection, seizures, and cerebral edema [41].

You et al. (2018) found that severe intracranial lesions had higher average FISS scores and reported a significant correlation between FISS scores and GCS. They also noted that lower GCS scores were associated with facial fractures. Patients with intracranial lesions and upper facial injuries are more likely to experience neurological deficits compared to those with midfacial fractures or mandibular fractures, which are more often linked to higher rates of brain injuries, although intracranial and facial lesions can occur simultaneously. Facial bone damage is linked to worsening neurological conditions, severe parenchymal damage, and cerebral edema [42]. This study has demonstrated that FISS scores are correlated with intracranial lesions, and the higher the FISS score, the greater the risk of severe intracranial lesions. This finding suggests that peripheral hospitals without CT scan capabilities could use FISS scores as an initial screening tool for the presence of intracranial lesions.

The study found no significant association between FISS scores and cervical fractures. Rahman & Chandrasala (2014) also noted that among patients with cervical spine injuries, the incidence of simple injuries was much higher in those with facial injuries, but no significant relationship between facial and neck injuries was found [43]. Manalu et al. (2018) reported an average FISS score of 3, with most patients scoring 2 or 4 (25.8%), and no cervical fractures were observed in their study [9]. The incidence of maxillofacial injuries with cervical fractures ranges from 0% to 8% [44]. Mukherjee further stated that cervical trauma associated with maxillofacial injuries is eight times more common than non-mandibular or isolated mandibular fracture patterns. Khsn et al. (2022) also found no significant relationship between FISS scores and intracranial or cervical injuries, but FISS remains a valuable tool for assessing maxillofacial trauma severity and determining appropriate treatment [7].

FISS can also serve as a communication tool with other healthcare personnel to accurately determine the severity and management of maxillofacial trauma patients [3,7]. Various authors have reported correlations between mandibular fractures and neck injuries, with the incidence of concurrent neck injuries with mandibular fractures ranging from 1.07% to 2.6% [45].

The risk of cervical spine injury is higher in relation to combined facial fractures involving more than one facial bone. A large study of over 1.3 million trauma patients from the United States and Puerto Rico found that in cases of two or more facial fractures, the prevalence of cervical spine injuries ranged from 7.0% to 10.8%, while in isolated mandibular, nasal, orbital floor, malar, maxillary, frontal, or parietal fractures, the prevalence of cervical spine injuries ranged from 4.9% to 8.0% [37]. Cervical and head injuries are frequently associated with midfacial fractures and naso-orbitoethmoid fractures, with an incidence of 0.3% to 4% [17]. The study results indicated no significant correlation between FISS scores and cervical fractures; however, patients with high FISS scores should be suspected of having multiple traumas in other parts of the body.

CONCLUSION

There is a correlation between the Facial Injury Severity Scale (FISS) and intracranial lesions, but no correlation between the Facial Injury Severity Scale (FISS) and cervical fractures.

ACKNOWLEDGMENTS

All patients, all authors, and all support in the paper.

DECLARATIONS

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by Udayana University/ Prof. Dr. IGNG Ngoerah General Hospital Bali with number 2148/UN14.2.2.VII.14/LT/2023.

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