ORIGINAL ARTICLE

Epidemiology and inter-observer reliability in identification of sub axial vertebral column fractures type using CT scans

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Abstract

Background: Vertebral Column Fractures (VCF) are a major public health concern with a high mortality rate, negative social and economic effects, and substantial morbidity. Through efficient management and preventative measures based on fundamental epidemiological data, the burden of disease can be reduced. *Aim and Objectives*: The objectives of this research work were to represent the epidemiology of VCF and to assess the interobserver agreement of VCF identification between spine surgeons using AO classification of Computed Tomography (CT) images. *Material and Methods*: A total of 456 cases of C3 to L5 spinal fractures with CT were noted. Comprehensive epidemiological profile of all the patients with VCF was recorded separately and was analyzed by SPSS software. Two spine surgeons classified 375 CT scans with a single level vertebral fracture using AO classification of the spine. Kappa coefficient (k), was used to find interobserver agreement in assessing of VCF. *Results*: Totally 456 cases of VCF with CT scan were collected. Mean ±SD age of men was 39.93 ± 12.07 years and women was 41.85 ± 12.22 years. The number of fractures in the 41-50 years age group was dominant (27.85%, n=127). About 82.20% of the patients had sustained a single fracture. The most common level was the thoracolumbar region (T12- L1), accounting for 41.60%. Type A fractures (68.00%) were the leading type of VCF. In deciding the subtype according to AO among single fracture, current study presented a very good interobserver agreement with (k = 0.884 with p-value = 0.018). *Conclusion*: In summary, current study presented a very good interobserver agreement in identifying the subtypes of VCF according to AO classification and also demonstrated epidemiology of VCF in west coast of south India.

Keywords: AO classification, Thoracolumbar, Vertebral Column Fractures

Introduction

Vertebral Column Fracture (VCF) is a common orthopaedic trauma condition, which often leads to disabilities and sometimes mortality [1-2]. In countries like India and other low, middle income countries burden of trauma related to VCF is growing in the recent past. This is mainly because of increase in road traffic accident and fall from heights. Traumatic injuries to the vertebral column and spinal cord are projected to be the third leading cause of mortality mainly in the developing nations [3]. A higher proportion of spinal column fractures mainly occurs in adult male population in majority of the countries which can be attributed to higher incidence of road traffic accidents and fall from height in this group [4-6]. Despite the fact that VCF account for only a minute percentage of all fractures, their occurrence has consequential socioeconomic impacts. Patients with VCF have

long-term hospitalization requiring immediate treatment and lengthy follow-up amounting to higher financial burden [7-8]. The quality of life of these patients, functional independence and family dynamics are compromised.

Many classification systems have been proposed to investigate fractures [9]. But only a few are reproducible very easily. The most widely used classification system is *Arbeitsgemeinschaftfür Osteosynthesefragen* (AO) group. The AO classification system aims at creating a standard classification system for VCFs and is reproducible [10]. According to AO, fractures of the vertebral column from C3 - L5 region constitute a scale of fractures ranging from the simple undisplaced fractures to complex dislocated fractures. Depending on three main fracture patterns, the fracture morphology is assessed as compression injury (Type A injury) to the vertebral body without posterior ligamentous complex involvement, distraction injury (Type B injury) of posterior ligamentous complex or anterior longitudinal ligament and, translation injuries (type C) involving displacement in any direction which does not include sub classification. The type A and type B injury are further sub classified into A0-A4 and B1- B3 respectively [11-13].

Limited literature is available on epidemiological profile of types and subtypes of VCF as per AO. Accurate fracture identification is very much essential for VCF management and to determine fracture prognosis. The management of VCF includes different aspects like the patient profile, morphology of fracture, accessible infrastructure and available surgical expertise [14-17]. A good degree of agreement in deciding the type of fracture between spine surgeons is of paramount importance for proper management of VCF.

With this background, the present study was conducted to represent the epidemiological profile of VCF and to assess the interobserver agreement of VCF identification between spine surgeons using AO classification with CT images.

Material and Methods

Ethical considerations

The study commenced after getting approval from Institutional Ethics Committee (IEC) (No: 513/ 2020) and permission from medical superintendent of the hospital and in charge of Medical Records Department (MRD) for accessing the records. The present hospital-based time bound retrospective, cross-sectional study was conducted in a tertiary care teaching hospital situated in west coast of South India. The current study involved time bound sampling of all records of 456 patients; with CT images for VCF during the time period from 2017 to 2020. The data were acquired from medical records of VCF patients admitted in the hospital. There was no direct interaction with the patients and no personal information was revealed. This study involved VCF from C3 to L5 region. From these patients, variables such as sex, age, affected region of the fracture, level of the fracture, type of the fracture were collected using the data extraction sheet. This study was based on morphological classification of VCF and no neurological status and patient modifiers were considered. CT scans of 375 patients with single level VCF were included for interobserver reliability. Patients below 18 years, above 60 years and with multi-level fractures were excluded.

Images

Axial, sagittal and coronal CT images of all the participants showing different types of VCF were selected from the Picture Archiving and

Communication System (PACS). Patient data were anonymized by removing identification data of patients from the images.

Classification System

CT images of all patients were classified into Type A, B, C with subtypes by two spine surgeons using AO classification system.

Statistical analysis

The variables were coded and entered into Statistical Package for Social Sciences IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. Categorical data was expressed as proportions and continuous data was expressed as mean, standard deviation and range. Results were presented in tables.

Interobserver agreement in deciding the type of fracture according to AO classification between two spine surgeons of equivalent experience was assessed on CT scan images of 375 patients with single level fractures. Cohen's *kappa* method was used for assessing the interobserver agreement between two surgeons, which takes the ordinal variables. The scores 0.81–1.00 indicate excellent agreement, 0.61–0.80 indicate good, 0.41–0.60 indicate moderate, 0.21–0.40 indicate fair, 0.00–0.20 indicate weak, <0.00 indicate no agreement [10].

Results

Interobserver agreement in deciding the type of fracture according to AO between the spine surgeons demonstrated an excellent interobserver agreement ($k = 0.88$), taking into account subtype of the VCF images (Table 1).

The epidemiological profile of 456 patients with VCF was studied. The male to female ratio was 6:1,with 85.10% of the patients being men (n=388) and 14.90% women (n=68). The mean age ± SD of both male and female patients was 39.93 ± 12.07 years and 41.85 ± 12.22 years respectively. The majority of the fracture victims were in the age group 41 to 50 years (27.85%, n= 127), followed by 18 to 30 years (26.10%, n= 127) (Table 2).

The type and region wise distribution of VCF is shown in Table 3. Among 456 fractured patients, 82.20% (n=375) patients had a single fracture in the entire vertebral column and 17.80% (n=81) patients had multiple fractures in different regions of the vertebral column. When the regionwise distribution of the single fracture was analyzed, it was found that most of the fractures were in the thoracolumbar region (n=156, 34.2%) followed by thoracic (n=81, 17.8%), cervical (n=75, 16.4%), and lumbar (n=63, 13.8%) regions. Among the single level fracture patients, Type A fracture was the most common type, which accounted for 68.00 % (n=255). In the type A fractures, the subtype A1 was most common and accounted for 35.69% (n=91) of Type A. Among Type B fractures (n=66, 17.60%) the subtype B1 was most common and accounted for 68.18% (n=45) of Type B. Type C fracture accounted for 14.40% of all the single fracture cases (n=54). Majority of the fractures in lumbar region were Type A4 while they were Type A1 in cervical, thoracic and thoracolumbar region. Out of 456 fracture victims, 81 patients had multiple fractures. In multiple fractures, the majority had Type A fractures, which accounted for 87.43% (n=167) in which A0 subtype fracture was more common. A detailed description of AO classification of the multiple fractures is depicted in Table 4.

Table 1: Interobserver agreement of vertebral column fracture classification between two spine surgeons

Classification	*Kappa* value (Spine Surgeon vs Spine Surgeon)	*p*
AO classification	0.884	0.018

Table 2: Age and gender distribution of study participants (n= 456)

Baseline characteristics	Number	Percentage (%)
Gender		
Male	388	85.10
Female	068	14.90
Mean age in years (± SD)		
Male	39.93 ± 12.07	
Female	41.85 ± 12.22	
Age group in years		
18-30	119	26.10
31-40	104	22.81
41-50	127	27.85
51-60	106	23.24

Table 3: Type and region wise distribution of vertebral column fracture (n=456)

Fracture	Number	Percentage (%)
Single	375	82.20
Multiple	081	17.80
Single VCF region (n=375)		
Cervical (C3 – C7)	075	20.00
Thoracic (T1 – T11)	081	21.60
Thoracolumbar (T12 – L1)	156	41.60
Lumbar (L2 – L5)	063	16.80
Single VCF type (AO) (n=375)		
Type A	**255**	**68.00**
A0	027	10.59
A1	091	35.69
A2	028	10.98
A3	051	20.00
A4	058	22.74
Type B	**066**	**17.60**
B1	45	68.18
B2	19	28.79
B3	02	03.03
Type C	**054**	**14.40**

Table 4: AO classification of multiple fractures (n=081, 191 Fractures)

Fracture type		
Type A	**167**	**87.43**
A0	063	37.73
A1	058	34.73
A2	012	07.19
A3	021	12.57
A4	013	07.78
Type B	**011**	**05.75**
B1	010	90.91
B2	001	09.09
B3	0	0
Type C	**013**	**06.82**

Discussion

In the present study the epidemiological profile of VCF was studied and the interobserver agreement of VCF identification between two spine surgeons was done with CT images using AO classification for a period of 3 years from July 2017 to June 2020. To the best of our knowledge, few studies have assessed the inter-observer agreement between the two spine surgeons in classifying VCF using AO classification systems. The present study exhibits an excellent inter-observer agreement for VCF classification (*k*-value 0.884, *p*-value 0.018). This is similar to the study reported by Karamian *et al*. [18] which also exhibited an excellent inter-observer reliability for sub axial fracture morphology using AO classification system (*k*-value 0.87) and excellent reliability for fracture subtype (*k*-value 0.80). However, a study done by Wood *et al*. [19] obtained the agreement of *k*-value 0.53 by considering the nine subtypes of fractures of AO, indicating moderate interobserver agreement. Another study done by Urrutia *et al*. [20] for AO spine sacral fracture classification system was found to have substantial interobserver agreement at the fracture type level (*k*-value 0.68) and moderate agreement at the subtype level (*k*-value 0.52). The higher degree of agreement in the present study could be because, the classification was done by two spine surgeons. This study also shows good reproducibility of the AO classification system.

VCF are commonly caused by vehicle accident, fall from height and sports activities. An exhaustive comprehension of epidemiology of VCF will assist the management, prevention and subsequently help decrease the fracture incidence and increase the social health and economy. In the current study VCF predominantly occurred in the male population than the female which was in line with the study done by Lomaz *et al.* [4]. Here fractures were more in the age group of 41-50 years, but it was more in the 20-39 years' age group in the study by Lomaz *et al.* [4]. The people in this age group are economically productive and hence VCF may have a serious influence on the economy [8]. When the gender distribution of VCF was analyzed, more than four- fifth were males, which is similar to the study by Lomaz *et al.* [4].

In this study, the occurrence of a single fracture in patients is common when compared to multiple fractures. Among single fractures, the most

common vulnerable region of fracture was thoracolumbar T12-L1 (41.60%) which was similar to a study done in China where the maximum fractures were in T12 and L1 vertebra of the vertebral column [21]. It may be because of the transition from the fixed thoracic region to the movable lumber region (T12- L1). Since Magnetic Resonance Imaging (MRI) was not being practiced in our hospital during the data collection period, ligamentous injury for subtyping Type B was based solely on the increased inter-spinous distance. Other imaging modalities like radiographs and MRI were not considered in this single centered study. This could be considered as a limitation of this study.

Conclusion

According to this study, men experience VCF at a higher rate than women. When compared to multiple level fractures, single level fractures were more prevalent. The occurrence of Type A fractures was more in both single and multiple level fractures. Additionally, a sizable segment of the population who were young and middle-aged suffered from VCF. The current study demonstrated excellent interobserver agreement in classifying the subtype of VCF according to AO classification.

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