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Classification of Radiological Changes in Burst Fractures

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Abstract

AIM: Burst fractures can occur with different radiological images after high energy. We aimed to simplify radiological staging of burst fractures.

METHODS: Eighty patients whom exposed spinal trauma and had burst fracture were evaluated concerning age, sex, fracture segment, neurological deficit, secondary organ injury and radiological changes that occurred.

RESULTS: We performed a new classification in burst fractures at radiological images.

CONCLUSIONS: According to this classification system, secondary organ injury and neurological deficit can be an indicator of energy exposure. If energy is high, the clinical status will be worse. Thus, we can get an idea about the likelihood of neurological deficit and secondary organ injuries. This classification has simplified the radiological staging of burst fractures and is a classification that gives a very accurate idea about the neurological condition.

Introduction

Sometimes neurological deficit is not observed in burst fractures while there may also be an evident neurological deficit and secondary organ injury and even death [1][2]. Several classifications have been developed for spine injuries. AO (Arbeitsgemeinschaft für Osteosynthese Fragen) divided thoracolumbar injuries into three groups from morphological and pathological aspects (A: Compression; B: Distraction; C: Axial Strain and rotational deformity). Each group was divided into subgroups according to the morphological injury and grade of instability. However, there is no information about the neurological deficit in this classification. Burst fractures take place in group A in AO classification [3]. Fractures passing through the pedicles were added to the classification, but interpedicular separation and bone fragments with the excess pediculolaminar junction (corner) (PLC) in the spinal canal were not included in the study of Magerl et al. [3]. Although several classifications were proposed, Thoracolumbar Injury Classification and Severity Score (TLICS) were introduced in 2005 [4].

This classification is based on the morphology of the injury, the status of the posterior longtidunal ligament (PLL) and neurologic examination [4]. The energy that is generated due to axial and flexional loading in burst fractures is transmitted to the corpus and forces the corpus, which leads to some changes.

Burst fractures are classified according to the pathomorphological changes based on their radiological appearance.

The aim of this study is to create a simpler radiological classification in the burst fractures and to present their relation to secondary injuries.

Materials and Methods

After the approval was obtained from the ethics board of our hospital, the tomographic images and medical charts of 80 patients who were diagnosed with burst fractures were examined.

The patients were evaluated concerning age, sex, fracture segment, neurological deficit, secondary organ injury and radiological changes that occurred.

The classification was made according to the changes on the tomographic images as an indicator of the energy that was exposed. Neurological status was classified according to the ASIA scoring system [5]. Secondary organ injury was assessed.

Secondary organ injury was evaluated in the light of the abdominal CT reports and abdominal USG reports. Rib fractures, lung contusions, haemothorax, pneumothorax, liver and spleen injuries were determined.

Radiological changes were assessed and classified according to the axial sections on CT.

Group 1: Fractures extend forward or laterally from the corpus. In general, a piece of the bone fragment may move to the spinal canal. The width of this spur usually depends on the distance between the radix of the pedicles (Because the pedicles are an obstacle before the bone fragment broken and detached from the corpus).

Different bone fragments can be protruded if the energy that is exposed also contains rotational motion in addition to the flexion and axial loading. PLL and spinal cord are the breaking points where some bone fragments stop moving and also leap or move backwards due to the effect of the moment’s dynamism. Consequently, some bone fragments can be seen in front of the corpus or/and near the corpus.

Usually, one piece of bone fragment moves on to the spinal canal. The protruded bone fragment may get closer to the PLC. Interpedicular distance is constant.

Group 2: There may be bone fragments in front of the corpus or/and near the corpus. There are some bone fragments that come closer to the PLC, but they don’t lead to the separation and splitting of the posterior components and don’t move into the spinal canal. Interpedicular distance is constant.

Group 3: There can be fractures in front of the corpus and at the sides of the corpus. There are bone fragments in the spinal canal. There are fractures on the lamina and spinous process. Interpedicular distance is extended.

PLC is used as a reference point while classifying the burst fractures. If the bone fragments can't reach the PLC, it should be classified as Group 1. The fracture should be classified as Group 2 if it reaches the PLC and splits into pieces by crushing the corner. The fracture should be classified as Group 3 if it passes through the PLC and breaks the posterior components. The staging of burst fractures is shown in (Figure 1).

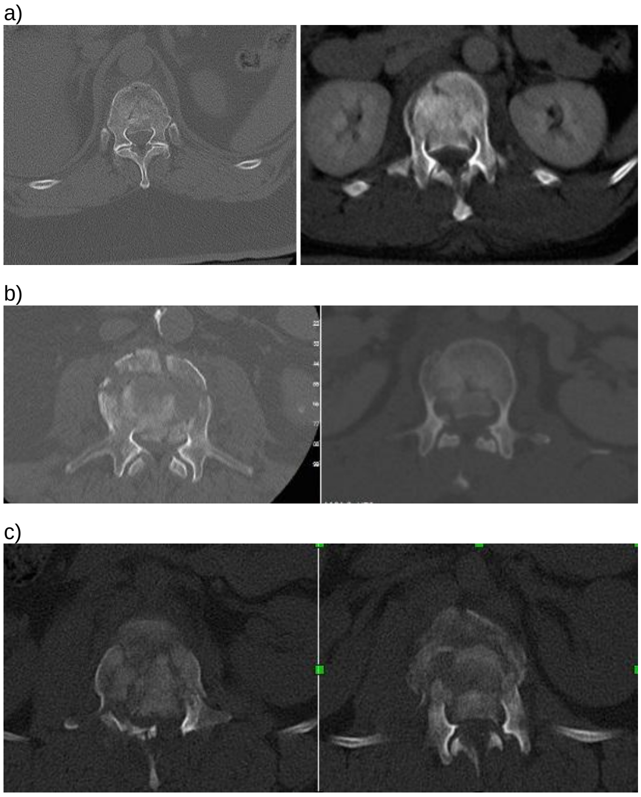

Figure 1: a) Grade 1) The bone fragments can't reach the PLC; b) Grade 2) The fracture reaches the PLC and splits into pieces by crushing the corner; c) Grade 3) The fracture passes through the PLC and breaks the posterior components

Results

There were 27 female and 53 male patients in the group diagnosed with burst fractures. The mean age of the patients was 49.3. The mean age of the male patients was 49.4 (16 - 84) while it was 49.2 (20 - 72) for the female patients.

Five of the cases were observed in the thoracic region (6.2%), 17 at T12 (21%), 2 at both T12 and L1 (2.5%), 35 at L1 (43.7%) and 21 at lumbar region (26.2%) (Table 1).

Table 1: Distribution of cases according to the region

Region	Number of Cases
Thoracic	5 (6.2%)
T12	17 (21%)
T12/L1	2 (2.5%)
L1	35 (43.7%)
Lumbar Region	21 (36.2%)

It was observed that burst fractures were grade 1 in 38% of the patients (22 male, 16 female), grade 2 in 24% (18 male, 6 female) and grade 3 in 18% (13 male, 5 female) of the patients (Table 2).

Table 2: Table shows the patients according to grades and also with neurological deficit rates and secondary organ injury rates

Grade	Female	Male	Total	Cases with neurological deficit	Percentage of neurological deficit	Cases with secondary organ injury	Percentage of secondary organ injury
1	16	22	38 (47.5%)	2	5.2%	2	5.2%
2	6	18	24 (30%)	13	54.1%	3	12.5%
3	5	13	18 (22.5%)	13	72.2%	8	44.4%
Total	27	53	80	28		13	

Neurological deficit was observed in 2 (2 / 38) of Grade 1 patients, in 13 (13/24) of Grade 2 patients, and in 13 (13/18) of Grade 3 patients (Table 2).

Two of Grade 1 patients were observed to have ASIA D neurological status; 12 of Grade 2 patients had ASIA D neurological status while 1 had ASIA C neurological status; 6 of Grade 3 patients had ASIA D neurological status, 4 had ASIA C neurological status, and 3 had ASIA A neurological status.

As regards secondary organ injury; rib fractures were observed in 2 of Grade 1 patients; 2 of Grade 2 patients had rib fractures while 1 had lung contusion. Rib fractures, lung, liver or spleen injuries were observed in 8 of Grade 3 patients (Table 2).

And also in our staging system, the proportion of dural injury was high in stage 2 and stage 3 patients. It was observed that if the grade of the fracture increased, CSF leak also increased.

Discussion

Tomographic changes in burst fractures may be observed in different ways. Burst fractures may occur in front and at the sides of the corpus, in the middle column; while depending on PLL injury, the bone fragment may flow to the spinal canal. A whole piece of bone may continue to progress along the canal by hitting the PLC. It may come back after hitting and can be divided into pieces there. Therefore, pediculolaminar corner is extremely important, because PLC may prevent the overflowing of the bone fragment. PLC can't cope with the high energy exposed by the trauma and does not resist anymore.[6] And thus bone fragments may lead to breakage and separation at pedicles. PLC will be broken, and the bone parts will not be able to bounce back there. So the bone fragments will continue to advance in the canal as a result. So the neurological condition will be worse because of the compromise in the spinal canal.And also in our data, the neurological deficit rate increases as the grade increases. The rate of neurological deficit in grade 3 patients is as high as 72%. At this point, we think that the PLC's resistance is an important point for a compromise that may occur in the spinal canal and for the neurological situation to be encountered.

Of course, it may not always be right to say that the severity of this neurological deficit correlates with the severity of trauma and radiological images. For example, the Grade 3 radiological appearance of the patients does not always necessarily mean that the deficit will be severe. There are patients in grade 3 group with ASIA D score while the patient is among the grade 2 patients with ASIA C score. But as it is seen in our study; in grade 3 patients, the neurological deficit rate is more than the others.

If the bone fragments cause breakage of PLC and extension of interpedicular distance, it may move further and may lead to fractures at laminas and separation of laminas [7].

It has been shown in many studies that separation of pedicles worsens the clinical picture in burst fractures [8][9][10][11]. The extension of the interpedicular distance is concordant with worse clinical status and worse radiological images.

Petersilge et al. reported that 9 of 12 patients whose interpedicular distance extended had at least 50% spinal canal compromise, and this group was found to have the worst clinical picture in their study [12].

The size of the bone fragment and the degree of energy that is exposed are highly associated.

These changes as an indicator of energy that is exposed can also give a hint for secondary organ injury and neurological deficit. Therefore, the size of the bone fragment in the spinal canal can indicate organ injury and neurological deficit that may occur [13][14][15][16][17]. The bone fragments in the canal were proportional to and neurological deficit secondary organ injury in our study.

In our study, rib fractures as secondary organ injury were observed in Grade 1 patients; lung contusions were also observed in one of Grade 2 patients. Severe secondary organ injuries were observed in Grade 3 patients. In a study on the condition of PLL and the size of bone fragment protruding to the spinal canal, Hu et al. concluded that the size of the bone fragment was associated with neurological deficit [18] In this study, the size of the bone fragments was statistically evaluated according to the axial width and height on the sagittal plane in CT. The results and their relations were calculated and observed.

In the study of Dai et al., the anterior and posterior side of the bone fragment was shown to be the most relevant parameter in ASIA scoring system, and it was also demonstrated that repositioning of the bone fragments provided a significant improvement only in that parameter [19]. Therefore, the fragments in the canal should be repositioned and attempts should be made to decrease the grade of the burst fracture.

Some studies have reported that there is not a direct relationship between the proportion of bone in the spinal canal and neurological deficit [20]. The bone fragment may move through the spinal canal due to the dynamism during the fracture and return to the corpus. The bone fragment may move back to the corpus after hitting PLL, spinal cord and PLC depending on the size of the energy.

Cerebrospinal fluid (CSF) leak in burst fractures is related to lamina fractures in which the interpedicular distance is extended, and the spinal canal is narrowed [21]. Moreover, in our staging system, the proportion of dural injury was high in stage 2 and stage 3 patients. Although we did not find significant results, the relation between the number of bone fragments in the spinal canal and the dural injury was observed to increase. It was observed that if the grade of the fracture increased, CSF leak also increased.

It is necessary to develop a new simple staging system to assess both radiological and clinical status at the same time for burst fractures that are the worst and most frequently encountered spinal traumas. This classification system will help clinical assessment of the situation. The possibility of secondary organ injuries will increase, and neurological status will worsen if the grade of trauma increases according to ASIA scoring system.

We think that the most important parameter is the extension of the interpedicular distance and the relation between the bone fragment in the canal and PLC.

In conclusion, in burst fractures, if the energy that is exposed increases, the fragment moves on and leads to neural injury and breaks the posterior component of the spine. We aimed both to simplify the classification in the burst fracture by our classification method and to give an idea about the neurological condition.

According to this classification system, secondary organ injury and neurological deficit can be an indicator of energy exposure. If energy is high, the clinical status will be worse. Thus, we can get an idea about and secondary organ injuries.

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