What is the importance of the spinal canal encroachment in the management of thoracolumbar burst fracture without neurological deficit? A review

Qual a importância da compressão do canal vertebral na decisão de conduta da fratura em explosão toracolombar sem déficit neurológico? Revisão

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ABSTRACT

Introduction: The relevant features in the treatment of thoracolumbar fractures vary in the literature. The classical surgical indications of burst fractures are loss of vertebral body height, kyphosis, neurological deficit and canal encroachment. Recent papers have attributed less importance to canal impingement as a surgical indicator in intact patients, irrespectively of the degree of encroachment. The several thoracolumbar fracture classifications have prompted efforts to guide the surgical indications. We analyzed the relevance attributed to the canal encroachment by thoracolumbar fracture classifications in the management of burst fractures without neurological deficit.

Objective: To evaluate the relevance attributed by the thoracolumbar fractures classifications to the canal encroachment in the management of burst fractures without posterior ligamentous complex disruptions or neurological deficits.

Methods: A literature search was performed by tracking the related articles of thoracolumbar fractures classifications from Vaccaro’s to Holdsworth’s study. We analyzed the role of canal impingement in the management of burst fractures without posterior ligament complex injury or neurological deficits in each classification.

Results: Seven classifications were included. Holdsworth considered the burst fractures as stable, irrespectively of the amount of canal impingement or neurological deficit. Denis considered that the burst fracture carried a neurological instability criterion, therefore, in these cases he suggested surgical treatment because of the risk of new neurological damage. McAfee postulated that there is no reliable predictor to correlate the severity of canal encroachment with the risk of neurological damage. Ferguson and Allen discussed the possibility of anterior decompression, stabilization and anterior fusion of the spine in certain cases of burst fractures. The classifications of McCormack, Karaikovic and Gaines, Magerl and Vaccaro did not include canal encroachment in their considerations.

Conclusion: The thoracolumbar fractures classifications did not directly consider the severity of canal encroachment in the treatment decision making of burst fractures without neurological damage. It is not possible to predict which patients will deteriorate if not operated. It remains unclear what is the risk of neurological deterioration in a SCE greater than 50%.

Keywords: Spinal trauma, burst fractures, canal encroachment, neurological status, decision making, classifications.

SINOPSE

Introdução: As características relevantes no tratamento das fraturas toracolombares variam na literatura. As indicações cirúrgicas clássicas de fraturas tipo explosão são perda de altura do corpo vertebral, cifose, déficit neurológico e compressão do canal. Estudos recentes têm atribuído menos importância à compressão do canal como um indicador cirúrgico em pacientes neurologicamente intactos. As várias classificações de fraturas toracolombares tentam orientar a indicação cirúrgica. Analisamos a relevância atribuída à compressão do canal pelas classificações de fraturas toracolombares na conduta das fraturas explosão sem déficit neurológico. Método: Avaliar a relevância atribuída pelas classificações de fraturas toracolombares à compressão do canal na conduta da fratura explosão, sem lesão do complexo ligamentar posterior ou déficit neurológico. Resultados: Foi realizada uma revisão da literatura por “tracking” dos artigos relacionados às classificações de fraturas toracolombares a partir do artigo de Vaccaro até o de Holdsworth. Analisamos o papel da compressão do canal na conduta da fratura explosão sem lesão ligamentar posterior ou déficit neurológico em cada classificação. Conclusão: As fraturas explosão como estáveis, independentemente do grau de compressão do canal ou déficit neurológico. Denis...
considered that a fracture explosion determines instability neurological, portanto, nest cases he suggested the treatment cirúrgico, devido ao risco de dano neurological novo. McAfee postulated that this does not exist, predictor confiable to correlate the risk of severe compression of the canal with the risk of neurological damage. Fergusson and Allen discutiram a possibilidade of descompressão anterior, estabilização and fusuão anterior da columna vertebral em determinados casos of fractures explosão. As classifications de McCormack, Karaikovic and Gains, Magorl and Vaccaro não incluía a compression do canal en suas considerações. Conclusão: As classificações de fraturas toracolombares não consideram, diretamente, a gravidade de compressão do canal na decisão de conduta da fratura tipo explosão, sem déficit neurological. Não é possível prever quais pacientes evoluíram com dano neurological se não forem operados. Ainda não está claro qual o risco de deterioração neurological em uma compression do canal superior a 50%.

Palavras-chave: Trauma raquimedular, fraturas explosão, compressão do canal, estado neurological, decisão de conduta, classificações.

INTRODUCTION

The relevant features in the treatment of thoracolumbar spine fractures (TLF) vary in the literature and result in different management protocols. The classical surgical indications of TLF are loss of vertebral body height, kyphosis (which denotes posterior column distraction), neurological deficit and spinal canal encroachment (SCE). The severity of SCE has been considered by many authors as an independent surgical indication criterion. The canal impingement by bone fragment can potentially produce a neurological deficit, either in an early or late phase.

Nevertheless, recent papers have attributed less importance to SCE as a surgical indicator in intact patients, irrespectively of the degree of encroachment.

What might be the role of spinal canal encroachment in the management of TLF without posterior ligamentous complex (PLC) injury or neurological deficits?

The several TLF classifications have prompted during decades efforts to guide the surgical indications. We analyzed the relevance attributed to the SCE by TLF classifications in the treatment decision in stable burst fractures without neurological deficit.

OBJECTIVE

To evaluate the relevance attributed by the modern TLF classifications to the SCE in the management of burst fractures without PLC disruptions or neurological deficits.

METHODS

A literature search was performed by tracking the related articles of thoracolumbar fractures classifications, published in English language, from Vaccaro’s study, the latest widespread TLF classification, to Holdsworth’s study, which is considered the first classification of the TLF treatment modern era. Only the classical TLF classifications were included due to the fact that they have been extensively evaluated and validated.

We analyzed the role of SCE in the treatment decision in burst fractures caused by pure axial load mechanism (vertical compression), without PLC injury or neurological deficits, by discussing the treatment orientations of each classification regarding to this kind of injury.

RESULTS

Seven TLF classifications were included in this review.

The results regarding the management of burst fractures in neurologically intact patients and the influence of SCE in the management decision in these classifications are demonstrated in Table 1. None of the classifications included the severity of canal encroachment in decision management in TLF.

Table 1 – Recommended management and importance of the SCE in TLF classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Recommended management</th>
<th>Importance of the canal encroachment</th>
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<tbody>
<tr>
<td>1 - Holdsworth</td>
<td>Immobilization in plaster bed and turning case for 8 to 12 weeks</td>
<td>NC</td>
</tr>
<tr>
<td>2 - Denis</td>
<td>Surgery* **</td>
<td>**</td>
</tr>
<tr>
<td>3 - McAfee</td>
<td>Body cast or orthosis</td>
<td>NC</td>
</tr>
<tr>
<td>4 - Ferguson &amp; Allen ***</td>
<td>Conservative treatment</td>
<td>Anterior decompression, stabilization, in certain cases</td>
</tr>
<tr>
<td>5 - Load Sharing</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>6 - Magorl</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>7 - Vaccaro</td>
<td>Conservative treatment</td>
<td>NC</td>
</tr>
</tbody>
</table>

* Discuss with the patient the risk of neurological deterioration
** Defines middle column injuries as neurological instabilities
*** This lesion did not lead to further deformity or increasing neurological injury but the authors discuss the possibility of anterior decompression, stabilization and anterior fusion in certain cases
NC: not considered
Holdsworth 8 was the first one to describe Burst fractures using the two-column concept. Burst fractures were considered stable lesions, irrespectively of the amount of SCE or neurological deficit.

Denis, McAffee and Ferguson & Allen used in their classifications the three-column concept introduced by Denis.

Denis 4 suggested a specific classification for instability associating mechanistic and neurologic features in spine trauma. He considered that the burst fracture carries a neurological instability criterion, therefore, in these cases he suggested surgical treatment due to the risk of neurological damage in previously intact patients.

In contrast to Denis, McAffee et al 12 and Ferguson & Allen 6 used in their classifications the three-column concept introduced by Denis 4.

Ferguson and Allen 6 reported that burst fractures (vertical compression lesions) did not lead to further deformity or increasing neurologic injury. However, the authors discussed the possibility of anterior decompression, stabilization and anterior fusion of the spine in certain cases.

The classifications of McCormack et al 13, Magerl et al 11 and Vaccaro et al 21 did not include SCE in their considerations.

**DISCUSSION**

There are characteristics of the burst TLF that are considered classical indicators for surgery, such as loss of vertebral body height, distraction or PLC lesion, neurological deficit and canal encroachment 3,7,10,16,24. Lesions of PLC and neurological deficits are well established surgical indications 21.

Severe vertebral body compressions (greater than 50%) indirectly result in PLC distraction and are considered for surgery. Despite some authors consider the severity of spine canal encroachment in vertical compression fractures as a surgical determinant, others do not think so 3,25.

Most of the classifications are based on the two-column concept 9. This concept is supported by the probability of late deformity and/or kyphosis (mechanistic model) 21. They do not consider the risk of neurological damage in fractures defined as stable. None of these classifications estimate the risk of late spinal cord injury in traumatic canal encroachment, except Denis 4. This author discusses the surgical treatment for every middle column lesion. In fact, most papers report low risk of new deficits in neurologically intact patients in the absence of PLC injury, in spite of their residual vertebral canal.

The fundamental question is if severe canal encroachment associated to mechanical incompetence of vertebral body could result in further compression and neurological damage (Figure 1).

**Figura. 1.** Artistic illustration of a stable burst fracture with severe canal encroachment.

Holdsworth 8 used the two-column concept: he described the burst fracture as an injury caused by vertical compression mechanism that is stable and in which spontaneous fusion is expected. He did not discuss the risk for neurological deterioration.

Denis 4, in 1983, introduced a grade system that defined burst fractures as the second degree of instability (neurological instability), i.e., injuries with risk of neurological deterioration. He reported late neurological deficit in 20.3% of conservative burst fractures. Denis and his three-column concept had great influence on the establishment of classical surgical indicators at that time 3,7,10.

Ferguson and Allen 6 reported two types of canal encroachment in burst injuries with ligamentar complex preservation, concentric or plateau compression, although these did not result in increased neurological injury or spine deformity.

However, McAffee et al 12 state that there is not a completely reliable predictor to evaluate the severity of canal encroachment and the risk of neurological deficit.

According to Magerl et al 11, in type A fractures (compression fractures) the stability in compression may be intact, impaired, or lost, depending on the extent of destruction of the vertebral...
The stability in flexion may be intact, or it may be reduced due to the impaired compressive resistance of the vertebral body. However, stability in flexion is never completely lost since, by definition, PLC must be intact in type A injuries. Really stable injuries only occur in type A. Burst fractures are defined as type A3. Complete burst fractures (A3.3) are unstable in flexion-compression and may result in additional loss of vertebral body height. The spinal canal is often extremely narrowed by posterior wall fragments. They did not consider the amount of SCE in surgical decision.

Although late neurological damage has not been valued by most of classifications, many authors describe it after conservative treatment of burst fractures. Mumford et al reported 1 case of neurological deficit out of 41 patients with mean canal encroachment of only 37%. They identified three factors involved in mechanical failures after posterior fixation of vertebral fractures: amount of damaged vertebral body, the spread of the segments in the fracture site and the amount of corrected traumatic kyphosis. However, they did not consider the amount of SCE in surgical decision.

The natural history of thoracolumbar burst fractures in 54 patients treated conservatively showed good results. Fractures with anterior column compression and spinal canal narrowing exceeding 50% were in a large extent complicated by intractable low back pain, neurological damage and signs of instability.

Many authors consider canal encroachment greater than 50% as surgical criterion. The analysis of the prospective studies comparing surgical versus conservative treatment can clarify the role of SCE in the TLF decision. There are three prospective studies comparing conservative and surgical managements.

In 2001, Shen et al compared the results of nonoperative treatment versus short-segment posterior fixation using pedicle screws and concluded that the operative treatment provides partial kyphosis correction and earlier pain relief, but the functional outcome at 2 years is similar. Early activity to the point of pain tolerance can be safely allowed. The mean canal compression was of 34% in the conservative group.

In 2003, Wood et al. reported that operative treatment of stable thoracolumbar burst fracture in neurologically intact patients provided no major long-term advantage compared to a non-operative treatment. However, in the group treated nonoperatively, the average degree of anteroposterior canal compromise on presentation was only 34% (5% to 75%). The author did not present the results for each degree of canal compression, therefore, it is difficult to conclude the risk of canal impinging in burst fractures treated nonoperatively.

In 2006, Siebenga et al. published a prospective study comparing conservative and surgical treatment of patients with TLF (T10-L4). In the conservative treatment group, one out of 15 patients evolved with conus syndrome and urinary dysfunction. Recently, isolated sphincter involvement has been valued as neurological deficit in TLF.

The role of spinal canal compression cannot be neglected, mainly associated with a mechanical incompetent fragmented vertebral body. Vertebral body occupying the canal places neural structures at risk. Despite some descriptions indicating that late neurological deterioration gradually occurs and can be reverted after surgical treatment, there are cases without recovery once neural deficit is installed.

Not all burst fractures should be operated on. Probably most of them should be submitted to a conservative treatment and those patients with high risk of neurological deterioration should be recommended for surgery to prevent new damage.

There are serious reasons to stimulate the search for the best and worst cases for conservative treatment, mainly delineating trials to observe the mechanical and neurological behavior of spinal canal encroachment greater than 50% in patients submitted to conservative treatment. In these ones, the results would have the potential for avoiding unnecessary neurological deficits.

**Conclusions**

TLF classifications did not directly consider the severity of SCE in the treatment decision making of burst fractures without neurological damage. Most of the burst fractures treated conservatively presented good outcomes, although the majority had canal encroachment lower than 50%. Many studies do not describe the characteristics of the fractures that resulted in late neurological deficits. Thus it is not possible to predict which patients will deteriorate if not operated on; it remains unclear what is the risk of neurological deterioration in a SCE greater than 50%.

Prospective studies of burst fractures with severe SCE and with no neurological damage can clarify the real role of SCE in this type of fracture.
REFERENCES


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