ORIGINAL ARTICLE
SPINAL TRAUMA AND FRACTURES

PERCUTANEOUS INSTRUMENTATION WITHOUT ARTHRODESIS FOR THORACOLUMBAR BURST FRACTURES (A3/A4, B): A RETROSPECTIVE STUDY

INSTRUMENTAÇÃO PERCUTÂNEA SEM ARTRODESE EM FRATURAS TORACOLOMBARES DO TIPO EXPLOSÃO (A3/A4, B): ESTUDO RETROSPECTIVO

INSTRUMENTACIÓN PERCUTÁNEA SIN ARTRODESIS EN FRACTURAS TORACOLUMBARES DEL TIPO EXPLOSIÓN (A3/A4, B): ESTUDIO RETROSPECTIVO

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ABSTRACT

Objective: There is still no consensus as to the treatment options for thoracolumbar burst fractures, although these fractures are widely described in the literature. The aim of this study was to evaluate the clinical and radiological outcomes of percutaneous instrumentation without arthrodesis as a method of fixation of these lesions. Methods: This retrospective, cross-sectional study evaluated 16 patients by measuring regional kyphosis using the Cobb method and the scores for quality of life and return to work (Oswestry Disability Index, VAS, SF-36 and Denis). Results: Six months after surgical treatment, 62.5% of all patients showed minimal disability according to the Oswestry Disability Index, maintenance of regional kyphosis correction and no synthesis failure. Conclusions: The clinical and radiological outcomes of the study suggest that minimally invasive fixation is indicated for the treatment of thoracolumbar burst fractures. ***Level of evidence IV; Observational study: retrospective cohort.***

Keywords: Spine; Spinal Fractures; Spinal Injuries; Fracture Fixation.

RESUMO

Objetivo: As fraturas toracolombares do tipo explosão, embora amplamente descritas na literatura, permanecem sem consenso quanto às modalidades de tratamento. O objetivo do presente estudo foi avaliar os resultados clínicos e radiológicos da instrumentação percutânea sem artrodese como método de fixação dessas lesões. Métodos: O estudo transversal retrospectivo avaliou 16 pacientes por meio da aferição da cifose regional pelo método de Cobb e dos escores de qualidade de vida e retorno ao trabalho (Índice de Incapacidade de Oswestry, EVA, SF-36 e Denis). Resultados: Seis meses depois do tratamento cirúrgico, verificou-se 62,5% dos pacientes com incapacidade mínima segundo o Índice de Incapacidade Oswestry, manutenção da correção da cifose regional e ausência de falha da síntese. Conclusões: Os desfechos clínicos e radiológicos do estudo sugerem que a fixação minimamente invasiva é relevante para o tratamento das fraturas toracolombares do tipo explosão. ***Nível de evidência IV; Estudo observacional: coorte retrospectiva.***

Descritores: *Coluna Vertebral; Fraturas da Coluna Vertebral; Traumatismos da Coluna Vertebral; Fixação de Fratura.*

RESUMEN

*Objetivo: Las fracturas toracolumbares del tipo explosión, aunque están ampliamente descritas en la literatura, siguen sin tener consenso en cuanto a las modalidades de tratamiento.. El obetivo del presente estudio fue evaluar los resultados clínicos y radiológicos de la instrumentación percutánea sin artrodesis como método de fijación de estas lesiones. Métodos: El estudio transversal retrospectivo evaluó a 16 pacientes, midiendo la cifosis regional mediante el método de Cobb y las puntuaciones de calidad de vida y reincorporación al trabajo (*Índice de Discapacidad de *Oswestry, VAS, SF-36 y Denis). Resultados: Seis meses después del tratamiento quirúrgico, el 62,5% de los pacientes presentaron discapacidad mínima según el* Índice de Discapacidad de *Oswestry, mantenimiento de corrección de cifosis regional y ausencia de fallo de síntesis. Conclusiones: Los resultados clínicos y radiológicos del estudio sugieren que la fijación mínimamente invasiva es pertinente para el tratamiento de fracturas toracolumbares del tipo explosión.* ***Nivel de evidencia IV; Estudio observacional: estudio de cohorte retrospectivo.***

Descriptores: *Columna Vertebral; Fracturas de la Columna Vertebral; Traumatismos Vertebrales; Fijación de Fractura.*

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http://dx.doi.org/10.1590/S1808-185120212004250462

Received on 03/30/2021 accepted on 09/09/2021
Reviewed by: Dr. Mauro dos Santos Volpi/Dr. Luiz Gustavo Dal Oglio da Rocha

INTRODUCTION

Thoracolumbar burst fractures account for approximately 45% of all major injuries in this region, with at least half of patients maintaining intact neurological function. Despite the high incidence and extensive description of this topic in the literature, the best treatment strategies remain controversial.[1,2]

Short-segment pedicle screw instrumentation for the treatment of thoracolumbar fractures gained popularity in the 1980s. However, a high rate of early failure soon became evident, especially in cases with anterior spinal involvement.[3] In 1994, McCormack et al. proposed a classification that introduced the concept of load sharing as a means of describing the extent of bone comminution, the quantification of fracture displacement, and the degree of correction of the kyphotic deformity,[4] with the clear intention of enabling an objective tool to predict failure of solitary posterior fixation and to act as a guideline for the therapeutic decision on complementation through anterior support.

In recent decades, several studies have provided evidence that short-segment posterior fixation with screw fixation at the level of the fracture is sufficient to achieve stability in some injury patterns, such as burst fractures, avoiding the need for circumferential reconstruction and long segment instrumented thoracolumbar fusion.[2,4-7] Over this period, biomechanical analyses have yielded basic knowledge, which led to the development of synthetic materials with greater rigidity and better preparation for load sharing across the three columns described by Denis.[4,8]

The dissemination of minimally invasive surgery concepts has drawn the attention of surgeons to the proven minimization of soft tissue injury, reduction of intraoperative blood loss and better postoperative pain scores than those of other approaches.[9] As part of a context of several surgical treatment options for unstable thoracolumbar injuries, the idea of performing posterior fixation without the need for arthrodesis appeared as a viable option for restoring function and maintaining mobility in cases where there is evidence of neurological integrity.[10-15]

The aim of this study was to evaluate the outcomes of surgical treatment of thoracolumbar burst fractures using short-segment fixation without arthrodesis.

CASE STUDIES AND METHODS

This study was approved by the Institutional Review Board (IRB) of IPETEC (Institute for Research, Technological Innovation and Education), under Opinion no. 4,007,361 in 2019, with CAAE number 30745220.9.0000.5479. A cross-sectional study of a consecutive series of patients treated for thoracolumbar burst fractures (AOSPINE A3/A4 - no posterior ligamentous complex injury and B - with posterior ligamentous complex injury) was carried out between 2018 and 2020 in a quaternary hospital in the city of São Paulo. For the definition of surgical treatment, in cases classified as A3/A4, without proven mechanical instability, surgery was indicated based on the principles of early mobility and immediate return to activities among patients, as an alternative to medical treatment; patients with B fractures, in turn, met the original criteria of the classification that categorizes this group of injuries as unstable. Inclusion criteria were: participants of both sexes, undergoing surgical treatment and evaluated six months after surgery at an outpatient appointment, with no evidence of neurological deficit on admission. Patients identified as having pathological fractures or fracture-dislocations, those with incomplete medical records and/or scans, or patients who had not completed the Informed Consent Form were excluded.

The surgical treatment considered for this study was minimally invasive posterior fixation (stabilization without arthrodesis), performed one level above and one level below the fracture, in addition to screw placement at the level of the fracture, as described by Kanna et al.[16] A search was carried out among patients registered in the data control records of a tertiary referral hospital with its own department of orthopedics and traumatology through the imaging and diagnostics center (IDC) to identify cases with fractures of the thoracic and lumbar spine.

The sample group of sixteen patients was initially analyzed according to descriptive data, which revealed a mean age of 39.5 years (±15) and a prevalence of males (56.25%) compared to females (43.75%). The most common mechanism of injury was fall from height (75%), followed by car accidents (25%). The average postoperative hospital stay was 2.5 days (±0.7).

Patients then underwent a cross-sectional clinical assessment of their functional status and quality of life using the Oswestry Disability Index (ODI),[17] Visual Analog Scale for Pain (Lumbar VAS)[18-21] and SF-36[21] Health Status questionnaires, all validated for use in Portuguese. At the same time, an assessment of radiographs, CT and MRI scans of the thoracolumbar spine, performed before and after the surgical procedures, was carried out in order to enable the application of the AOSpine,[23,24] McCormack – Load Sharing[4] and Thoracolumbar Injury Classification and Severity Score (TLICS)[23] classifications. Regional kyphosis was measured according to the Cobb method in the pre- and postoperative periods, in the lateral view of the affected segment.[25]

The statistical analysis included quantification of descriptive data through mean and standard deviation for continuous variables and the use of percentages for categorical variables using the software program SPSS Statistics 21.

RESULTS

Regional kyphotic deformity in the preoperative period had a mean of 15.9° (±7.07), with a mean variation for the postoperative period of 6.9° (±5.09). Conversely, the TLICS (Thoracolumbar Injury Classification and Severity Score) index produced a mean score of 3.75 (±1.52). (Table 1)

Patients were subdivided according to the AOSpine Classification,[23,24] with L1/A4 (25%) having the highest incidence. (Table 2) The McCormack[4] (Load Sharing) classification was also used, yielding 3 and 6 points as the most common scores, assigned to 4 patients each (25%). (Table 3)

We can see the quantification of patients by the levels of the ODI (Oswestry Disability Index) in relation to the AOSpine classification (Table 4) and according to the McCormack classification (Load Sharing). (Table 5)

Regarding clinical outcomes of pain and quality of life, the mean score according to the Visual Analog Scale for Pain was 4.1 (±1.6). Meanwhile, the quality of life values as measured by the SF-36 Physical and SF-36 Mental tools were 73.2 (±15.6) and 76.1 (±8.5), respectively. (Table 6) In our evaluation of the Denis scale, the values recorded were 2.43 (±0.8) for the pain subtype and 2.37 (±1.1) for the work subtype. (Table 7) Moreover, we found a correlation

Table 1. Descriptive Data.

Characteristics	Total
Sample Size	16 (100%)
Age	39.5 years (±15)
Postoperative Hospital Stay in Days	2.5 (±0.7)
Sex	
Female	7 (43.75%)
Male	9 (56.25%)
Mechanism of Injury	
Fall from Height	12 (75%)
Car Crash	4 (25%)
Oswestry Disability Index (ODI)	
Minimal	10 (62.5%)
Moderate	4 (25%)
Severe	2 (12.5%)
Kyphotic Deformity (° Cobb)	
Before	15.9 (±7.07)
After	6.9 (±5.09)
TLICS	3.75 (±1.52)

Legend. ± - standard deviation; ° Cobb – Cobb angle.

between least disability in the ODI and the best results in the other evaluated scores (Table 8).

No patients in the studied sample group were diagnosed with loosening of the synthetic material or infection.

Table 2. AOSpine classification.

AO Classification	N
L1/A4	4 (25%)
L1/A3	1 (6.25%)
T8/A4	1 (6.25%)
L3/A2	1 (6.25%)
L3/A4	1 (6.25%)
L1/B2	3 (18.75%)
T12/B2	3 (18.75%)
T12/A3	1 (6.25%)
T10/B2	1 (6.25%)

Legend. N – number of participants.

Table 3. McCormack Classification (Load Sharing).

McCormack Classification	N
3 points	4 (25%)
4 points	2 (12.5%)
5 points	3 (18.8%)
6 points	4 (25%)
7 points	2 (12.5%)
8 points	1 (6.3%)

Legend. N – number of participants.

Table 4. AOSpine Classification and Oswestry Disability Index (ODI).

	AOSpine Classification								
ODI	T8/A4	T10/B2	T12/A3	T12/B2	L1/A3	L1/A4	L1/B2	L3/A2	L3/A4
Minimal	1	1	0	2	1	1	2	1	1
Moderate	0	0	0	1	0	2	1	0	0
Severe	0	0	1	0	0	1	0	0	0

Table 5. McCormack Classification (Load Sharing) and Oswestry Disability Index (ODI).

	McCormack Classification (Load Sharing)					
ODI	3 points	4 points	5 points	6 points	7 points	8 points
Minimal	1	1	3	2	2	1
Moderate	3	1	0	0	0	0
Severe	0	0	0	2	0	0

Table 6. Pain and Quality of Life Scales.

	N	Mean (±)
SF-36 Physical	16	73.2 (±15.6)
SF-36 Mental	16	76.1 (±8.5)
Visual Analog Scale for Pain	16	4.1 (±1.6)

Legend. N – number of participants; ± - standard deviation.

Table 7. Denis Scale.

	N	Mean (±)
Denis Pain	16	2.43 (±0.8)
Denis Work	16	2.37 (±1.1)

Legend. N – number of participants; ± - standard deviation.

Table 8. Clinical outcomes according to the Oswestry Disability Index.

	N		Mean (±)			
Oswestry Disability Index		SF-36 Physical	SF-36 Mental	VAS Pain	Denis Pain	Denis Work
Minimal	10	81.8 (±10.3)	80 (±0.0)	3.1 (±0.9)	1.9 (±0.5)	1.7 (±0.4)
Moderate	4	64.5 (±11.4)	74,5 (±6.8)	5.5 (±0.5)	3 (±0.0)	3.2 (±0.9)
Severe	2	48 (±0.0)	60 (±16.9)	6.5 (±0.7)	4 (±0.0)	4 (±1.4)

Legend. N – number of participants; ± - standard deviation; VAS – visual analog scale.

DISCUSSION

Burst thoracolumbar fractures characteristically involve very different aspects in the literature in terms of classifications and treatment guidelines.[1,2] When evaluating the possible correlations between the mechanisms of injury, radiological findings and clinical presentation of patients, the absence of a rule of correspondence between them is clear.[9] The degree of involvement of the spinal canal, for example, was the target of attempts to establish direct correlation with the presence of neurological deficit. In practice, the presence of fractures with less than 40% involvement associated with severe neurological deficits was described; on the other hand, there were injuries involving more than 90% of the spinal canal without any neurological sequelae.[25,26]

In general, burst fractures can be considered mechanically stable provided that the posterior osteoligamentous complex is preserved. Therefore, the disturbance of these structures is key to the instability of injuries, with the main signs being high degrees of axial compression (>50%) or more than 25° of angulation.[1,6,28]

Having defined the surgical treatment for injury stabilization, advocates of the percutaneous technique report the reduction of operative time and blood loss, as well as less soft tissue trauma, as the main advantages. Conversely, those who oppose minimally invasive techniques cite the long learning curve required by the surgeon and the possibility of inadequate restoration of the kyphosis. Lee et al., showed a loss of 3.1° in the percutaneous group versus 3.5° in the open group for regional kyphosis.[11] Dong et al. found no significant differences between techniques in terms of their curative effects or radiological patterns, with a profound similarity in their ability to achieve good results.[10] Lee et al., Vanek et al. and Dong et al. observed significantly lower scores on pain scales in patients undergoing percutaneous surgery, especially in the early postoperative period; the authors attributed the better response to faster recovery from muscle pain, resulting from less dissection of the paravertebral musculature in the minimally invasive group, as compared to the group undergoing traditional open surgery.[10,11,14]

Short-segment posterior instrumentation has proven to be a method of achieving stability in burst fractures. The placement of pedicle screws in the fractured vertebral body produces a reliable construction from a biomechanical point of view, and short-term clinical results have indicated that this method helps to correct kyphosis and restore the height of the affected vertebral body, including injuries with evidence of posterior ligament complex involvement.[16,29] Another no less important factor is that surgery allows the immediate start of postoperative mobilization without the weight of an orthosis, while eliminating the need for an external orthosis for three to six months in cases of conservative treatment. In other words, in addition to being a feasible option for the treatment of unstable lesions, minimally invasive fixation plays an intermediary role when there is no objective indication for surgical or non-surgical treatment.[9,30]

The principle of "internal orthosis" used in fixations without arthrodesis involves the preservation of mobile segments and effective correction of kyphosis, even after removal of the synthetic device. (Figure 1) In our study, we chose to maintain the synthetic device after fracture healing, given the difficulty of recalling patients and the lack of evidence in the literature that there are better results in long-term follow-up for patients undergoing removal of implanted material after consolidation.[2, 31-33]

The attempt to find a classification with good reproducibility, considered a viable guideline for surgical treatment and for predicting the possibility of therapeutic failure, has become the topic of studies by several authors since the popularization of third-generation implants. As mentioned above, we evaluated the lack of direct correlation between Load Sharing (McCormack et al.,[4]) and the need for circumferential fixation of burst fractures, as well as the inability of the TLICS score to cover all indications for surgical treatment of these injuries.[34,35] Although there are signs that Load Sharing values greater than six points are indicative of a greater chance of technical failure if the surgeon opts for posterior instrumentation

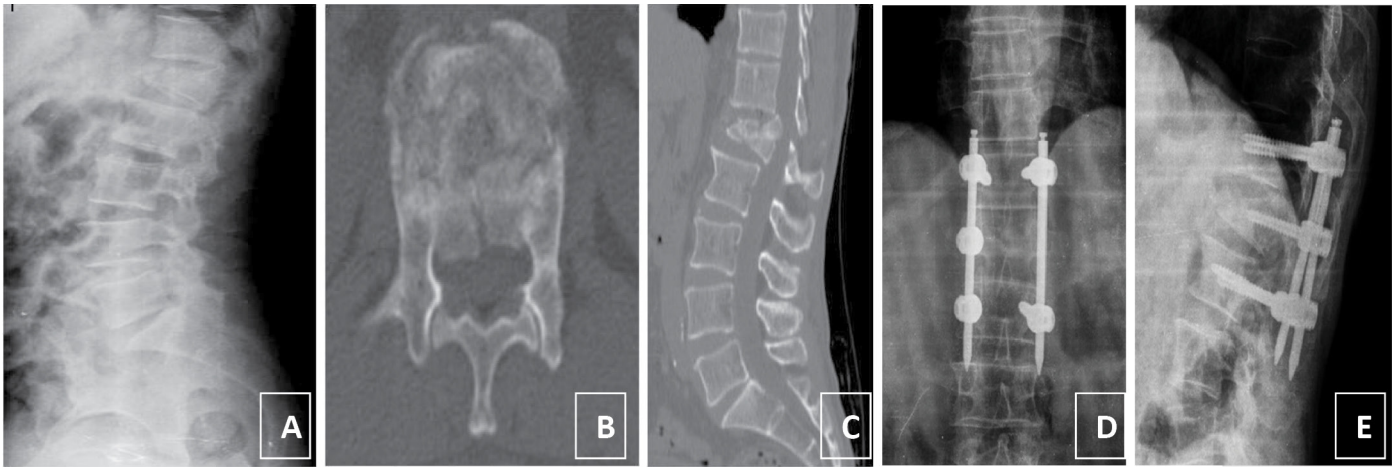

Figure 1. A, B and C – L1 burst fracture (AOSpine A4); D and E – Percutaneous posterior fixation of T12-L2 (Radiographs 6 months after surgery).

alone, the evolution of implants has undoubtedly allowed greater biomechanical rigidity for pedicle fixations, with low degrees of loss of normal spinal kyphosis during follow-up and no clinical correlation with functional deterioration or implant breakage.[36-38]

Arthrodesis surgery of the segments adjacent to the fracture and conservative treatment with orthotics also give rise to misgivings regarding the difficulties of pain management and the sequelae and restrictions imposed on returning to work, mainly in the case of the economically active population, which is widely affected by traumatic thoracolumbar injuries. Consequently, the good clinical results - ODI with predominance of patients showing the least disability (62.5%) and only two others with severe disability (12.5%), SF-36, VAS and Denis (pain and work) - presented by patients undergoing minimally invasive fixation, although with short-term follow-up, provide a basis to consider treating this population group with short-segment instrumentation without arthrodesis, with a view to achieving less pain and early rehabilitation.[17,20-21,31, 38,39]

Although percutaneous fixation of thoracolumbar fractures has been promoted since the 1980s, it is still the subject for reflection with regards to the actual applicability of the technique. Given the importance of speculating whether comminution of the fracture is a predictor of possible failure of an insufficient fixation, the risk of loss of correction in the medium to long term (follow-up longer than two years) must be considered.[4,5, 14,18] We must also recognize the greater ability to correct kyphosis and restore vertebral height through open fixation with arthrodesis, especially in cases with evidence of absence of postural reduction and clinical or radiological signs of posterior ligamentous complex injury.[13]

In short, the best descriptions of outcomes that favor the percutaneous instrumentation technique suggest a direct relationship with cases without severe fracture comminution or ligament injury.[10,11,15,34]

Although our study identified clinical and radiological outcomes that support the technique, and despite the fact that it has been well documented in recently published meta-analyses, there is still a lack of estimable randomized clinical trials with a follow-up of at least two years aimed at comparing the minimally invasive approach of short--segment instrumentation without arthrodesis with traditional approaches involving fusions of more segments and extensive muscle exposure.[39] It is equally important to always consider the principles of direct decompression and intersegmental fusion, not promoted through the percutaneous technique, and already well established for cases with neurological damage and marked instability (ligament injury, severe kyphosis and non-apposition of fragments).[27]

CONCLUSION

The short-term clinical results suggest that percutaneous instrumentation without arthrodesis is safe and can be used to treat thoracolumbar burst fractures, with favorable clinical outcomes and maintenance of correction of regional kyphosis.

All authors declare no potential conflict of interest related to this article.

CONTRIBUTIONS OF THE AUTHORS: Each author made significant individual contributions to this manuscript. PHCP: writing, data analysis; RGMM, LDK and WZS: writing and data analysis; NA: review and statistical methods; AOG: writing, data analysis; OA: writing and data analysis; MFSC: statistical methods and data analysis; RM: review and data analysis.

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