

FUNCTIONAL OUTCOME OF BURST FRACTURES OF THE THORACOLUMBAR SPINE MANAGED NON-OPERATIVELY, WITH EARLY AMBULATION, EVALUATED USING THE LOAD SHARING CLASSIFICATION

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The purpose of this prospective study was to assess the functional outcome of conservative treatment with early ambulation of thoracolumbar burst fractures, using the Load Sharing classification.

From 1997 to 2001, 60 consecutive patients with single-level thoracolumbar spinal injury, with no neurological impairment, were classified according to the Load Sharing scoring and were managed non-operatively. A custom-made thoracolumbosacral orthosis was worn by all patients for six months, and early ambulation was recommended. Several radiological parameters were evaluated ; the Denis Pain and Work Scale was used to assess the clinical outcome. The average follow-up period was 42 months (range, 24 to 55 months).

During this period the spinal canal occupation was significantly reduced. Other radiological parameters, such as Cobb's angle and anterior vertebral body compression, showed loss of fracture reduction, which was not statistically significant. However, the functional outcome was satisfactory in 55 of 60 patients with no complications recorded on completion of treatment.

Load Sharing scoring is a reliable and easy-to-use classification for the conservative treatment and prognosis of thoracolumbar spinal fractures. Because of the three characteristics of the fracture site this classification can also predict the structural results of spinal injury, such as posttraumatic kyphosis, as well as the functional outcome in conservatively treated patients.

Keywords : thoracolumbar spine ; fractures ; non-operative treatment ; functional outcome.

Mots-clés : rachis thoraco-lombaire ; fractures ; traitement conservateur ; résultats fonctionnels.

INTRODUCTION

Burst fractures, as defined by Denis (7), involve compression failure of the anterior and middle columns of the spine. The management of these unstable burst fractures in the thoracolumbar segment of the spine has been the subject of controversy for many years. The advantages of surgery include a shorter period of bed rest and hospitalization, better correction of kyphotic deformity, avoidance of later deterioration caused by instability, and an opportunity to perform direct or indirect decompression of the neural elements (1, 5, 9). Conservative management of thoracolumbar burst spine fractures in neurologically intact patients, with bracing and early mobilization, may prevent deformity, and postural reduction can produce indirect decompression of the spinal canal. This type of

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Table I. — Associated injuries in 34 of 60 patients with thoracolumbar fractures

Type of injury	Number of patients
Lower limb	25 (25%)
Upper limb	6 (10%)
Thorax	3 (5%)

management also eliminates prolonged periods of recumbency and hospitalization (3, 17).

Non-surgical treatment of thoracolumbar burst spine injuries should be based on a classification system, in which the characteristics of the injury, such as displacement of the fracture, comminution, deformity and other factors predisposing to the generation of pain and neurological deficit, could be recorded. The Load Shearing classification (18) for burst fractures met the above criteria.

The purpose of this prospective study was to assess the efficacy of Load Shearing scoring on selection, non-operative treatment with early ambulation, and functional outcome of the patients included in this study.

MATERIAL AND METHODS

During a 4-year period (June 1997 to November 2001), 100 consecutive patients with single-level burst fractures in the thoracolumbar zone (T11-L2) were treated in our Department. A total of 60 patients who met the criteria for inclusion, were involved in this study: 38 males and 22 females. The mean age of the study group was 46.8 years (range, 18 to 73 years). The average follow-up period was 42 months (range, 24 to 55 months).

Study inclusion was limited to neurologically intact patients with Load Sharing scoring of 6 or less. Patients who were able to tolerate the brace without acute (traumatic) or chronic cardiopulmonary problems, and who presented a single-level non-pathological or osteoporotic burst spinal fracture in the thoracolumbar zone (T11-L2), were also included in the study.

Forty patients were excluded from the study; six with pathological fractures; twenty-four with osteoporotic fractures, and ten with cardiopulmonary problems. The last ten patients were treated operatively with short-segment posterior pedicle screw instrumentation.

The mechanism of injury included motor vehicle accidents (15 patients, 25%), and falling from a height

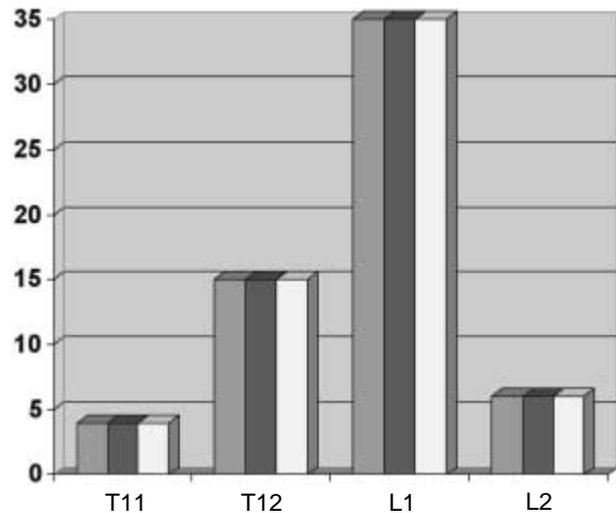


Fig. 1. — The distribution of fracture levels. L1 fractures are the most common (58%); 83% of the thoracolumbar fractures are L1 and T12.

(45 patients, 75%). The associated injuries are summarized in table I. Fracture distribution according to vertebral level is shown in fig. 1.

Upon admission, the complete medical history with a detailed clinical evaluation were recorded and radiological examinations were performed. Initial anteroposterior and lateral xrays were taken with the patient recumbent because of the acuteness of the injury (fig. 2a, 2b).

Xrays at follow-up evaluations were taken at 3, 6, 12 months, two and four years consecutively, with the patient upright (fig. 3a, 3b).

Before and after treatment and in the final follow-up, the following parameters were manually measured on lateral spinal radiographs by two independent examiners: the anterior vertebral body compression percentage (AVC) and the amount of kyphosis at the fracture site (fig. 4a). The AVC was calculated according to the Willen method: percentage of anterior vertebral compression with respect to the next adjacent intact vertebrae, above and below the fractured vertebra (26). Kyphosis was measured using the Cobb method: degree of kyphosis at the fracture site from the next adjacent vertebrae above and below the fracture site (fig. 4b).

A computed tomographic (CT) scan of the injured vertebrae, to assess vertebral body comminution and the presence of spinal canal narrowing by bone fragments from the fractured vertebra, was performed on all patients upon admission (fig. 5a, 5b). Spinal canal occupation (SCO) was calculated according to the Willen formula (26). The maximum percentage occupation of



Fig. 2a. — Anteroposterior xray showing a burst fracture of L1 in a 40-year-old man.



Fig. 2b. — Lateral xray showing a burst fracture of L1 in a 40-year-old man (same patient as in fig. 2a).

the involved canal's sagittal diameter was compared with the average of the spinal canal diameter at the adjacent vertebrae above and below the fracture.

Spinal injuries were classified according to the Load Sharing classification for burst fractures (table II). Load Sharing classification grades the extent of vertebral body comminution, the amount of fracture displacement and the degree of correction of kyphotic deformity before and after brace placement (18). Clinical follow-up evaluation was done through the use of a questionnaire in which the patients were asked to rate their pain and their work status, before and after injury, on a scale from 1 to 5 according to Dennis (8). Functional outcome for each patient in the study was correlated with the Load Sharing scores.

Mean duration of hospitalization was 10.5 days (range, 3 to 25 days). When distention of abdomen and ileus resolved, patients were placed in a custom molded acrylic thoracolumbosacral orthosis (TLSO). The brace

Table II. — The Load Sharing Classification

Number of patients	Load Sharing Classification
25	3
27	4
5	5
3	6

was carefully molded to try to correct as much deformity as possible and to indirectly decompress the spinal canal through ligamentotaxis. Mobilization to an erect position and ambulation were permitted immediately. The brace was worn for six months (4). While wearing the brace, patients were taught isometric exercises to help maintain the condition of trunk muscles. After removal of the brace the patients were allowed to return to work.



Fig. 3a. — Anteroposterior xray, 2 years later, of the same patient as in fig. 2a, 2b.



Fig. 3b. — Lateral xray showing the compression of L1 fracture, 2 years later, in the same patient as in fig. 2a, 2b.

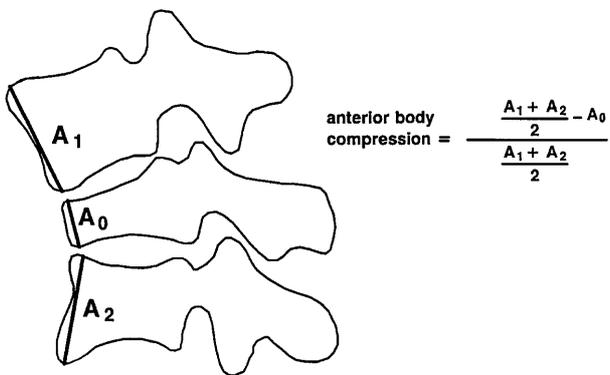


Fig. 4a. — Schematic diagram of AVC measurements on lateral radiograph.

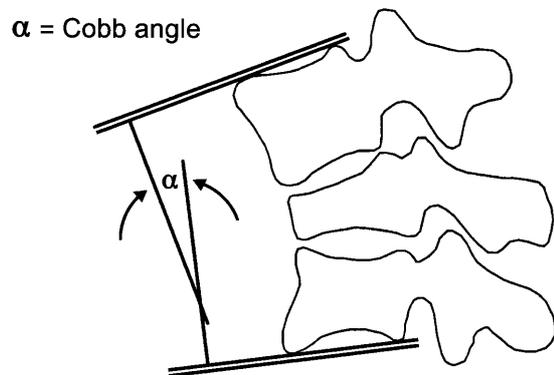


Fig. 4b. — Schematic diagram of Cobb's angle measurements on lateral radiograph.



Fig. 5a. — Computed tomographic scan showing the vertebral body comminution and the occupation of the spinal canal by bone fragments of L1 vertebra at injury.



Fig. 5b. — Computed tomographic scan 12 months later, showing reduction of spinal canal occupation.

RESULTS

Radiographic evaluation

The initial percentage of AVC averaged $35\% \pm 27.8\%$ (range 6% to 64%). At follow-up it was $44.5\% \pm 29.5\%$ (14% to 76%), and the mean loss of AVC correction at the last follow-up was $9.5\% \pm 3.5\%$. The mean loss of final AVC was statistically insignificant ($P > 0.05$).

The average percentage of SCO at injury was $32\% \pm 6.5\%$ (range 24% to 40%) and the mean SCO four years later was $22\% \pm 5\%$ (range 17% to 28%) (fig. 5a, 5b). The difference between the two values was $10\% \pm 2.5\%$ which was statistically significant ($P < 0.01$).

The mean Cobb angle at injury was $6^\circ \pm 4^\circ$ (range 2° to 12°). Four years later, the average angle was $8^\circ \pm 3.5^\circ$ (range 4° to 12°), with a mean loss of correction $2^\circ \pm 1.5^\circ$. The mean final loss of correction was not statistically significant ($P > 0.01$).

Functional Outcome

The functional outcome in this study group was satisfactory in 55 (91%) and unsatisfactory in 5 (9%) of the 60 patients. Fifty patients (83%) rated their pain as slight or none, showed complete

recovery and returned to their previous activities. Load Sharing scoring for these patients was 3 to 4. Four patients (7%) with Load Sharing scoring of 3, 4, or 5 complained of moderate pain and needed anti-inflammatory medication. These two patients were unable to return to previous employment but were fully employed in a new occupation. One patient (3%), with Load Sharing scoring of 5, rated his pain as moderate to severe, used occasional medication, and was able to take up a new job. Five patients who reported constant, severe pain and required continuous medication were completely unable to work. The Load Sharing scores for those patients were 5 to 6 (table III).

Complications

Three patients with urinary tract infections were treated with antibiotics (cephalosporin per os). No neurological deficits were recorded.

DISCUSSION

The treatment of thoracolumbar fractures remains controversial despite the advances in operative techniques, the increased knowledge of spine biomechanics and improvements in recovery of the central nervous system. The indications for operative and non-operative treatment of these fractures

Table III. — The Dennis Pain and Work Scale 40 months following injury and the Load Sharing Classification

Pain (P) Scale Grade	Number of patients	Work Scale (W)	Number of patients	Load Sharing scoring
1. No pain.	30	1. Heavy labor.	28	3,4
2. Minimal pain, no medication	20	2. Sedentary job or lift restrictions.	22	3,4
3. Moderate pain, no work interruption	4	3. Unable to return to original work, but working full time	5	3,4,5
4. Severe pain absence from work	1	4. Part time work.	0	5
5. Pain constant, incapacitating	5	5. Unable to work.	5	5,6

are even more confusing, especially when patients remain neurologically intact (6, 10, 23). The popularization of pedicle screw fixation and the modern instrumentation systems which have been developed are advocated in the operative treatment of thoracolumbar fractures with anterior and posterior fusions (14, 15, 16).

In contrast, Weinstein (24) concluded that non-operative treatment is a viable alternative in burst fractures with no neurological deficit. Cantor *et al.* (3) and Weitzman (25) reported satisfactory results from conservative treatment of patients with intact posterior elements and thoracolumbar burst fractures, with early ambulation in a thoracolumbosacral orthosis (TLSO). Chow *et al.* (4) concluded that non-surgical management of thoracolumbar burst fractures with hyperextension casting or bracing was a safe and effective method of treatment in selected patients. Mumford *et al.* (20) found no correlation between initial severity of injury, shown on xray images, or residual deformity, following closed management, and the quite low incidence of subsequent neurological deficit in neurologically intact patients treated non-operatively.

Dennis *et al.* (8) and Jacobs *et al.* (13) retrospectively compared patients who were treated operatively with those treated non-operatively. They concluded that stabilization and fusion of acute burst fractures with no neurological deficit has significant advantages over conservative treatment. However, in these studies, the treatment selected was not based on comparison of the specific types of injuries with a common classification.

Classification of an injury should permit its identification by means of a simple algorithm

based on easily recognizable radiographic and clinical characteristics, regarding the severity of the spinal injury. In addition, it should provide concise terminology as a guide to appropriate treatment and its functional outcome. Many classifications have been proposed which have added to the knowledge and understanding of spinal injuries (7, 11, 12). However, unidentified ligamentous ruptures, dislocations, spontaneously reduced spinal subluxation and the inability to demonstrate the maximal displacement by available imaging techniques, are limitations in all classifications.

The vertebral fracture anatomy is also of great importance. The vertebral fragments of a burst spinal fracture do not transfer load as well as the intact vertebrae. Load Sharing classification is assessed in order to accumulate the total point score for vertebral fracture anatomy and is determined by three radiographic components; the degree of the entire vertebral body comminution, the quantification of displacement for bony fracture fragments, and the amount of kyphosis correction necessary to restore the physiologically normal sagittal plane alignment at the level of the injury. A point value system is used to grade severity: one point for mild, two points for moderate, and three points for severe. The amount of comminution is assessed: one point for comminution when 30% or less of the vertebral body is broken on sagittal CT reconstruction images, two points for 30% to 60% comminution of the body, and three points for greater than 60% comminution. The amount of displacement of fracture fragments is assessed: one point for 0 to 1 mm displacement, two points for at least 2 mm of displacement in less than 50% of the

cross-sectional area of vertebral body as viewed by CT, and three points for 2 mm or greater displacement in over 50% of the cross sectional area. Finally, the amount of correction of kyphotic deformity is assessed : one point for 3° or less correction, two points for 4° to 9° of correction, and three points for 10° or more correction. This classification correlates the fracture anatomy with mechanical stability but does not identify ligament disruption (18).

Using this three-point system, Parker *et al.* (21) reported successful thoracolumbar spinal repair. The importance of fracture comminution in postoperative functional outcome was also shown by McLain *et al.* (19). None of the patients in his series, who had minimally comminuted injuries or a strut graft, experienced postoperative collapse or implant problems. In contrast, patients with higher degrees of vertebral body comminution had an average of 10° correction of kyphosis loss, resulting in increased symptoms of pain and greater severity of symptoms, which required re-operation in some cases. Several authors (1, 3, 20), however, have shown no relation between kyphosis and pain.

In the current series, patients with a thoracolumbar burst spinal fracture and with a Load Sharing score of 6 points or less, were treated in a closed manner with a custom molded thoracolumbosacral brace. The mean loss of kyphosis in our study group was 2° and the average AVC loss was 9.5% (statistically not significant), more than at the time of the initial injury. Mumford *et al.* (20) has reported an 8% mean loss of AVC and 90% satisfactory results. The SCO was reduced to 10%, which was statistically significant. Indeed, it has been clearly shown that over a period course of between six months and two years the burst fracture remodels itself with a return to nearly normal dimensions of the canal (2). The functional outcome of our study group was satisfactory in 55 of 60 patients (91%) with a Load Sharing scoring of 3 and 4. Patients with 5 and 6 points had poor functional outcome.

CONCLUSION

The decision-making for conservative management with early ambulation of thoracolumbar burst spine fractures should not be based solely on the

Load Sharing score. A thorough physical, neurological and spinal examination and thorough patient evaluation regarding prior activities, social and educational background and future plans, should be carried out. Reviews of patients radiographs and C/T scans are also essential to determine the risks and benefits of non-operative treatment.

Load Sharing scoring is a reliable and easily used classification for the conservative treatment and prognosis of thoracolumbar spinal fractures. Because of the three characteristics of the fracture site this classification can also predict the structural effects of the spinal injury, such as post-traumatic kyphosis and thereby the functional outcome in conservatively treated patients.

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SAMENVATTING

A. ALIGIZAKIS, P. KATONIS, K. STERGIPOULOS, I. GALANAKIS, S. KARABEKIOS, A. HADJIPAVLOU. *De waarde van de "load-sharing" classificatie in de evaluatie van het functioneel resultaat van thoracolumbaire compressiefracturen conservatief behandeld met snelle herneming van de gang.*

Tussen 1997 en 2001 werden 60 opeenvolgende patiënten met een enkelvoudige thoracolumbaire compressie fractuur zonder neurologische verwikkelingen geklasseerd volgens de "Load-Sharing" score. De behandeling was conservatief met een op maat gemaakte en gedurende zes maanden gedragen thoracosacrale orthese. Snelle herneming van de gang werd aangemoedigd. De evaluatie gebeurde radiologisch met verschillende parameters, en klinisch met de Denis schaal voor pijn en werkcapaciteit. De gemiddelde opvolgingstermijn bedroeg 42 maanden (gaande van 24 tot 55). In dit tijdsverloop ontstond een duidelijke verruiming van het mergkanaal op het getroffen niveau. Alhoewel de Cobb hoek en de anterieure compressie index tijdens dit verloop een radiologische, maar statistisch niet belangrijke vermindering van de bekomen reductie toonden, was het functioneel resultaat bevredigend bij 55 van de 60 patiënten en traden geen verwikkelingen op in de loop van de behandeling. De "Load-Sharing" score gebaseerd op drie breukkenarakteristieken is een betrouwbare maatstaf voor de conservatieve behandeling en voor de anatomische (bv. blijvende kyphosis) en functionele uitkomst van thoracolumbaire wervelfracturen.

RÉSUMÉ

A. ALIGIZAKIS, P. KATONIS, K. STERGIPOULOS, I. GALANAKIS, S. KARABEKIOS, A. HADJIPAVLOU. *Résultats fonctionnels du traitement conservateur, avec ambulation précoce, de fractures-éclatements du rachis thoraco-lombaire en utilisant une classification basée sur la participation à la charge.*

Cette étude prospective avait pour but d'évaluer le résultat fonctionnel d'un traitement conservateur, avec ambulation précoce, des fractures-éclatements du rachis thoraco-lombaire, en utilisant une classification basée sur la participation à la charge. De 1997 à 2001, 60 patients successifs, présentant un fracture du rachis thoraco-lombaire à un seul niveau, sans atteinte neurologique ont été classifiés selon l'évaluation de la participation à la

charge et traités sans intervention chirurgicale. Une orthèse thoraco-lombo-sacrée sur mesure a été portée par les malades durant six mois, et on leur a recommandé une ambulation précoce. Différents paramètres radiologiques ont été évalués, tandis que l'échelle de douleur et de travail de Denis était utilisée afin d'évaluer les résultats cliniques. La durée moyenne du suivi a été de 42 mois (extrêmes : 24 à 55 mois). Pendant cette période, l'occupation du canal rachidien a été réduite de manière significative. D'autres paramètres radiologiques, tels que l'angle de Cobb et la perte de hauteur du corps vertébral antérieur ont montré une perte de réduc-

tion non significative de la fracture. Le récupération fonctionnelle était toutefois satisfaisante chez 55 des 60 patients, et on n'a pas enregistré de complications en fin de traitement. L'évaluation de la participation à la charge constitue une classification fiable et d'utilisation facile dans le traitement conservateur et le diagnostic des fractures du rachis thoraco-lombaire. Basée sur trois caractéristiques du site de la fracture, cette classification peut également laisser présager des résultats structurels du dégât vertébral, comme une cyphose post-traumatique, et, par conséquent, du résultat fonctionnel chez les patients soumis à un traitement conservateur.