

DAMAGE CONTROL IN THORACIC AND LUMBAR UNSTABLE FRACTURES IN POLYTRAUMA. SYSTEMATIC REVIEW

CONTROLE DE DANOS EM FRATURAS INSTÁVEIS TORÁCICA E LOMBAR EM POLITRAUMATIZADOS. REVISÃO SISTEMÁTICA

CONTROL DE DAÑOS EN FRACTURAS TORÁCICAS Y LUMBARES INESTABLES EN POLITRAUMATIZADOS. REVISIÓN SISTEMÁTICA

JAVIER PEÑA CHÁVEZ¹, JOSÉ MANUEL PÉREZ ATANASIO¹, EDGAR ABEL MÁRQUEZ GARCÍA¹, JUAN CARLOS DE LA FUENTE ZUNO¹, RUBÉN TORRES GONZÁLEZ¹

ABSTRACT

The objective of this systematic review was to integrate the information from existing studies to determine the level of evidence and grade of recommendation of the implementation of damage control in unstable thoracic and lumbar fractures in polytraumatized patients. Eighteen papers were collected from different databases by keywords and Mesh terms; the level of evidence and grade of recommendation, the characteristics of the participants, the time of fracture fixation, the type of approach and technique used, the length of stay in the intensive care unit, the days of dependence on mechanical ventilator, and the incidence of complications in patients were assessed. The largest proportion of the studies were classified as level 4 evidence and grade C of recommendation which is favorable to the implementation of damage control in unstable thoracic and lumbar fractures in polytraumatized patients as a positive recommendation, although not conclusive. Most papers advocate fracture stabilization within 72 hours of the injury which is associated with a lower incidence of complications, hospital stay, stay in the intensive care unit and lower mortality.

Keywords: Multiple Trauma; Spinal fractures/surgery; Fracture fixation; Lumbar vertebrae; Thoracic vertebrae.

RESUMO

O objetivo desta revisão sistemática foi integrar as informações dos estudos existentes para determinar o nível de evidência e grau de recomendação da aplicação do controle de danos em fraturas torácica e lombar instáveis em pacientes com politraumatismo. Foram incluídos 18 artigos encontrados em diferentes bancos de dados, usando-se palavras-chave e termos do MeSH; avaliaram-se: nível de evidência e grau de recomendação, características dos participantes, momento em que se realizou a fixação da fratura, tipo de acesso e a técnica utilizada, dias de permanência na unidade de terapia intensiva, os dias de dependência de ventilação mecânica e a incidência de complicações dos pacientes. A maior proporção de artigos foi classificada como nível 4 de evidência, com predomínio do grau C de recomendação, o que torna favorável à implementação do controle de danos em fraturas torácicas e lombares instáveis em pacientes com politraumatismo, não sendo, contudo, concludente. A maioria dos artigos preconiza a estabilização da fratura nas primeiras 72 horas da lesão, o que está associado a menor incidência de complicações, permanência hospitalar, permanência na unidade de terapia intensiva e a menor mortalidade.

Descritores: Traumatismo múltiplo; Fraturas da coluna vertebral/cirurgia; Fixação de fratura; Vértebras lombares; Vértebras torácicas.

RESUMEN

El objetivo de esta revisión sistemática fue integrar la información de los estudios existentes para determinar el nivel de evidencia y grado de recomendación de la aplicación del control de daños en fracturas torácicas y lumbares inestables en pacientes politraumatizados. Se incluyeron 18 artículos localizados en diferentes bases de datos a través de palabras clave y términos del MeSH; se valoró el nivel de evidencia y grado de recomendación, las características de los participantes, el momento en que se realizó la fijación de la fractura, el tipo de abordaje y técnica utilizada, los días de estancia en la unidad de terapia intensiva, los días dependientes de ventilador mecánico y la incidencia de complicaciones de los pacientes. La mayor proporción de los estudios se catalogaron como nivel de evidencia 4 y se obtuvo un grado C de recomendación como predominante lo cual coloca la aplicación de control de daños a fracturas torácicas y lumbares inestables en pacientes politraumatizados como una recomendación favorable pero no concluyente. La mayoría de los artículos abogan por una estabilización de la fractura en las primeras 72 horas de la lesión lo cual se asocia a menor incidencia de complicaciones, estancia hospitalaria, estancia en la unidad de cuidados intensivos y menor mortalidad.

Descriptores: Traumatismo múltiple; Fracturas de la columna vertebral/cirugía; Fijación de fractura; Vértebras lumbares; Vértebras torácicas.

INTRODUCTION

In the 1990s, treatment paradigms were aimed at reducing the number of emergency surgical procedures performed in patients polytraumatized by the deadly trio (coagulopathy, hypothermia, and hypotension),^{1,2} because it was observed that changes to the immune system and coagulation resulting from the "first hit", caused by the traumatic event put the patient at risk of suffering other injuries ("second hit") as a result of the surgical procedures to which

they would be subjected.^{3,4} From this emerged the philosophy of "damage control".⁵

Thus, the priority of surgical interventions, and the time to perform them, were dependent on the patient's physiological state.⁶

In the field of orthopedics, these concepts have been well understood for the management of long bone and pelvic fractures in polytraumatized patients.⁷

In the case of isolated spinal fractures, the treatment regimen

1. "Dr. Victorio De La Fuente Narváez" High Specialty Medical Unit. Federal District, Mexico.

Study conducted at the "Dr. Victorio De La Fuente Narváez" High Specialty Medical Unit. Federal District, Mexico.

Correspondence: Dr. José Manuel Pérez Atanasio. Health Research Division, "Dr. Victorio De La Fuente Narváez" High Specialty Medical Unit. Av. Manifold 15 s / n Esq. Av. Instituto Politécnico Nacional. Col. Magdalena de las Salinas, Delg. Gustavo A. Madero. 07760 CP. drmanuelperez@yahoo.com

has been adequately defined and standardized; however, the optimum time, and the best type of fixation to use in unstable thoracolumbar fractures in polytraumatized patients, are still controversial.⁸

At present, the management of unstable thoracic and lumbar fractures consists mainly of: 1) deferred fixation after the associated lesions have been resolved or 2) a more aggressive approach called "early total care" via invasive anterior approaches, corpectomy, and anterior fusion based more on purely mechanical aspects than on the physiopathology of the traumatized patient.⁸

There is evidence to demonstrate a significant increase in mortality, from 2.5% to 7.6%, resulting from definitive early fixation of the spine within the first 48 hours following the trauma.⁹ On the other hand, bed rest, and insufficient mobility of the patient due to deferred stabilization of the fractures, have been associated with severe post-traumatic complications.^{10,11}

The concept of "spinal damage control" is defined as a procedure carried out in stages, consisting of the immediate reduction and posterior instrumentation of unstable thoracic and lumbar fractures in severely injured patients (ISS greater than 15) within the first 24 hours, followed by complete 360° fusion during the physiological "window of opportunity", if anterior decompression and fusion have been indicated for neurological or biomechanical reasons.^{9,12} The second procedure should be performed three days after the initial trauma, in order to avoid the acute hyperinflammation phase and ensure adequate recovery from bleeding and coagulopathy, reducing the risk of transoperative bleeding of the spongy bone and the epidural veins.³

Thus, both the physiopathological state of the polytraumatized patient and the timing and nature of the surgical intervention are taken into account, avoiding "second hit" complications and reducing post-traumatic morbidity and mortality in patients in critical condition, resulting in reduced surgical and hospitalization times and fewer days of dependence on a ventilator. It also results in fewer

early postoperative complications, such as wound complications, urinary tract infections, and pulmonary complications, including pneumonia and pulmonary embolism.⁸

Among the disadvantages are potential intraoperative complications, such as poor placement of the transpedicular screws, the risk of incomplete decompression of the spinal canal, and the need for a second surgery in more than 95% of patients.⁸

The objective of this systematic review was to integrate the information from the studies to determine the level of evidence and the grade of recommendation regarding the application of damage control in unstable thoracic and lumbar fractures in polytraumatized patients.

METHODS

This systematic review was conducted based on the PRISMA Declaration.¹³ The study was registered under protocol number R-2014-3401-7.

The criteria were articles related to the early surgical treatment of thoracic and lumbar fractures in polytraumatized patients with ISS > 15, in English and Spanish, including clinical trials and observational studies.

The Medline, Ovid, EBSCO host, The Cochrane Library, The Cochrane Library plus, EMBASE, LILACS, ScieELO, Springer Link, MD Consult, and Science Direct databases were used to search for articles published from 1990 to 2014, with June 19, 2014 as the cut-off date for the search.

The title and the abstract of each article were examined to eliminate clearly irrelevant or duplicate articles. The complete text of potentially relevant articles was retrieved for evaluation, and to determine the level of compliance with the eligibility criteria, as shown in Figure 1.

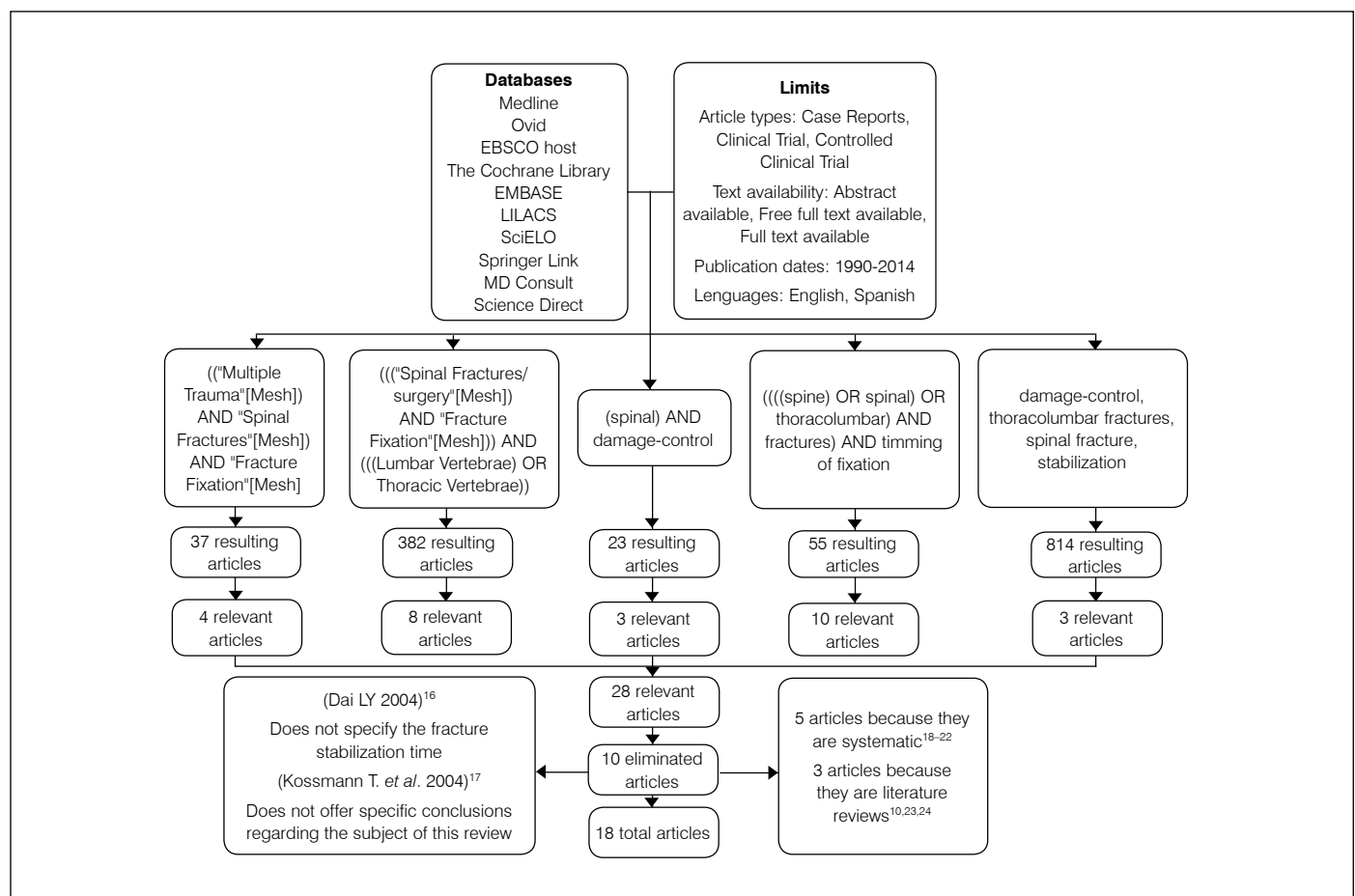


Figure 1. Research flowchart.

The articles were sent to two independent reviewers (PAJM and MGEA) who applied the CONSORT guide¹⁴ to the only randomized clinical study¹⁵ encountered and the Oxford Centre for Evidence-Based Medicine (CEBM) scale to all of the articles, in order to classify the level of evidence and the grade of recommendation. Interobserver reliability was analyzed using the intraclass correlation coefficient and interobserver variability calculation (Kappa).

For each article, the participant characteristics were evaluated (age, severity of the trauma according to ISS, and the level of the fractures), the time the fixation of the fracture was performed, the type of approach and technique used, the number of days in the intensive care unit, the number of days of dependence on a ventilator, and the incidence of complications.

Table 1. Summary of the Evidence.

Source	Principal Conclusion	Level of Evidence	Grade of recommendation
J Trauma, 2008 Kerwin <i>et al.</i> ²⁵	Try to achieve physiological stability to stabilize the fracture in the first 72 hours. Use clinical judgment to determine the time of stabilization.	4	C
J Crit Care, 2014 Park <i>et al.</i> ²⁶	Patients with ISS>26 have better clinical course after early stabilization (<72 h), surgery should be considered based on the patient's medical condition and the anesthetic and surgical risks.	2b	B
J Can, 2011 Pakzad <i>et al.</i> ³⁹	Patients stabilized after 24 hours are nearly 8 times more likely to suffer complications related to prolonged bed rest. Those stabilized within the first 24 hours are more likely to recover. An effort should be made to avoid delaying early treatment.	4	C
J Orthop Trauma, 2013 Vallier <i>et al.</i> ³⁶	The times spent in hospital and in the ICU are clearly influenced by the time the surgery is performed, which in turn, should be determined taking both the physiological state of the patient and the complexity of the surgery into account.	2b	B
Ann Surf, 2001 Croce <i>et al.</i> ²⁷	The fixation of the fracture within the first 72 hours is beneficial in traumatized patients; it reduces the incidence of pneumonia in patients with fractures of the thoracic spine, with severe associated thoracic lesions, and in patients without neurological deficit.	4	C
J Trauma Acute Care Surg, 2014 Blumel <i>et al.</i> ²⁸	The stabilization of the fracture before 72 h have elapsed is apparently beneficial and every effort should be made for an early treatment, associated with a reduced hospitalization time and a low frequency of complications.	4	C
Spine J, 2013 Konieczny <i>et al.</i> ²⁹	Patients with severe thoracic trauma and initially low hemoglobin counts may be at risk for a poor clinical outcome from early fixation. Therefore, the patients who are candidates for early surgery must be carefully selected.	2b	B
Eur J Trauma Emerg Surg, 2007 Hierholzer <i>et al.</i> ³⁵	Surgery within the first 24 h is associated with a reduction in mortality, in the duration of ventilation, and in the stay in the ICU.	4	C
J Bone Joint Surg, 2006 McHenry <i>et al.</i> ⁶⁴	A surgical delay of more than two days results in an increased risk of respiratory failure, but the time of the surgery must be determined on an individual basis.	3b	B
J Trauma, 2010 Frangen <i>et al.</i> ³⁰	Early stabilization (<72 h) is safe. In seriously injured patients it does not alter the perioperative pulmonary function and it results in a shorter stay in the ICU and a shorter hospitalization.	4	C
J Trauma, 2005 Kerwin <i>et al.</i> ³¹	Early stabilization (<72 h) reduces the hospital stay. Patients with traumas of the thoracic spine and spinal cord lesions have a greater benefit in terms of morbidity, hospital stay, and stay in the ICU. Mortality is higher in patients with ISS > 25. A rigid protocol indicating early stabilization of the spine does not seem to be justified. Early stabilization should always be performed if possible, but it should be individualized, optimizing any physiological changes preoperatively.	4	C
J Trauma Acute Care Surg, 2013 Stahel <i>et al.</i> ⁹	Recommends posterior fixation before 24 h, in case of compromise of the anterior spine or instability, anterior 360° fusion 3 days after the trauma to avoid the acute phase of hyperinflammation and to ensure resuscitation. It reduces days on the ventilator, hospitalization time, and early postoperative complications.	2b	B
J Orthop Trauma, 2013 Vallier <i>et al.</i> ³⁷	Recommends definitive management of mechanically unstable fractures of the pelvis, acetabulum, proximal femur, femoral shaft, and spine within the first 36 h whenever the patient displays an adequate response to resuscitation based on the improvement of acidosis.	4	C
J Orthop Trauma, 1996 Schlegel <i>et al.</i> ³²	Surgical intervention before 72 h reduces the rate of complications, days in the hospital and in the ICU in patients with multiple traumatic injuries and surgical fractures of the spine. In patients with isolated fractures of the spine, the time of fixation does not change the outcome.	4	C
J Trauma, 2006 Schinkel <i>et al.</i> ³³	Stabilization of the thoracic spine before 3 days seems to be favorable; there is an improvement in the TRISS, less hospitalization and ICU time, shorter duration of ventilation, and lower incidence of pulmonary failure. Patients with ISS>38 benefit more.	4	C
Arch Orthop Trauma Surg, 2008 Cengiz <i>et al.</i> ¹⁵	Stabilization within the first 8 h seems to be favorable. It can improve neurological recovery, reduce hospitalization time and systemic complications in patients with spinal cord lesions.	1b	A
Spine, 1999 McLain <i>et al.</i> ³⁸	Stabilization before 8 hours is safe and appropriate in polytraumatized patients when the neurological deficit is progressive, the trauma is thoracoabdominal, or the instability of the fracture increases the risk of deferred treatment. Surgical intervention before 24 h is not more dangerous than that performed between 24 and 72 hours.	2b	B
J Trauma, 2007 Kerwin <i>et al.</i> ⁹	Fixation prior to 48 h seems to increase mortality. Incomplete resuscitation prior to surgery seems to contribute. Surgical fixation before 48 h is not justified. Clinical judgment should be used and the physiological state of the patient should be considered to determine the best time to perform the fixation.	4	C

RESULTS

Twenty-eight potentially relevant articles were located. Once the complete text had been retrieved and the level of compliance with the inclusion criteria determined, two articles were rejected - one¹⁶ because it did not specify the time the fixation of the fracture was performed, and the other¹⁷ because it did not offer specific conclusions regarding the theme of this review, as well as five systematic reviews¹⁸⁻²² and three literature reviews^{10,23,24} leaving a total of 18 articles. (Figure 1)

The clinical trial¹⁵ complied with 20 of the 22 CONSORT guide items.¹⁴ All the studies were evaluated using the Oxford Centre for Evidence-Based Medicine (CEBM) scale to classify the level of evidence and the degree of recommendation.^{8,9,15,25-39} (Table 1)

The interobserver reliability was analyzed using the intraclass correlation coefficient and interobserver variability calculation (Kappa), obtaining agreement of 100% and eliminating the need for a third reviewer for the articles.

The significant results for this review were those derived from thoracic and lumbar fractures, although some studies included patients with cervical fractures or those with spinal fractures in combination with fractures of the lower limbs.

The studies included divided the time of fixation of the spinal fracture according to the hours elapsed between the time of the trauma and the fixation. Most of them (nine articles)²⁵⁻³³ defined early stabilization as that performed within the first 72 hours and late stabilization as that performed more than 72 hours following the trauma.

Two studies^{9,34} used 48 hours as the cutoff point for the definition of early and late stabilization.

Four studies^{8,35-37} used 24 hours as the cutoff for early and late fixation, of which only Stahel *et al*⁸ specified the application of a protocol for the early fixation groups of patients who, after the fixation within the 24 hours following the trauma, presented unstable anterior lesions of the spine and were scheduled for anterior 360° fusion three days after the trauma if there were biomechanical or neurological indications, in order to avoid the acute phase of hyperinflammation and ensure recovery.

Cengiz *et al*¹⁵ were the only authors to randomly assign patients to one of the fracture stabilization groups. In all the other studies, the moment of stabilization as determined by the surgeon, depending on the availability of surgical time or determined by the patient's conditions.

Injury Severity Score

The average ISS was reported by to the stabilization group (early vs. late) in most cases. The average ISS for the early fixation groups ranged from 16-42 points with an average of 26.35, while in the late fixation group, the average ISS vs. 27.78, with a range from 13 to 42.5.

Cengiz *et al*¹⁵ do not specify the ISS, but only refer to the exclusion of clinically unstable patients with spondyloptosis, a biochemical profile compatible with severe multisystem injuries, and patients not able to endure radical surgery.

Fracture fixation approach and technique

In ten studies, neither the type of approach for spinal fracture stabilization (anterior or posterior) nor the type of fixation performed (transpedicular fixation, 360° fusion) is reported. The other studies mention both anterior and posterior approaches performed in isolation, simultaneously, or consecutively, depending on the type of instability, without any systematized order for cases in which both are performed in the same patient, and without specifying the type of fixation system used, with the exception of the study by Stahel *et al*,⁸ which establishes a standardized damage control protocol for unstable spinal fractures consisting of early posterior fixation via a transpedicular system during the first 24 hours following the trauma. In those patients with unstable injuries of the anterior spine, anterior 360° fusion was scheduled for three days after the trauma. All the patients, except for one case of a B2 Chance fracture handled by exclusive posterior fixation with posterolateral fusion, required a second procedure to stabilize the anterior spine (97.6%).

Schlegel *et al*³² used an anterior approach for lesions of the anterior and middle spine involving the bone canal with neurological compromise or a posterior approach for patterns of posterior instability (luxation fractures, Chance fractures, burst fractures without neurological involvement). The type of fixation was not reported according to the approach used.

Cengiz *et al*¹⁵ reported only the use of the posterior approach with the insertion of transpedicular screws and rods.

In the study by McLain *et al*,³⁸ all the patients underwent posterior instrumentation, and anterior decompression was used in 26% of the patients as part of the initial operation for neural decompression, mechanical stabilization, or both.

McHenry *et al*³⁴ report a predominance of posterior approaches, representing 92% of cases versus the anterior approach, used in 8% of cases.

The results reported regarding the number of days in the ICU were described in 13 of the studies, with a maximum average of 16 days for the early spinal fracture stabilization group. For the late stabilization groups a maximum average of 21.3 days was found. Cengiz *et al*¹⁵ reported a mean of zero days in the ICU, however, this should be viewed with caution, as clinically unstable patients with spondyloptosis, a biochemical profile compatible with severe multisystem injuries, and patients not able to endure radical surgery, were excluded, and the need for intensive care in these patients was unlikely.

The number of days of dependence on a ventilator was reported in 12 articles, with a maximum average of 9.9 days for the early stabilization group and a maximum average of 20 days for the late stabilization group.

The main complications reported were pulmonary (pneumonia, pulmonary embolism, acute respiratory stress syndrome), deep vein thrombosis, sepsis, bed sores, acute renal failure, and complications related to the surgical wound, with a larger number of studies reporting a lower incidence of complications in the early stabilization group.^{8,27,28,33,36,37}

Mortality was reported in 16 studies, and was not taken into account in only two studies.^{8,39} In the majority of studies, it was reported by fracture stabilization group (early vs. late), with a maximum percentage of 7.6% among the early treatment groups and 17% for the late groups.

Croce *et al*,²⁷ upon stratifying their results by ISS, found that in patients with ISS ≥ 25 points, early fixation (< 72 h) of the spinal fracture is associated with less time in the ICU, shorter hospitalization times, and less costly procedures, but with a significant increase in mortality (5.6% vs. 2.7%). The causes of death reported were sepsis, drain damage, transesophageal fistula, and multiple organ failure.

Frangen *et al*,³⁰ upon stratifying the population by ISS, reported higher mortality in the early stabilization group for patients with ISS ≥ 38 points.

Kerwin *et al*^{9,31} do not report a significant difference between the stabilization groups. However, unlike the studies already mentioned, these authors report mortality of 6.3% in the early stabilization group (<72 h) and of 17% in the late group (>72 h), reporting this difference as significant.

In terms of the level of evidence, one article was found with level 1b, five articles with level 2b, one article with level 3b, and 11 articles with level 4. (Table 1).

The grades of recommendation found were grade A in one study, grade B in six studies, and grade C in eleven studies. (Table 1)

DISCUSSION

Table 1 summarizes the main conclusions of the articles included in this review, as well as the level of evidence and grade of recommendation, according to the methodology used in each study.

The main limitation is the quality of the existing studies in reference to damage control applied to spinal fractures in polytraumatized patients. Most of the articles are retrospective, using databases, so they contain no information that is not conditioned by the bias of the results or the inferences that could be drawn from them, or else they are based on cohort studies, but not randomized. Only two studies are relevant in terms of methodological quality. One of them¹⁵ is the only one randomized for the time of the fixation of the fracture, and for this reason, a level of evidence and grade of recommendation higher than the others is warranted. However, its possible application to the polytraumatized patient may be biased since it excludes unstable patients (spondyloptosis, biochemical profile compatible with severe multisystem injury, and patients not able to endure radical surgery). The other study⁸ is relevant because it is the only one that proposes a damage control protocol for thoracic and lumbar spines in patients with severe lesions and that follows the patients

in a prospective manner. The rest of the studies only focus on establishing the definitive moment of stabilization, but neither prioritize nor stress which surgical procedures should be performed, in what order, at what time, or under what circumstances.

FINAL CONSIDERATIONS

Most of the studies were classified as level of evidence 4 with a predominance of grade of recommendation C, which led to the conclusion that the application of damage control to unstable thoracic and lumbar fractures in polytraumatized patients is a favorable, though inconclusive recommendation.

Most of the articles advocate stabilization of the spinal fracture

in seriously injured patients in the first 72 hours following the injury, which is associated with less incidence of complication, shorter hospitalization time, shorter stay in intensive care, and lower mortality.

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