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

Received on 03/02/2015, accepted on 04/27/2015. http://dx.doi.org/10.1590/S1808-1851201514020R131

Coluna/Columna. 2015;14(2):152-6
has been adequately defined and standardized; however, the optimum time, and the best type of fixation to use in unstable thoraco-lumbar 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 360º fusion during the physiological “window of opportunity”, if anterior decompression and fusion have been indicated for neurological or biomechanical reasons.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.
The articles were sent to two independent reviewers (PAJM and MGEA) who applied the CONSORT guide to the only randomized clinical study 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.

### 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 - one because it did not specify the time the fixation of the fracture was performed, and the other because it did not offer specific conclusions regarding the theme of this review, as well as five systematic reviews and three literature reviews leaving a total of 18 articles. (Figure 1)

The clinical trial complied with 20 of the 22 CONSORT guide items. 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. (Table 1)

### Table 1. Summary of the Evidence.

<table>
<thead>
<tr>
<th>Source</th>
<th>Principal Conclusion</th>
<th>Level of Evidence</th>
<th>Grade of recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>J Trauma, 2008 Kerwin et al.</td>
<td>Try to achieve physiological stability to stabilize the fracture in the first 72 hours. Use clinical judgment to determine the time of stabilization.</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>J Crit Care, 2014 Park et al.</td>
<td>Patients with ISS&gt;26 have better clinical course after early stabilization (&lt;72 h), surgery should be considered based on the patient's medical condition and the anesthetic and surgical risks.</td>
<td>2b</td>
<td>B</td>
</tr>
<tr>
<td>J Can, 2011 Pakzad et al.</td>
<td>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.</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>J Orthop Trauma, 2013 Vallier et al.</td>
<td>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.</td>
<td>2b</td>
<td>B</td>
</tr>
<tr>
<td>Ann Surg, 2001 Croce et al.</td>
<td>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.</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>J Trauma Acute Care Surf, 2014 Bliemel et al.</td>
<td>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.</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>Spine J, 2013 Konieczny et al.</td>
<td>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.</td>
<td>2b</td>
<td>B</td>
</tr>
<tr>
<td>Eur J Trauma Emerg Surg, 2007 Hierholzer et al.</td>
<td>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.</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>J Bone Joint Surg, 2006 McHenry et al.</td>
<td>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.</td>
<td>3b</td>
<td>B</td>
</tr>
<tr>
<td>J Trauma, 2010 Frangen et al.</td>
<td>Early stabilization (&lt;72 h) is safe. In seriously injured patients it does not alter the peroperative pulmonary function and it results in a shorter stay in the ICU and a shorter hospitalization.</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>J Trauma Acute Care Surg, 2013 Stahel et al.</td>
<td>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.</td>
<td>2b</td>
<td>B</td>
</tr>
<tr>
<td>J Orthop Trauma, 2013 Vallier et al.</td>
<td>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.</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>J Orthop Trauma, 1996 Schlegel et al.</td>
<td>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.</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>J Trauma, 2006 Schinkel et al.</td>
<td>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&gt;38 benefit more.</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td>Arch Orthop Trauma Surg, 2008 Cengiz et al.</td>
<td>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.</td>
<td>1b</td>
<td>A</td>
</tr>
<tr>
<td>Spine, 1999 McLain et al.</td>
<td>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.</td>
<td>2b</td>
<td>B</td>
</tr>
<tr>
<td>J Trauma, 2007 Kerwin et al.</td>
<td>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.</td>
<td>4</td>
<td>C</td>
</tr>
</tbody>
</table>
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) 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 used 48 hours as the cutoff point for the definition of early and late stabilization.

Four studies used 24 hours as the cutoff for early and late fixation, of which only Stahel 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 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 was 27.78, with a range from 13 to 42.5.

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

In the study by McLain et al, 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 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 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 injury, 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. Mortality was reported in 16 studies, and was not taken into account in only two studies. 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.

Crocce et al, 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, tracheosophageal fistula, and multiple organ failure.

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

Kerwin et al 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 them 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 study 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...
REFERENCES


