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REVIEW

Timing of thoracic and lumbar fracture fixation in spinal injuries: a systematic review of neurological and clinical outcome

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Abstracts A systematic review of all available evidence on the timing of surgical fixation for thoracic and lumbar fractures with respect to clinical and neurological outcome was designed. The purpose of this review is to clarify some of the controversy about the timing of surgical fracture fixation in spinal trauma. Better neurological outcome, shorter hospital stay and fewer complications have been reported after early fracture fixation. But there are also studies showing no difference in neurological outcome when compared to late treatment. Mortality is another controversial point since a recent report of higher mortality in early treated patients. A systematic review of the literature was preformed. Ten articles were included. Early fracture fixation is associated with less complications, shorter hospital and ICU stay. The effect of early treatment on the neurological outcome remains unclear due to the contradictory results of the included studies. Early thoracic and lumbar fracture fixation results in improvement of clinical outcome, but the effect on neurological outcome remains controversial.

Keywords Review · Spinal fractures · Timing · Surgical fixation · Outcome and trauma

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Introduction

Traumatic injuries of the spinal column are less common than extremity fractures and have a low functional outcome [23]. Spinal fractures have an annual incidence of 64 per 100,000 [23] and neurological deficit is seen in 10–30%, resulting in an estimated 12,000 new spinal cord injuries in the United States every year [23, 50, 53]. Only 54% of all patients with spinal fractures return to their previous level of employment [31].

Spinal stabilization with internal fixation is indicated in unstable spinal fractures, spinal cord compression and progressive neurological deficit [31, 38, 53]. Although early spinal stabilization in thoracic and lumbar fractures is associated with shorter hospital stay, less complications and more neurological recovery, timing of surgical fixation of unstable fractures remains controversial [11, 21, 30, 32, 49, 53].

The arguments for early fixation of unstable thoracic and lumbar spine fractures are mainly based on the results of animal spinal cord decompression studies and clinical studies on timing of femur fracture fixation. Improved neurological outcome is reported after early decompression in animal experiments [7, 14, 17, 18, 52]. Advantages of early femur fracture fixation are well known and reported by several studies [5, 6, 10, 20, 24, 40, 47]. Clinical research in the past decade suggests that early stabilization of spinal fractures may improve neurological outcome, reduce complications, ICU and hospital stay [8, 10, 11, 19, 26, 30, 32, 36, 41, 45, 49]. Early stabilization is considered safe but a recent study by Kerwin et al. [26] reports a trend to higher mortality in early-operated patients. Neurological outcome is a subject of debate; while some articles report no difference in neurological outcome in early and late stabilized spinal fractures [22, 42, 54], other studies report a significantly better neurological outcome in early operated patients [19, 45].

In order to clarify some of the controversy on the timing of surgical stabilization a systematic review was conducted. An electronic literature search was preformed, the retrieved articles were critically appraised and levels of evidence (LOE) were determined. The aims of this review are to report all the available evidence for the timing of stabilization of traumatic thoracic and lumbar fractures and to identify patient related facts (e.g., trauma severity and fracture level) in which the outcome was obtained.

Methods

The electronic databases of MEDLINE (http://www.pubmed.com), EMBASE (http://www.embase.com) and Cochrane Collaboration (http://www.cochrane.org) were searched. Details about the search strategy are stated in Table 1. There were 181 hits in MEDLINE and 236 in EMBASE, no articles were found in the Cochrane library. All articles were screened for relevancy by reading titles and abstracts. Inclusion criteria were clear comparison of outcome between different time points and traumatic fractures that required surgical stabilization of the thoracic or lumbar spine. Trauma severity was not a selection criteria and patients ranging from polytrauma to single level fractures were included in this study. Articles concerning children, the cervical spine, conservative treatment, pathologic fractures and decompression surgery without fixation or stabilization were excluded.

In Medline ten articles [8, 10–12, 26, 29, 30, 32, 43, 45, 49] were found and one article [19] was found after reference tracking. In EMBASE two additional articles [29, 48] were found resulting in a total of 13 articles (Table 2). Full text copies were obtained and analyzed. Mean age, fracture characteristics, trauma severity, neurological impairment, surgical treatment, use of corticosteroids and rehabilitation protocols were assessed. The articles by Prasad et al. [43], De Luna et al. [12] and Magerl [29] were excluded. The reasons for exclusion were no clear comparison between different time points and full text of the article by De Luna et al. [12] was not available. The remaining ten articles were critically appraised (Table 3). Quality assessment was based on the Cochrane Handbook for Systematic Reviews of Interventions 4.2.4. [51]. In order to determine the possibility of selection bias the selection procedure and the homogeneity of the patient populations were examined. The studies were also assessed on standardization of operative procedure and peri- and postoperative care in order to determine the risk on performance bias. Attrition bias was scored on the basis of percentage follow-up and exclusion criteria. The risk on detection bias was based on the description of how the data was acquired and how statistical analysis was performed. Levels of evidence (LOE) of the included articles were determined according to the center for evidence based medicine (CEBM) instructions (http://www.cochrane.org).

Results

Patient and study characteristics (Tables 2, 3)

The age of the 1,427 patients in the included studies are comparable, most patients are in the fourth decade of life at the time of injury, with a mean age of 35.3 years. Trauma severity scores were similar in the studies that included all trauma levels and higher in the studies by McLain [32] and Dai et al. [11] which focus on polytrauma patients. McKinley et al. [30], Dai et al. [11] and Rath et al. [45] only included patients with neurological impairment; in the other studies the percentage of neurological impairment ranges between 47 and 76%.

Pharmaceutical treatment with corticosteroids is mentioned by McLain [32], Rath et al. [45] and Schlegel et al. [49]. McLain [32] initiates treatment with corticosteroids as soon as possible at the emergency room. Corticosteroid therapy was not adminis-

Table 1 Search strategy (results: 01-04-2006)

Database	Search	Limits	Hits
MEDLINE	(surgical OR surgery) AND (treatment OR stabilization OR fracture repair OR fixation) AND (spinal OR spine OR vertebral) AND (trauma OR injury OR fracture OR polytrauma) AND (timing OR early OR urgent) AND (outcome OR complications OR stay)	Title/abstract	181
EMBASE	[surgical OR ('surgery'/exp OR 'surgery')] AND [treatment OR stabilization OR ('fracture'/exp OR 'fracture') AND repair OR fixation)] AND [(spinal OR ('spine'/exp OR 'spine') OR vertebral] AND [('trauma'/exp OR 'trauma') OR ('injury'/exp OR 'injury') OR ('fracture'/exp OR 'fracture') OR ('polytrauma'/exp OR 'polytrauma')] AND (timing OR early OR urgent) AND (outcome OR complications OR stay)	None	236

Table 2 Patient characteristics

Authors	No. of patients	Age	Fracture level	Trauma severity	Neurological impairment
Schinkel et al. [48]	≤72 h: 12 ≥72 h: 15	37.6 (14–78)	Thoracic 27	ISS 18.9	49.7%
Kerwin et al. [26]	≤72 h: 73 ≥72 h: 85	39.5	Thoracic 90 Lumbar 68	ISS 21.8	ND
Rath et al. [45]	≤24 h: 11 24–48 h: 7 ≥48 h: 24	44.3 (15–84)	Thoracolumbar (T12-L2) 31 Other 11	ND	100%
Chipman et al. [8]	≤72 h: 69 ≥72 h: 77	35.8	Thoracolumbar 146	ISS 20.8	65.6%[a]
Dai et al. [11]	≤72 h: 41 ≥72 h: 50	34.8 (17–64)	Thoracolumbar (T12-L2) 91	ISS 31.8 (13–66)	97%
McKinley et al. [30]	≤72 h: 307 ≥72 h: 296	36.2	ND	ND	100%
Croce et al. [10]	≤72 h: 60 ≥72 h: 68	32.1	Thoracic 79 Lumbar 49	ISS 22.5	46.8%
Gaebler et al. [19]	≤8 h: 26 8–240 h: 50 ≥240 h: 12	32.6	Thoracic 34 Lumbar 54	15.9% Polytrauama	76%
McLain [32]	≤24 h: 14 24–72 h: 13	28.7	Thoracic 9 Lumbar 18	ISS 39.1	62.8%
Schlegel et al. [49]	≤72 h: 59 ≥72 h: 58	29.3 (2–83)	Tharacic 28 Thoraco-lumbar (T11-L2) 53 Lumbar 17 Cervical 19	ISS 19.8	59%
Prasad et al. [43]	29	ND	Thoracic 25 Lumbar 26	ND	ND
De Luna et al. [12][b]	24	–	–	–	–
Magerl [29]	45	ND	ND	ND	ND

ND Not described

[a] Only in patients with ISS ≥ 15, none of the 58 patients with ISS ≤ 15 had neurological impairment

[b] Full text not available

tered to patients that were operated 1 week or more after initial trauma in Rath et al.'s [45] study. Schlegel et al. [49] describe that corticosteroids were not administered during his study since the beneficial effect of steroid derivates was not made public at the time of study.

Rehabilitation after fracture stabilization is described by only three articles [19, 32, 49]. An orthosis and early mobilization were included in the rehabilitation protocol of these studies.

Quality (Table 4)

Since all studies were prognostic outcome studies they were scored LOE IIc. They were assessed on the risk of selection, performance, attrition and detection bias.

Gaebler et al. [19] and McLain [32] display adequate selection and standardization. Doubt exists on the selection procedure in the article by Schlegel et al. [49], which included patients ranging from 2 to 83 years of age at the time of injury. In the study population described by Schinkel et al. [48] there is much difference in age and neurological impairment between the study groups. The studies by Mckinley et al. [30] and Chipman et al. [8] do not describe fracture characteristics.

The studies by Mckinley et al. [30], Croce et al. [10], Chipman et al. [8] and Kerwin et al. [26] lack standardization, they do not clearly describe the used operative technique and peri- and postoperative care was not standardized. Dai et al. [11], Schinkel et al. [48] and Rath et al. [45] adequately describe the standard operative procedure, but postoperative treatment or rehabilitation is not mentioned. Loss of follow-up was 33% in the late follow-up group of Schlegel et al. [49] and 15% in the study of Gaebler et al. [19]. Mckinley et al. [30] describe 1-year follow-up but does not mention for which percentage of the patients this follow-up was obtained and could only report time to surgery in days and not in hours.

Results and conclusions of the included articles

Results and conclusions of these articles were assessed and compared with each other. A summary of the re-

Table 3 Study characteristics

Authors and recruitment	Treatment	Corticosteroids	Rehabilitation	Follow up	Outcome
Schinkel (1999–2003)	Ventrodorsal approach, posterior transpedicular stabilization and scopic anterior fusion	ND	ND	Hospital discharge	Lung function, ventilator days, hospital and ICU stay
Kerwin (1988–2001)	ND	ND	ND	Hospital discharge	Mortality, pneumonia, ICU stay, hospital stay and ventilator days
Rath (1990–1997)	Posterior transpedicular stabilization and decompression if necessary	Administered in fractures less than 1 week old	ND	8–36 months (mean 14.2)	Neurological outcome (Frankel)
Chipman (1994–2001)	Anterior or posterior repair	ND	ND	Hospital discharge	Complications, ICU stay, hospital stay and neurological outcome
Dai (1988–1997)	Segmental instrumentation, anterior and posterior approach	ND	ND	3–12 years (mean 5.2 years)	Mortality, complications and neurological outcome (ASIA)
McKinley (1995–2000)	Laminectomies, spinal decompression, spinal fusions and internal fixations	ND	ND	1 year	Hospital stay, rehabilitation length, charges and neurological outcome (ASIA)
Croce (1996–1999)	ND	ND	ND	Hospital discharge	Mortality, pneumonia, ventilator days, ICU stay, hospital stay and charges
Gaebler (1985–1992)	Posterior pedicle instrumentation and decompression if necessary	ND	Light orthosis for 3 months	1.9–9.3 years (mean 5.6)	Complications, revisions, radiographic measurements and neurological outcome (Frankel)
McLain (1988–1993)	Posterior spinal stabilization and combined with anterior procedure for decompression or stabilization if necessary	Initiated in the emergency room	Molded orthosis and early mobilization	2 years	Mortality and neurological outcome (Frankel)
Schlegel (1986–1989)	Anterior or posterior approach	Not administered	Orthosis and rehabilitation protocol	Hospital discharge (neurological impairment 3.6 years)	Complications, ventilator days, ICU stay, hospital stay and charges
Prasad recruitment period unknown	26 × transpedicular screw plate fixation, 2 × interlaminar wire fixation and 1 × laminectomy	ND	ND	Hospital discharge	Neurological outcome (Frankel)
De Luna (1985–1987)	Segmental spinal instrumentation with bent rods	–	–	–	Complications
Magerl (1961–1977)	ND	ND	ND	Mean 4.7 years	Complications and neurological outcome (Frankel)

ND Not described

sults is shown in Table 4. McLain [32] and Croce et al. [10] report that stabilization within 72 h is safe in polytrauma patients and does not result in a higher mortality. Kerwin et al. [26] suggest individualized preoperative optimization. Dai et al. [11] agree with Kerwin et al. [26] and state that thoracolumbar fracture fixation should not be dependent on a rigid protocol. When patients are hemodynamically unstable and poorly resuscitated late stabilization is preferred. McLain [32] concludes that early stabilization is appropriate in progressive neurological deficit and unstable fractures (Tables 5, 6).

Rath et al. [45] and Gaebler et al. [19] found a significantly more neurological improvement in early-operated patients. Chipman et al. [8], Dai et al. [11] and McKinley et al. [30] report no difference in neurological outcome.

Fewer complications after early surgery are reported by Chipman et al. [8]. The incidence of pneumonia and pulmonary complications like acute respiratory distress

Table 4 Study quality

Authors and year	Study design	Selection bias	Performance bias	Attrition bias	Detection bias	LOE
Schinkel et al. [48]	RCS	+/–	+/–	[a]	+	IIc
Kerwin et al. [26]	RCS	+	–	[a]	+	IIc
Rath et al. [45]	RCS	+	+/–	+	+	IIc
Chipman et al. [8]	RCS	+/–	–	[a]	+	IIc
Dai et al. [11]	RCS	+	+/–	+	+	IIc
McKinley et al. [30]	PCS	+/–	–	+/–	+/–	IIc
Croce et al. [10]	RCS	+	–	[a]	+	IIc
Gaebler et al. [19]	RCS	+	+	+/–	+	IIc
McLain [32]	PCS	+	+	[a]	+	IIc
Schlegel et al. [49]	RCS	+/–	+	–	+	IIc

RCS Retrospective comparative study, *PCS* prospective comparative study, (+) low risk of bias, (+/–) moderate risk of bias doubtful, (–) high risk of bias

[a] Attrition bias not determined, follow up was limited to hospital discharge

Table 5 Results of the studies that combine thoracic and lumbar fractures

Authors and year	Mortality		Complications		Hospital stay (days)		Neurological outcome	
	<72 h	>72 h	<72 h	>72 h	<72 h	>72 h	<72 h	>72 h
Rath et al. [45]	–	–	–	–	–	–	Improvement 1.64 Frankel grades[a,b]*	Improvement 0.61 Frankel grades[b,c]*
Chipman et al. [8]	–	–	All complications 39.1%	All complications 54.6%	9.9* ICU 3.5*	18.9* ICU 8.5*	–	–
McKinley et al. [30]	–	–	Pulmonary 34.6%*	Pulmonary 45.4%*	14.1*	19.3*	ASIA motor index 16.21	ASIA motor index 17.42
Gaebler et al. [19]	5.5%[d]		Wound inf. 3.8%[e]	Wound inf. 4.0%[f]	27.3[e]		–	–
McLain [32]	7.1%[a]	7.7%[g]	ARDS b 0%[a]	ARDS 7.7%[g]	–	–	Improvement 1.10 Frankel grades[a,b]	Improvement 0.57 Frankel grades[b,g]
Schlegel et al. [49][a]	–	–	Pulmonary 6.8%*	Pulmonary 27.6%*	18.3 * ICU 3.0*	29.0* ICU 7.8*	Improvement 1.20 Frankel grades[b]	Improvement 1.20 Frankel grades[b]

Pulmonary All pulmonary complications, *Wound inf.* deep wound infection

*$P < 0.05$

[a] <24 h

[b] Neurological outcome only described in patients with neurological impairment at arrival at the hospital

[c] >24 h

[d] Data not available for separated groups

[e] <8 h

[f] 8–240 h

[g] 24–72 h

Table 6 Results of studies that describe thoracolumbar fractures

Authors and year	Mortality		Complications		Hospital stay (days)		Neurological outcome	
	<72 h	>72 h	<72 h	>72 h	<72 h	>72 h	<72 h	>72 h
Dai et al. [11]	3.3%[a]		Pulmonary 21%[a]		18.2[a]		Recovery rate 71.4%[a]	
Chipman et al. [8]	–	–	All complications 39.1%*	All complications 54.6%*	9.9* ICU 3.5*	18.9 * ICU 8.5*	–	–

[a] Data not available for separated groups

*$P < 0.05$

syndrome (ARDS) is lower in the early operated groups, reported by Kerwin et al. [26], McKinley et al. [30], Croce et al. [10] and Schlegel et al. [49]. Kerwin et al. [26] and Croce et al. [10] report this decrease in pneumonia especially for thoracic fractures. Dai has found no statistical difference in complication rate in early and late operated patients. Gaebler et al. [19] and Dai report complications related to the internal fixation such as implant loosening or failure of fixation. Dai et al. [11] had no implant failure in his 91 patients and implant loosening was found in 4.5% by Gaebler et al. [19] and failure of fixation in 6.8%.

Decreased hospital stay in early operated patients is found in the articles by Kerwin et al. [26], Chipman et al. [8], McKinley et al. [30], Croce et al. [10] and Schlegel et al. [49]. Shorter ICU stay in early-operated patients is reported by Chipman et al. [8], Croce et al. [10] and Schlegel et al. [49].

Discussion

The electronic literature search resulted in ten articles that were relevant for this systematic review. All studies were graded LOE IIc since they are all prognostic outcome studies. Critical appraisal of the included studies showed important flaws in several of them. For example, surgical techniques are poorly described in six of the ten articles. On the basis of LOE and the quality of the included studies we must conclude that the available evidence is limited. Nevertheless, this does not mean that we cannot draw some conclusions from those studies.

Controversy exists on the safety of surgery within 72 h. McLain [32], Kerwin et al. [26] and Croce et al. [10] report a similar mortality in early and late procedure for thoracic or lumbar fractures. Kerwin et al. [26] report a trend to a higher mortality in his article, but only in early treatment of cervical spine fractures. Since none of the studies report a higher mortality in early-operated patients with thoracic or lumbar fractures we can conclude that early surgery is safe.

Because perioperative mortality is quite uncommon with reported incidences between 0 and 7.7%, study size is an important factor in the accuracy of mortality results. Mortality results are often based on a small number of deceased patients, and therefore the precision of these results is often limited. For more accurate mortality results, larger patient populations are needed.

Hospital and ICU stay is decreased by early treatment. In all included articles that report hospital stay a reduced number of hospital days and ICU days are found in the early-operated patient groups. A much longer hospital stay was found in the study by Schinkel et al. [48] since the neurologically impaired patients stayed in the treating hospital during their rehabilitation instead of another rehab institution.

Differences in incidence of complications are reported in almost all included studies. Only Dai et al. [11] and Gaebler et al. [19] found no significant difference in complication rate. Decrease of pulmonary complications, like ARDS and pneumonia, are reported for early-stabilized thoracic and lumbar fractures. Comparing the outcome of thoracic with the outcome of lumbar fractures (Tables 7, 8), the effect of early surgery is more profound in thoracic fractures. A possible explanation can be found in the articles by Chipman et al. [8], Kerwin et al. [26] and Croce et al. [10]. All three studies show a trend to a higher ISS in thoracic than in lumbar fractures. Chipman et al. [8] also report significantly more complications and longer hospital stay in patients with ISS > 15 compared with ISS < 15. Based on this data we can conclude that the clinical outcome of traumatic spinal fractures is not only influenced by timing of surgery but also by fracture level and trauma severity. These findings suggest that early surgery is especially advantageous in patients with high ISS and thoracic fractures.

The study by Gaebler et al. [19] describes implant loosening and failure. There was no difference in incidence between early and late stabilized for this type of complication. Hardware failure ranges from 0 to 17% [13, 19, 33, 34, 38]. Re-operation is needed in half of the patients with hardware failure [13]. To reduce the risk of hardware failure experienced spine surgeons should be available for 24 h a day to perform early surgery as advocated by several studies discussed in this review. This could be a problem for a small trauma center because this may result in an increase in staff working hours and expenses.

Rath et al. [45] and Gaebler et al. [19] report more neurological improvement in early-stabilized patients. Early treatment is defined as treatment within 24 h in the article by Rath et al. [45] and within 8 h by Gaebler et al. [19]. Chipman et al. [8], Dai et al. [11] and McKinley et al. [30] report no difference in neurological outcome, but they define early surgery within 72 h.

Animal studies have reported an improved neurological outcome in early decompressive surgery in spinal cord injury [7, 14, 17, 18, 52]. The timing of decompression in animal studies ranges from minutes to hours rather than days. The earlier the decompression, the better is the neurological outcome; this is reported by several animal studies [7, 14, 17, 18]. These results cannot be simply compared with clinical results,

Table 7 Results of studies that describe thoracic fractures

Authors and year	Mortality		Complications		Hospital stay (days)		Neurological outcome	
	<72 h	>72 h	<72 h	>72 h	<72 h	>72 h	<72 h	>72 h
Schinkel et al. [48]	0%	0%	–	–	113 ICU 10	55 ICU 9	–	–
Kerwin et al. [26]	0.4%	4.1%	Pneumonia 10.2%*	Pneumonia 26.8%*	11.31* ICU 3.6*	22.4* ICU 9.2*	–	–
Croce et al. [10]	0%	2%	Pneumonia 3.0%*	Pneumonia 37.0%*	13.0* ICU 7.0*	30.3* ICU 15.1*	–	–

*$P < 0.05$

Table 8 Results of studies that describe lumbar fractures

Authors and year	Mortality		Complications		Hospital stay (days)		Neurological outcome	
	<72 h	>72 h	<72 h	>72 h	<72 h	>72 h	<72 h	>72 h
Kerwin et al. [26]	0%	0%	Pneumonia 16.7%	Pneumonia 6.8%	10.4* ICU 3.3	18* ICU 2.7	–	–
Croce et al. [10]1	0%	0%	Pneumonia 3.0%	Pneumonia 0%	11.2* ICU 4.1*	16.7*ICU 7.1*	–	–

*$P < 0.05$

since these experiments are conducted under highly standardized conditions with short and limited spinal cord compression. Therefore, extrapolation of these results to the human clinical situation is doubtful since in patients surgical decompression is rarely preformed within several hours, the injury is never standardized and there is no diagnostic means to determine the exact type and severity of the neurologic injury. Nevertheless, several LOE I and II clinical studies support these findings in patients with spinal cord injury [17, 18, 28, 35, 39, 55] and reviews recommend early surgery in spinal cord injury [2, 16, 36, 41, 44]. But there are also articles that report no difference in neurological outcome between early and late decompression [22, 42, 54].

There are strong indications that the positive effects of clinical outcome are obtained when a patient is treated within 72 h. However, the effect of timing of decompressive and stabilizing surgery on the neurological outcome remains controversial. At this moment there is no clear definition for what is early and what is late in spinal trauma surgery. This results in differently stratified patient populations; in this review we have found three different definitions of early surgery within 8, 24 and 72 h (Table 2). These definitions are based on studies that report improved outcome in early femur fracture fixation [5, 40]. It is questionable whether these can be extrapolated to spinal injuries. Furthermore, we could not find evidence for these definitions in any animal or clinical study concerning spinal cord injury. The complex pathophysiology of spinal cord injury with primary and secondary processes, immediate, acute, intermediate and late phases make it difficult to clinically distinguish between early and late intervention [15, 37]. Moreover, next to timing there are several other factors that may influence the neurological outcome of spinal injuries like fracture level and trauma severity [1, 25], this makes it difficult to determine which patients may benefit from early treatment and which will not, or possibly in which patient early treatment might even be harmful. More etiological and clinical research is needed to improve insight in the pathophysiology of spinal cord injury resulting in a better interpretation of the effect of timing on neurological outcome.

Randomized controlled trails are difficult and partly unethical to conduct in trauma patients [4, 27, 46]. But since the effect of timing on the outcome of trauma patients is a prognostic question a level I answer can be delivered by a high quality prospective study, with an adequate patient selection, adequate standardization of surgical, peri- and postoperative treatment and adequate follow-up. Early treatment should be divided into subgroups, for example in patients operated within 8, 12 and 24 h. Stratification for fracture level, injury severity score [3, 9] and initial neurological status is also needed to more specifically determine the effect of early surgical stabilization on the outcome of thoracic and lumbar fractures.

Conclusion

The available data strongly support that early intervention in thoracic and lumbar spine fractures is safe and advantageous. Especially patients with thoracic fractures and a high ISS may benefit most from early fixation. Neurologic injury patterns are diverse and prognosis is difficult to determine in acute setting. The available data suggest that some of these patients may benefit from early intervention. Large-scale multicenter prospective data collection may provide some of the answers to these questions.

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