Percutaneous pedicle screw fixation in polytrauma patients

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Abstract

Purpose The clinical outcome of polytrauma patients underwent spine fixation was analyzed and correlated both to surgical time (early versus delayed) and to fixation type (open versus percutaneous).

Methods Twenty-four polytrauma patients were retrospectively evaluated. Patients were evaluated according to age, accident dynamic, mechanical ventilation need, blood transfusion need, SAPS II score, type of vertebral injury, time of fixation (within or after 72 h) and type of fixation.

Results Nine patients underwent percutaneous pedicle screw fixation and 12 open fusion. An early fixation allows better clinical outcome considering ICU stay (13.7 versus 21.71 days), H-LOS (25.8 versus 69.5 days), mechanical ventilation need (7 versus 16.2), blood transfusion need (250 versus 592 cc).

Conclusions In polytrauma patients an early spine fixation improves clinical outcome. Patients underwent percutaneous screw fixation showed a better outcome compared to open surgery group obtained despite worst clinical conditions.

Keywords Amyelic fractures · Polytrauma · Early fixation · Percutaneous screw fixation

Introduction

Early long bones fractures fixation is, nowadays, a largely accepted treatment in medical literature and its positive effects have become more and more obvious within the amelioration of standardized techniques of osteosynthesis [1, 2]. In the last few years, several authors have begun to apply the same concepts to spine fracture stabilization. At the beginning only the positive effect on neurologic outcome has been extensively demonstrated [3, 4]. Despite this increasing interest, few studies have debated the positive role of early spine fixation in non neurologic outcome [5–7]. Schlegel was the first to identify 72 h as the turning point between early and delayed spine stabilization. He chooses 72 h because this time that there were the highest differences between the two groups [8]. Later, several studies demonstrated that an early spinal fixation was associated with a significant reduction in intensive care unit length of stay (ICU LOS), hospital length of stay (HLOS), incidence of pneumonia, reduced pain induced by spinal column instability and hospital charges, also for patients with an injury severity score of (ISS) >25 [6–10]. The greater advantages were seen in patients with thoracic spine injuries and associated thoracic trauma, in which an early fixation results both in the reduction of ICU and

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H-LOS as in the reduction of ventilations days and incidence of respiratory complications [5]. Timing of spinal fixation is crucial for a faster mobilization of patients to provide appropriate critical care, physical therapy, pulmonary toilet, and rehabilitation [11]. Despite these encouraging results in spine surgical community consensus about the optimal timing of spine fracture fixation is lacking. Therefore, an “ideal treatment algorithm” is desirable especially for fractures without neurological involvement both in terms of timing and or surgical approach. The purpose of our study is to analyze the clinical outcome of polytrauma patients who underwent spine fixation correlating both to surgical time (early versus delayed) and to type of fixation (open versus percutaneous).

Methods

The clinical conditions of 24 polytrauma patients, 18 male and 6 female, with a mean age of 48.1 years (range 19–81), hospitalized in our ICU from January 2009 to September 2011 were analyzed in a retrospective way. Patients were divided in two groups, considering surgical time: a group A, which underwent early surgical treatment (<72 h) and a group B, which underwent delayed surgical treatment (>72 h). Patients were also divided considering type of surgical approach: a group C, which underwent open pedicle screw fixation and a group D, which underwent percutaneous screw fixation. In all open procedures Expedium system (DePuy Spine, Raynham, Massachusetts, USA) was implanted while in all percutaneous procedures Pathfinder system (Zimmer-Abbot Spine Austin TX, USA) was implanted. A further distinction was made in all groups for patients with thoracic trauma. Patients of all groups were evaluated and compared in terms of age, accident dynamic, ICU LOS, HLOS, mechanical ventilation need, blood transfusion need, associated trauma and fractures, SAPS II score and type of vertebral injury. Considering the SAPS II score value patients were divided in 4 quartile, the first quartile with a score ≤ 20 , the second one with a score between 20 and 32, the third one between 32 and 41 and the fourth one ≥ 42 . To assure statistical homogeneity only patients affected by thoracic and lumbar amyelic vertebral fractures were evaluated.

Statistics

Descriptive statistics were calculated. The results obtained were analyzed using the Mann–Whitney Test with Bonferroni correction. Significance was accepted at $p < 0.05$. Tests were carried out with SPSS software (SPSS Inc, Chicago, IL, USA). There are some limitations that need to

be acknowledged and addressed regarding the present study. The number of cases is too limited for broad generalizations. Further empirical evaluations and greater patients' series are needed to validate the present results.

Results

Twenty-seven amyelic fractures, 18 thoracic and 9 lumbar were observed in 24 polytrauma patients. According to Magerl classification [12] 19 type A 3, 1 type B 2 and 6 type C 1 and 1 C 2 fractures were identified. In 16 patients, the mechanism of trauma was a traffic accident and in eight a fall from height. At admission time all patients presented at least an associated trauma (Table 1), and 15 patients underwent at least another intervention associated to spine fixation (Table 2). Twelve patients underwent

Table 1 The type and number of the associated trauma in the 24 polytrauma patients examined in the study

Associated trauma	Number
Cranial trauma	10
Thoracic trauma	16
Abdominal trauma	5
Facial fractures	3
Clavicle fracture	2
Scapula fracture	1
Humeral fracture with arm amputation	1
Radius fracture	2
Rib and sternum fracture	7
Femoral fracture	2
Tibial and fibular fracture	3
Foot fracture	4
Acetabular, sacral and symphysis fracture	7

Table 2 The type and number of the associated surgical of 15 out of the 24 polytrauma patients examined in the study

Associated surgical treatment	Number
Ventriculostomy	1
Fixation of parietal bone fracture	1
Craniotomy	3
Splenectomy	2
Retroperitoneal packing	1
Maxillary fracture reduction and fixation	1
Forearm amputation	1
Sacral and pelvic fracture fixation	2
Long bone fractures fixation	5
Leg hematoma drainage	1

percutaneous pedicle screw fixation and 12 open fusions with ileous autologous bone graft. Patients who underwent percutaneous screw fixation generally presented more stable fractures and more elevated SAPS II score value at admission, belonging to the III and IV quartile, 29 versus 25, three in the early fixation group and 41 versus 24 in the delayed group. In the percutaneous group 7 patients underwent surgical treatment within 72 h from trauma and 5 after 72 h. In the open group six patients underwent early surgery and six delayed. Mean surgical time in the percutaneous group was 85 min (range 55–100), and 190 min in the open group (range 90–240).

Patients who underwent early fixation showed a better clinical outcome. In these patients a briefer ICU-LOS was registered both in percutaneous (13.3 versus 36 days $p = 0.005$) and open group (13.3 versus 28 days $p = 0.05$). No statistical differences were registered between the two group $p > 0.05$. Considering all the 13 patients underwent early fixation the same trend could be observed with a mean ICU los of 13.7 versus 21.71 days in the delayed group $p = 0.003$. A briefer H-LOS was also observed in all groups. Considering all patients an H-LOS of 25.8 days was registered in the early group and of 69.5 in the delayed group, $p = 0.003$. In the percutaneous group an H-LOS of 14.4 days was observed with an early fixation versus 64 days with a delayed one, $p = 0.004$. In the open group, an H-LOS of 35.4 days was observed in the early fixation group versus an H-LOS of 83.4 days in the delayed group, $p = 0.005$. Patients who underwent percutaneous fixation showed reduced hospital stay compared to the open group both with early and delayed treatment, despite worst general condition at admission, $p = 0.007$, $p = 0.008$. An early fixation admitted, also shorter mechanical ventilation time 7 days in the early group versus 16.2 in the delayed group, $p = 0.003$. Considering the surgical treatment, percutaneous group showed a mechanical ventilation need of 6.6 days versus 10.5 in the open group, $p = 0.05$ in the earlier group, and of 8.5 versus 31.2 days, respectively in the delayed group, $p = 0.007$. Greater advantages were seen in patients with an associated thoracic trauma. In this subgroup patients treated within 72 h, showed a briefer mechanical ventilation time, 6.8 versus 17.7 days, $p = 0.004$. A better mechanical ventilation need was seen in the open group with 14.7 versus 56 days, $p = 0.0002$. No statistically significant differences were seen in the percutaneous group, $p > 0.05$. Also the amount of blood transfusion during the ICU stay was evaluated. The lower need of blood transfusions was registered in patients who underwent surgical treatment between 48 and 72 h with 250 versus 392 cc in patients underwent to surgical treatment within 24 h and 592 in these which were treated after 72 h, $p = 0.01$. Taking into account the type of fixation a lower blood transfusion need

Table 3 The outcome of the patients belonging to the III and IV SAPS II score quartile

Timing surgical treatment pz of III e IV SAPS II score quartile	ICU-LOS	H-LOS	Mechanical ventilation need	Blood transfusion need
Early	24.6	39.6	24	356 cc
Delayed	43.6	95	44.6	895 cc
Significance $p < 0.05$	0.003	0.004	0.002	0.005

was seen in patients who underwent percutaneous screw fixation compared to open fusion both with an early treatment 266.6 versus 392 cc as with a delayed treatment 342.8 versus 1220 cc, $p = 0.001$. A major need of blood transfusion was seen in patients with an associated thoracic trauma, 400 cc in patients treated within 24 h, 333.3 cc in patients treated between 48 and 72 h and 690 cc in patients treated after 72 h. An early treatment was associated to lowed blood loss in patients who underwent open fixation 450 versus 850 cc in the delayed treatment, $p = 0.007$. No statistically significant differences were observed in the percutaneous group with thoracic trauma. The better outcome taking into account the worst clinical condition at admission was seen in patients belonging to the III and IV SAPS II score quartile (Table 3).

An early treatment also showed a reduced infection rate only 2 cases in the early group versus 7 cases in the delayed group. No hardware failure was observed and in patients with C type fractures treated in a percutaneous way a subsequent anterior fixation was performed at stabilizing of general conditions.

Discussion

The concept of early spine fixation for polytrauma patients is still a debated issue. The absence of guidelines is probably due to the known complexity in decision making for vertebral fractures in such a complex population. Polytrauma patients present a great number of associated lesions, visceral lesions and hemodynamic instability. These conditions make the decision about timing and type of surgical treatment very difficult. Several studies clearly questioning the prevalent philosophy according to which “the patients is too sick to operate on”, and underline as an early spine fixation, especially in polytrauma patients presents great advantages in non neurologic outcome [5, 11, 13]. Kerwin et al. [11] describes one of the major case series with 229 polytrauma patients, underwent early spine fixation within 72 h. The clinical outcome of these patients compared to this of patients underwent delayed treatment, showed a briefer ICU and H- LOS, a lower incidence of pneumonia and generally of respiratory complications. The

better outcome was seen in patients with thoracic trauma or in presence of a neurological involvement [11]. These data were confirmed in Croce group study [5]. Croce data underline as an early spine fixation at every level, is associated to a lower incidence of venous thrombosis, distress respiratory syndrome and H-LOS [5]. Schlegel showed as a delayed treatment after 72 h from trauma is associated to an increased pneumonia incidence risk till to 12.2 time, 4.8 time pressure sores onset risk, 3.2 time urinary tract infection risk of this of early fixation patients [10]. Patients underwent to delayed spine fixation showed also an increased mechanical ventilation need. Also in our series patients treated within 72 h showed a better outcome in terms of ICU stay (13.7 versus 21.71 days), H-LOS (25.8 versus 65.8), mechanical ventilation need (7 versus 16.2 days), a lower infections' incidence. Patients with thoracic fractures or with an associated thoracic trauma showed in our cohort the great advantages. This data are very important in the decision making about these patients, because thoracic fractures are the most common fractures in polytrauma patients and the thoracic trauma, the trauma with a major incidence in this population [14] Bellabarba et al. underlines as an early treatment bring to significant advantages in the outcome of most severe injured patients [15]. When an early treatment is performed, in severe injured patients is registered not only a lower incidence of complications but also a decrease in mortality, 0–11 % with an early fixation versus 0–17 % with a delayed one [15]. In our series better results were obtained in the most injured patients, belonging to the III and IV SAPS II score quartile. Sickest patients benefit more from early surgical treatment [10]. The clinical outcome of patients with vertebral fractures is influenced not only from the timing of surgical treatment but also from fracture level and trauma severity, throughout an early treatment largely contributes to the decrease of comorbidities in severe injured patients [16]. The eligibility of a polytrauma patient to early surgical treatment is largely influenced from the hemodynamic stability. By several authors is reported a blood loss increase in these patients, due both to normal post-traumatic bleeding, as to intra-operative bleeding from epidural and paraspinal vessels, as to the difficulties in obtaining high hypotension anaesthesia [17]. A post-operative bleeding reduction could be obtained by delaying surgery within 48 and 72 h [18]. Also in authors' series, an increase in blood transfusion need was registered in patients treated within 24 h from trauma, 392 versus 250 cc registered in patients treated within 48 and 72 h. An early surgical treatment admits to reduce the intra and post-operative bleeding compared to a delayed one, in which the amount of blood transfusion was 592 cc. In polytrauma patients, the presence of abdominal bleeding, lesions to vitals or vascular lesions has always to be considered [17].

Particularly severe vascular lesions, responsible of significant hemodynamic instability, at higher risk for patient life, could justify a delay in the final surgical treatment [19]. Just in these patients the concept of damage control become of great importance. In the last years, this concept gained a new role in the treatment of vertebral fractures, up to the creation of a proper algorithm based on the concept of spine damage control by Pape et al. [20]. The spread of this algorithm on a large scale has been possible thanks to the amelioration of the surgical technique in spine surgery and the introduction of percutaneous screw fixation. In trauma patients conventional open approaches are generally related to significant morbidity due to increased infection rate, high blood loss and approach related morbidity (muscle morbidity as denervation, revascularization damage, increased intramuscular pressures, etc. [21–23]). This increased morbidity associated to the difficult hemodynamic management and the possible ventilatory/perfusion mismatch in the first 48 h in polytrauma patients led, generally, to delay surgery. Percutaneous fixation is beginning to be considered as a temporary solution to these complications [23]. Early percutaneous fixation, also in unstable amyelic fractures, provides the possibility to obtain a temporary mechanical stability sufficient to enhance mobilization of the patients improving so pulmonary/respiratory care and nursing. Percutaneous screw fixation is characterized by faster surgical time, decreased blood loss and muscle morbidity and so represents a valid alternative treatment in the polytrauma population, which is characterized by transient malnutrition, immune changes and skin colonization [23]. Despite the proven advantages of this surgical technique consensus about its use in polytrauma patients in the spinal community is lacking. In our series polytrauma patients who underwent percutaneous screw fixation showed lower H-LOS compared to patients who underwent conventional open procedures (64 versus 83.4) and lower blood loss (342.8 versus 1220 in the delayed treatment) despite higher value of SAPS II score at admission time. Perhaps the possibility of stabilizing only once all skeletal lesions admit a faster recovery (Fig. 1a, b). Assurance of a basic mechanical stability is of high importance in polytrauma patients, assisted in ICU, to facilitate nursing and avoid neurological deficits consequent to numerous movements and associated possibility of breaking up stable amyelic fractures, as showed by Markandaya et al. [24].

Conclusion

Early treatment within 72 h of vertebral fracture in polytrauma patients showed a considerable efficacy in the amelioration of the clinical outcome of this complex population.

Fig. 1 **a** Preoperative CT scan view of patients with a SAPS Score II of 45, an A3.2 amyelic vertebral fracture, a pelvis ring fracture, a complex femoral fracture. **b** Postoperative X-ray of the same patient

showing lumbar percutaneous screw fixation, pelvis ring fixation, femoral external fixator performed in one surgical

The greater advantages were seen in most severely injured patients especially with thoracic fractures. Despite these encouraging results the last decision is left to the surgeon. So the surgeon has also to individualize this decision on every patient taking into account the skeletal lesions but above all the prioritize in terms of general conditions.

Conflict of interest The authors declare they have no competing interests.

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