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Comparative study of thoracolumbar fractures posterior fixations between long segment and short segment involving the fractured vertebra

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Abstract

Background. Thoracolumbar fractures are among the most common and unstable traumatic injuries to the spine. They require a rigid fixation. However, there are controversies in the choice of fixation types. This study aimed to compare long-segment posterior fixation (LSPF) bridging the injured vertebra and short-segment fixation with screws in the fractured vertebra (SSFFV).

Methods. This was an analytical study of 22 patients admitted to the Kinshasa University Teaching Hospital from 2020 to 2023 with thoraco-lumbar fractures. Variables of interest included: sex, age, occupation, cause of fracture, ASIA score, injured vertebra, Magerl fracture types, Sagittal Cobb angle (SCA), and level of fixation. Data were analysed using SPSS 26 software.

Results. Ten patients (45.4%) had SSFFV and 12 (54.6%) had LSPF. Overall, the sex ratio was 4.5 and, the mean age was 35.27±9.88 years. Road accidents accounted for 72.7% of causes, fracture of L1 (50%), ASIA A (41%) and Magerl B (54,5%). Pre-operative features did not show a difference between the two fixations. No difference was observed in function values before surgery (p=0.863) and at one year postoperatively (p=0.914). The mean SCA was 15.57 ± 5.90° before surgery, and 12.60±5.94° one year after surgery showing a significant correction of local kyphosis of 3° (P <0.001). There was no significant difference in the degrees of correction of local kyphosis immediately postoperatively (p=0.591) and at one year postoperative (p=0.819) and also in the degrees of loss of local kyphosis (p=0.870) between SSFFV and LSPF.

Conclusion. This study did not show a significant difference in functional recovery, reduction and loss of correction of traumatic kyphosis between the two fixations. The SSFFV therefore appears to be an effective alternative to LSPF.

Keywords
thoracolumbar fracture,
long-segment fixation,
short-segment fixation,
cobb's angle

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Introduction

Spinal fractures are among the most feared injuries by patients and doctors, and their consequences can be devastating, ranging from complete paralysis to death [1]. The thoracolumbar region is the transition from the rigid thoracic spine to the movable lumbar spine, and it is considered biomechanically to be the weakest part of the spine.

This characteristic makes it vulnerable to various high-energy injuries resulting from road accidents and falls [2]. Nearly 60-70% of all traumatic spinal injuries occur in this region [3,4]

Treatment of traumatic spinal cord injury can be conservative or surgical. In the majority of cases, surgical management may be warranted in unstable fractures, as is the case with the majority of thoracolumbar fractures, and those associated with neurological deficit [5]. Surgical approaches can be anterior, posterior, or a combination of anterior and posterior surgery. There is an abundant literature on different surgical techniques for reducing and stabilizing unstable fractures, but no consensus on the ideal treatment. Finally, the expertise and preference of the surgeon is an important factor.

The primary aims in surgical treatment are: the reduction of segmental kyphosis, the restoration of the stability of the spine and the decompression of the spinal canal, which allows an early mobilization of the patient [6]. In posterior spinal fixations, trans-pedicle screws are usually inserted above and below the fractured level to achieve reduction and control of segmental kyphosis. LSPF consists of attaching 2 levels above and 2 levels below the fractured vertebra. Short-segment posterior fixation (SSPF) fixes one level above and one level below the lesional focus. In the latter type of fixation, the screws can also be inserted into the injured vertebra if its pedicles are intact. This is the short-segment fixation involving the fractured vertebra (SSFFV). The number of fixation levels above and below the fracture is still controversial in the literature [2].

Although SSPF can achieve a satisfactory reduction, it often leads to instrumentation failure due to osteoporosis and loss of correction [7]. LSPF is an alternative solution, which can increase the rigidity of the construction and reduce the load on each screw by applying long segmental instrumentation. However, LSPF is unnecessarily extensive and decreases the number of motion segments. Saving the movement segments is an important principle of thoracolumbar spine surgery. In addition, this type of osteosynthesis is often associated with the development of adjacent segment degeneration disease [8–10]. As a result, the SSFFV appears to be an intermediate solution. It limits the number of merge segments and protects adjacent segments from degeneration. It improves the efficacy of SSPF compared to long-term control of kyphosis correction [3]. Many publications focused on comparing LSPF and SSPF, both of which bridge the fractured vertebra [1,5,11,12,13]. Few authors attempted to compare LSPF and SSFFV [14,15].

The purpose of this study is to determine if there is a difference in radiological and neurological outcomes between LSPF and SSFFV.

Methods

Study design and data collection process

This is a quasi-experimental study conducted at the Kinshasa University Teaching Hospital (KUTH) in the Democratic Republic of Congo (DRC) from 2020 to 2023. The intervention group is made up of SSFFV cases. The control group includes cases of LSPF or conventional long-segment fixation. The comparator is functional and radiological outcomes. Included in this study were all cases of unstable thoracolumbar junction fracture (T11-L2) with neurological deficit (ASIA A-D) operated in the Neurosurgery Department of the KUTH during the study period. There were 25 patients, of whom only 22 met our work criteria, 10 received SSFFV and 12 others received LSPF.

All cases of pathological thoracolumbar fractures (osteoporotic, tumor, etc.), fractures with both damaged pedicles and cases with a history of surgery at the thoracolumbar hinge were excluded. Variables of interest included : sex, age (year), dates of entry and discharge, occupation, residence, patient complaints, history, vital signs, cause of fracture, injured vertebra, Magerl fracture types, ASIA score, Sagittal Cobb angle (SCA), fixation level and complications. Data were collected prospectively. The diagnosis was made on the basis of radiological arguments. Patients were evaluated radiologically and clinically prior to surgery, immediately after surgery to assess the angle of correction of kyphosis, and at the end of the first postoperative year to assess loss of correction.

Surgical management

After induction of general anesthesia with endotracheal intubation, each patient was placed prone on a specialized surgical setting in which the upper half of the chest and iliac crests were supported by pads to create a spine hyperextension position and achieve postural reduction. All patients underwent posterior surgery. After incision and dissection of the soft tissues, the surgical procedure consisted of the placement of pedicle screws, followed by a decompression laminectomy, followed by a reduction in displacement and stabilization. For the short assembly with intermediate screws, the technique consisted of placing 6 screws, 2 of which were through the pedicles of the vertebra overlying the fractured vertebra, 2 in the pedicles of the injured vertebra and 2 last screws through the pedicles of the underlying vertebra. The choice of this possibility had to take into account the integrity of the pedicles of the traumatized vertebra and the thickness of the vertebral body.

Regarding osteosynthesis bridging the fractured vertebra, the long-segment set-up consisted of either 8 screws, 4 of which were screwed on 2 vertebrae above the fractured vertebra and 4 screws on 2 other vertebrae below it. The operation continued with the joining of different screws by means of 2 bars on either side of the spine. We used mono and poly-axial screws depending on the case.

Post-operative follow-up

It focused on two components : radiological and clinical. Radiographic evaluation included sagittal Cobb angle (SCA), degree of postoperative reduction, loss of correction at 1 year, and degree of definitive reduction at 1 year. The ACS was calculated from the intersection of two perpendicular lines, one to the plane of the upper plate of the overlying vertebra and the other to the plane of the lower plate of the underlying vertebra (Fig. 1) [16]. The degree of reduction was measured by the difference between the pre-operative and postoperative Cobb angle. And the loss of correction was measured by the difference between the postoperative Cobb angle and that calculated at one year postoperatively. The final degree of correction was the difference between the initial Cobb angle and the one measured at one year.

Figure 1. Sagittal Cobb angle : angle formed by the intersection of 2 perpendicular lines, one to the plane of the upper plate of the overlying vertebra and the other to the plane of the lower plate of the underlying vertebra.

Regarding clinical follow-up, daily medical visits were carried out to assess the ASIA score and compare it with the admission scores for the two groups of operated patients.

Statistical analysis of data

For the interpretation of the results, we used SPSS 26 software. The statistical tests performed were : percentage calculation, mean and standard deviation (χ, ±SD). The Pearson Chi-Square Test of Independence was used to compare neurological function using the ASIA score. The independent sample Student's t-test was performed to compare the Cobb angle of two groups of LSPF and SSFFV mounts. A difference was considered statistically significant for a P-value < 0.05.

Results

Pre-operative features of patients

We followed 22 patients with thoracolumbar spinal cord injury, 10 (45.4%) had SSFFV and 12 (54.6%) had LSPF. Overall, the sex ratio was 4.5 and the mean age was 35.27±9.88 years. Road accidents accounted for 72.7% of causes. These were often L1 fracture (50%), ASIA A score (41%) and Magerl B fracture (54.5%). Among the 10 SSFFV, 9 cases (90%) were male versus only one patient (10%) female, for a male/female sex ratio of 9. Patients aged 21 to 40 years accounted for 6 cases, or 60%. The mean age was 35.70±11.52 years. Road accidents were the leading cause of TVM with 8 cases (80%). All patients had a neurological deficit at admission : ASIA A score (40%), ASIA B (30%) and ASIA C (20%) and ASIA D (10). Six traumas (60%) involved the L1 vertebra. The fracture, Magerl type B, accounted for 60% of cases.

Of the 12 LSPF, 9 patients (75%) were male versus 3 (25%) female, i.e. a male/female sex ratio of 3. Eight traumatized patients aged of 21 and 40, 66.6 percent. The mean age was 34.92±8.79 years. Road accidents were the leading cause of TVM, with 8 cases (66.7%), followed by various falls in 4 cases (33.3%). Five patients (41.7%) had ASIA A score and 4 traumatized patients were ASIA B (33.3%). Five traumas (41.7%) had the L1 lesion and 4 (33.3%) had the T12 lesion. Magerl A and B fractures each accounted for 50% of cases. The mean Cobb angle at intake was 15.57±5.90° for the set, 14.89±4.64° for SSFFV, and 16.80±8.19° for LSPF. For all these preoperative features, the difference was not statistically significant between the two groups (Table 1).

Table 1. General data

Parameters	SSFFV N=10 (%)	LSPF N=12 (%)	Total 22 (%)	p-value
Age (years)				
▪ ≤ 20	1(10)	1(8,4)	2(9,1)	0,854
▪ 21 à 40	6(60)	8(66,6)	14(63,7)	
▪ 41 à 60	3(30)	3(25)	6(27,2)	
Mean Age	35,70±11,52	34,92±8,79	35,27±9,88	0,858
Sex				
▪ Male	9(90)	9(75)	18(81,8)	0,364
▪ Female	1(10)	3(25)	4(18,2)	
▪ Sex ratio	9	3	4,5	
Etiology				
▪ MVA	8(80)	8(66,6)	16(72,7)	0,529
▪ Fall	1(10)	4(33,4)	5(22,8)	
▪ Gunshot	1(10)	0(00)	1(4,5)	
ASIA				
▪ A	4(40)	5(41,7)	9(41)	0,863
▪ B	3(30)	4(33,3)	7(31,8)	
▪ C	2(20)	1(8,4)	3(13,6)	
▪ D	1(10)	2(16,6)	3(13,6)	
Injuried Vertebra				
▪ T 11	0(00)	2(16,6)	2(9,1)	0,558
▪ T 12	3(30)	4(33,3)	7(31,8)	
▪ L1	6(60)	5(41,7)	11(50)	
▪ L2	1(10)	1(8,4)	2(9,1)	
Magerl fracture				
▪ A	3(30)	5(41,7)	8(31,8)	0,688
▪ B	6(60)	5(41,7)	11(54,5)	
▪ C	1(10)	2(16,6)	3(13,7)	
SCA				
▪ Mean (°)	14,89±4,64	16,80±8,19	15,57±5,90	0,583

Table 2. Neurological Outcomes

ASIA	SSFFV						LSPF						p-value+	p-value*
	Pre-operative	After 1 year					Pre-operative	After 1 year						
		A	B	C	D	E		A	B	C	D	E	Pre-op	Post-op
A	4	4	0	0	0	0	5	3	2	0	0	0	0,863	0,914
B	3	0	2	1	0	0	4	0	2	1	1	0		
C	2	0	0	0	2	0	1	0	0	0	1	0		
D	1	0	0	0	0	1	2	0	0	0	0	2		
Total	10	4	2	1	2	1	12	3	4	1	2	2		

p-value +: pre-operative ASIA comparison between the two fixations
p-value*: ASIA comparison at one year postoperatively between the two groups.

Table 3. Neurological

SCA		Fixation	Mean (°)	DS (°)	N	p-value*
A	: Pre-operative	SSFFV	14,89	4,64	10	0,583
		LSPF	16,80	8,19	12	

Total			15,57	5,90	22	
B	: Immediate pre-operative	SSFFV	8,50	0,70	10	0,618
		LSPF	11,67	7,63	12	
Total			10,40	5,68	22	
C	: After 1 Year post-surgery	SSFFV	10,50	0,70	10	0,596
		LSPF	14,00	7,93	12	
Total			12,60	5,94	22	
Post-surgery correction		SSFFV	6,39	3,94	10	0,591
(A – B)		LSPF	5,11	0,56	12	
Total			5,07	0,22	22	
Post-surgery correction loss		SSFFV	2	0,00	10	0,870
(C - B)		LSPF	2,33	0,30	12	
Total			2,26	0,31	22	
Final Correction after 1 Year		SSFFV	4,39	3,94	10	0,819
(A- C)		LSPF	2,8	0,26	12	
Total			2,97	-	22	

N : number
* : Student's t-test for independent samples

Neurological Outcomes

No patients with ASIA A among the SSFFV improved their admission score. Of the 5 LSPF patients with ASIA A, 3 kept the same grade and 2 switched to ASIA B. One out of three patients with ASIA B on admission to the SSFFV group progressed to ASIA C. Similarly, two out of the 4 patients in the LSPF group with ASIA B at the start of hospitalization improved their neurological status, of which 1 went up to ASIA C and 1 to ASIA D. The two traumatized individuals in the SSFFV group with ASIA C at entry were transferred to ASIA D at admission. Similarly, the single ASIA C patient from LSPF was upgraded to ASIA D at the last assessment. The single ASIA D patient from SSFFV and the two ASIA D trauma patients from LSPF all achieved grade E after one year. There were no significant differences in function values before surgery (p=0.863) and at one year postoperatively (p=0.914) between the two groups (Table 2).

Radiological results

For all 22 patients, the mean SCA was 15.57 ± 5.90° before surgery, 12.60±5.94° at one year after surgery showing a significant correction of local kyphosis of 3° (P <0.001). For SSFFV, the mean SCA was 14.89±4.64° before surgery, 10.50±0.70° at one year after surgery with a significant correction of local kyphosis of 4.39 ±3.94 (P=0.049). The mean SCA of LSPF was 16.80±8.19° before surgery, 14.00±7.93° at one year postsurgery with a significant correction of local kyphosis of 2.8 ±0.26 (P=0.017). However, there was no significant difference in the degrees of mean pre-operative SCA (p=0.583), immediate postoperative mean SCA (p=0.618), mean SCA at one year postoperative (p=0.596), correction of local kyphosis in immediate postoperative (p=0.591), one year after surgery (p=0.819) and the degree of loss of this correction (p=0.870) between the two types of fixation (Table 3). Figures 1, 2 and 3 illustrate the evolution of SCA over different time points pre-operative, immediate post-operative, and at one year post-operative for SSFFV.

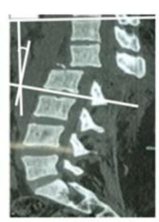

Fig. 1 : SCA before Surgery

Fig. 2 : SCA Immediate post-surgery

Fig. 3 : SCA 1 year after surgery

Discussion

Pre-operative data

Thoracolumbar fractures are among the most common traumatic injuries to the spine [17]. They frequently affect young male people. They are often caused by violent trauma such as road accidents and falls from very high places [5, 10, 18, 19]. Half of these lesions are unstable [20] and are much more relevant to the L1 [3,6,11,15,18,21]. Burst-type fractures (A3 according AO or to Type B of Denis classification) account for 21% to 58% of all fractures of the thoracolumbar spine [22] and approximately 70% of these fractures occur without immediate neurological injury and, ultimately, 55% remain neurologically intact. Neurological deficit is often incomplete [23]. Previous studies, which compared SSFFV and LSPF, noted that there was no difference in the socio-demographic and pre-operative characteristics of patients [3,11,22].

In our series, socio-demographic and pre-operative characteristics also did not show a significant difference between the two fixations. The sex ratio was 4.5, the mean age 35.27±9.88 years. Road accidents accounted for 72.7%, L1 fracture (50%) followed by T12 (31.8%), ASIA A (41%) and Magerl B (54.5%). Young male people engage in high-risk activities, exposing them to spinal trauma in order to provide for their families, which would justify their predominance. The high frequency of L1 and T12 lesions may highlight the vulnerability of these two hinge vertebrae between the thoracic rigid segment and the movable lumbar portion compared to other vertebrae [23]. The preponderance of Magerl B and ASIA A lesions in this study could be explained by the velocity of the traumatic agent. The majority of our injuries were caused by road accidents.

Neurological outcomes

At the end of one year, there was a significant improvement in neurological function from admission within each group and for all patients in general (p<0.001). No significant differences were observed between the two fixations in function values before surgery (p=0.863) and at one year postoperatively (p=0.914). These results confirm the data in the literature. Apart from ASIA A fractures, the other ASIA types evolve favorably after surgical fixation () in the following order: C>B>D>A [24]. After a rigid correction, many researchers point out that the majority of surgical patients improve their neurological function after a year or more [18]. However, many series claim that the two types of fixation are equivalent in terms of functional recovery [18,19,22].

Radiological outcomes

The primary objectives in the surgical treatment of thoracolumbar fractures, as mentioned above, are: correction or reduction of segmental kyphosis, restoration of spine stability, preservation of mobile segments of the spine, decompression of the spinal canal, which allows early postoperative mobilization of the patient [6, 11, 22].

According to the literature, the closer one is to the fracture site, the easier and better the reduction. Short-segment fixation with or without screws in the fractured vertebra satisfies this requirement and is recognized by some authors as the most suitable instrumentation to better correct local kyphosis while at the same time reducing the number of levels of immobilization [25]. However, other studies show that the difference between short screw fixation in the fractured vertebra and long-segment fixation bridging the fracture focus is not significant [2]. Short fixation has been criticized for not maintaining this correction of segmental kyphosis for a long time compared to long fixation [6]. However, much more recent work has not found a significant difference between the two surgical techniques in terms of loss of correction of local kyphosis after a fairly long setback time. Long-segment fixation is recognized as the most stable setup resulting in less loss of correction of segmental kyphosis due to multiple levels of fixation [6,11,22]. However, this extensive immobilization is often blamed by some authors as the source of subsequent pain and adjacent degeneration segment (ADS), especially in people over 50 years of age, which exposes patients to other surgical procedures [6,22].

However, recent studies have not found a significant difference between the two fixations in terms of stability and correction of segmental kyphosis from the angle of the ACS [13,15,22]. In our series, no significant differences were recorded between the two bindings in terms of correction or loss of correction after one year. The SSFFV achieved a final correction for local kyphosis of 4.39 ±3.94° and LSPF of 2.8 ±0.26° (p=0.583). The SSFFV lost the correction of segmental kyphosis by 2° and the LSPF by 2.33±0.30° (p=0.870). The majority of the literature did not note a final correction or loss of segmental kyphosis greater than 10° [18] and the surgical procedure resulted in a significant correction of the angle [3,15]. In our study, the final reduction at one year was less than 3°, and the final correction of segmental kyphosis was significant for all patients (P <0.001).

Conclusion

This case series did not show a significant difference in functional recovery, reduction and loss of correction of traumatic kyphosis between the two posterior fixations of thoracolumbar fractures. The SSFFV therefore appears to be an effective alternative to LSPF. It satisfactorily reduces traumatic kyphosis and the loss of correction is similar to that of LSPF after one year. This technique may be recommended for older people who have difficulty withstanding long procedures and heavy instrumentation. With the aging of the world's population as described by the WHO, we believe that SSFFV would become a technique of the future. It is also an osteosynthesis suitable for low-income countries that do not have a lot of equipment (screws, bars, plates). But many randomized studies with larger sample sizes are needed to confirm all these hypotheses.

Limits

The monocentric nature and small sample size of this study do not allow the results to be generalized. Some important elements were not calculated : the anterior height of the fractured vertebral body, the vertebral body index, and the spinal canal impingement. But this work has allowed us to get an idea of the neurological and radiological outcomes of these two types of fixation in our environment.

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