Influence of the Shape of Back on the Thoraco-lumbar Fractures

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Abstract

Introduction: The surgical management of degenerative and malformative spinal deformities takes into account the pelvic and spinal parameters. This concept is not applied in traumatology.

Purpose: To adapt the correction of traumatic kyphosis deformity to the type of backs in function of pelvic incidence and to study the influence of the shape of back on the localization, the type of fracture, the correction, and the loss at follow-up.

Methods: It is a prospective study of 80 patients operated from February 2005 to December 2010. Mean follow-up was 52 months (18-72). Patients were treated by the same surgeon by a posterior osteosynthesis using in situ contouring technique. We evaluated kyphosis deformity according the shape of backs assessed by the value of the pelvic incidence (PI) calculated in lying position.

Results: Our patients were classified with low PI (type 1, 2) in 35% of cases and high PI (type 3, 4) in 57% of cases. No significant difference was found in the repartition of fracture levels, type of fracture and the kyphosis deformity. However, the number of patients with good correction and with loss at follow-up was important in high pelvic incidence (p<0.001).

Discussion: Neurologic status is not the only point of decision in chirurgical treatment. The kyphosis deformity in trauma is also an important point, but this angle is not always easy to measure. The relationship between deformities with injury level of spine depends on type of backs. A patient with trauma (lying position), pelvic incidence is the only angle which gives an idea about the shape of backs. According to Roussouly’s classification, type 1 (long thoraco-lumbar kyphosis) and type 2 (flat), the correlation at the injury level is not necessary, but for type 3 and 4 (with harmony curvature), the correlation seems logical.

Keywords: Thoraco-lumbar fracture; Pelvic incidence; Shape of back; In situ contouring technique.

Introduction

Thoraco-lumbar fractures are the most frequent spinal injuries [1-3]. The traumatic injury first leads to a kyphotic deformity [4] noted and measured as previously described by several authors [5-8]. In fact, young and active people are the most affected by those fractures [9]. Actually, because of the constraint of the spine, the trauma may depend on the type of trauma. These fractures are more surgically treated, because the kyphosis deformity is not always easy to measure [11]. For some authors, the value of this deformity must be correlated with the injury level of spine, others do not index their measurements at the affected level [5,7-12-16]. Our objective was to prove the relationship between shape of back (pelvic incidence) (PI) and parameters, which evaluate the kyphosis deformity in thoraco-lumbar trauma. Pelvic parameters defined for many years by Duval-Beaupère and Legaye [17,18] are significant chain of correlations between positional pelvic and spinal parameters which are fundamental for the surgical management of spinal degenerative and malformative deformities [19-21]. Although, this concept is less spread in thoraco-lumbar fractures. With injured patients, PI is the only pelvic angle which helps us to understand the sagittal balance spine and gives an idea about the shape of back and about the degree of the kyphosis deformity.

The Purpose of this study was to adapt the correction of traumatic kyphosis deformity to the type of backs in function of PI and to study the influence of the shape of backs on the localization, the type of fracture, the correction, and the loss at follow-up.

We conducted a prospective and observational study of 80 thoraco-lumbar fractures, operated on by the same surgeon. Reduction was performed by the in situ contouring technique described by Jackson [22] and Steib [2].

Patients and Methods

The study was composed of 80 injured patients, mean age 36 years (16-68), BMI 25.39 (19-31) with a majority of men (61 men versus 19 women). The type of trauma was variable but home accidents were mostly encountered (Table 1). These fractures were treated by the same team from February 2005 to December 2010. Mean follow up was 52 months (18-72). The thoraco-lumbar junction fractures were defined as T12-L1 fractures, with extension to T11 and L2 (Table 1) [1,23]. The most frequent fractured level was L1. Fractures were classified according to Denis [24], as this classification seems to us the easiest to use (Table 1). We recorded a majority of Burst fractures (62%).

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majority of the injured experienced with no neurological troubles (68% Frankel E). There were 9 complete paraplegias (Frankel A) and 17 incomplete neurological troubles (3 Frankel B, 5 Frankel C, 9 Frankel D) (Table 1). In order to analyze the deformity, we studied the relation between the traumatic vertebra and the adjacent vertebrae (Figure 1) [1] on preoperative X-rays (lying position) as well as on immediate and long term post-operative X-rays (upright full spine X-rays). We were more interested not only with the relative deformation but also with the real deformation. Farcy sagittal index (SIF) [25] brings the real notion of the importance of the traumatic kyphosis [1]. It corresponds to the segmental kyphosis (SK) [one disc, one vertebra (inferior endplate of the injured vertebra/inferior endplate of the overriding vertebra)] diminished by the segment physiological kyphosis, which arbitrarily amounts to 5° in the thoracic spine, –10° in the lumbar spine and 0° in T12–L1. The normal index is zero. According to Roussouly's classification of lumber lordosis into four types to define the shape of the vertebra forming a perpendicular line with the rod) by compression-distraction maneuvers [1,2]. The sub-laminar hook is locked in compression on the screw that it protects. The postero-lateral articular graft is then implanted. Patients rapidly got up without any external fixation (4 days) [1,12,29]. Radiologic measurements are made by three different surgeons. The clinical results were evaluated according to Oswestry score [30].

### Results

Osteosynthesis was considered as long when we fix two discs below and above the fracture (64%) and as hybrid for the others: every time we fix two discs above and one disc below (36%). Osteosynthesis was always protected by posterior and postero-lateral graft. The operation was done within 12 days (1-21). Non-neurological patients waked-up at the fourth day (2-7) without any external contention. Hospitalization lasted 4 days (5-30).

Post traumatic deformity from 17.35° for the SIF arrived at -1.2° (correction 18.55°), for GSKD from 19° can reach -0.58° (correction 19.58°). The vertebral kyphosis (VK) passed from 17.8° to 3.99° (correction 13.7°). In the last follow-up, the loss of correction was (VK=0.27°, SIF=2.4°, GSKD=2.49°, P<0.0001). The real gain was (VK=12.8°, SIF=2.04, GSKD=2.49°) (Table 2).

The estimation of deformity for the two parameters (SIF, GSKD) did not have a significant difference for the whole study, this was explained by the important number of fractures in T12-L1 level (37 patients) (Figure 2) that corresponds to a flat segment. On the contrary, the value of these parameters was not the same according to the zone touched (p<0.0001) (Table 3). This is given us an idea to add a new parameter: pelvic incidence, the only angle calculated in patients with trauma, which divided our patients into two groups [29]: with low incidence (<50°) (29 patients) and with high incidence (≥50) (51 patients). Angular measurements in these two groups appear in the Table 4. We noticed that there was not a significant statistic difference between these two groups in level, type and neurological status (Table 5).

According to the correction obtained, a normal correction had a...
and none required material removal. While there were eight sepsis cases (10%), none of the patients who underwent surgery were reoperated on with a new posterior construct. In this emergency, we observed two cases of phlebitis and two superficial infections. Complications leading to back pain and neurological sequelae. The kyphosis angle even if it is not always easy to measure, is applicable for these backs (Figure 4).

The post-traumatic kyphosis is a true complication of spinal fracture and it is most frequent at the thoraco-lumbar junction, leading to back pain and neurological sequelae. The kyphosis angle even if it is not always easy to measure, is applicable for these backs (Figure 4).

Most authors do not index their measurement at the affected level [5,7,12-16]. Among them, Korovessis [14] used the Gardner Segment Kyphosis Deformity (GSKD) which is interesting when the upper endplate of the injured vertebra is no more identifiable.

The sagittal balance evaluated by an entire X-ray of spine, took three or six months after surgery (53 patients without neurologic deficit) allows us to verify the type of back finding an error in two patients (3%). The unbalance is found in 6 patients (11%).

**Discussion**

To compare with literature, our functional results are good [9,16,31], they are better than the results obtained by orthopedic treatment [31,32]. Before non-chirurgical treatment is practiced in 80% of fractures without neurological complications [33]. The neurological status is not the only point of decision in surgical treatment. The deformity in sagittal plan is also an important point [2].

The criteria of selection are extremely variables [8,32-34], the majority are an angulation > 25° or a compression > 50° [1].

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In our study, we are based on pelvic incidence defined for many years by Duval-Beaupère and Legaye [17] calculated on profile radiography of lumbosacral junction taken both femoral heads. It is a proper angle for every primordial individual to understand the thoraco-lumbar sagittal balance, but it cannot be modified as the growth is achieved. The value of this incidence gives us an idea about the importance of the traumatism but the regional kyphosis (RK) is meaningless if it is not correlated to the level. Farcy [25] was one of the first to make this distinction by defining the sagittal index Farcy (SIF) after Stagnara’s study [35]. He admitted a 5° kyphosis at each thoracic level, a 10° lordosis at each lumbar level and a flat area is wanted in T12-L1 [1,2]. If the local kyphosis (LK) angle gives an idea about the importance of the traumatism but the regional kyphosis (RK) is meaningless if it is not correlated to the level. Farcy [25] was one of the first to make this distinction by defining the sagittal index Farcy (SIF) after Stagnara’s study [35]. He admitted a 5° kyphosis at each thoracic level, a 10° lordosis at each lumbar level and 0° in T12-L1. The SIF corresponds to the difference between the calculated angulation and the ideal angulation.

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For some authors, the value of this deformity must be correlated with the injury level of spine and a slight kyphosis is acceptable in T11-T12 unacceptable in L1-L2 which is normally a level in lordosis while a flat area is wanted in T12-L1 [1,2]. If the local kyphosis (LK) angle gives an idea about the importance of the traumatism but the regional kyphosis (RK) is meaningless if it is not correlated to the level. Farcy [25] was one of the first to make this distinction by defining the sagittal index Farcy (SIF) after Stagnara’s study [35]. He admitted a 5° kyphosis at each thoracic level, a 10° lordosis at each lumbar level and 0° in T12-L1. The SIF corresponds to the difference between the calculated angulation and the ideal angulation.
lumbar fractures consists in choice the parameters which evaluate the traumatic deformity in function of pelvic incidence the only parameter calculated in injured patients.

The results of our study confirm our hypothesis by the significant difference of the traumatic deformity value found by the calculation of the SIF and the GSKD in the different segments of back (Table 3). This difference is not significant for the whole study seeing the important number of fractures in T12-L1(46%) in which the deformity is not major which make the values of SIF and GSKD near of each other (17.35°, 19°) (Table 2). The type of back is not influenced by the gender, age and BMI. The thoraco-lumbar junction is the most touched in our study (63%) similar to literature [1,2,34]. This notion is found in backs with high pelvic incidence (64%), but for backs with low pelvic incidence, this notion is less important (53%) without statistically significant difference.

The global correction is satisfied for the whole study, with real gain 12.8° (VK), 16.51° (SIF), 17.08° (GSKG) compared to literature [1,25]. The number of patients well-corrected by this technique varies in function of type of back (Table 5). Also, for backs with high incidence a good correction is obtained in 69% of cases whereas 31% for backs with low incidence (p<0.001).

The limitation of our study is that the different radiologic parameters were measured manually. These measures would be more precise if we used adapted software.

### Conclusion

The treatment of spinal fractures is still highly controversial. The
new techniques (screw, hooks, rod) improve the correction quality of the deformity of the kyphosis. If the vertebral deformity gives an idea about the importance of traumatism, the real regional deformity remains mal defined with or without the correlation with the injury level. In our opinion, this correlation depends on the shape of backs. Pelvic incidence is the only parameter calculated in injured patients. Relationships between this angle and the orientation of the sacrum, the sacral slope, and the characteristics of the lumbar lordosis were evident. For backs with high incidence (harmony curvature), the sacral slope increases with normal ratio with the correction and loss. Therefore, the shape of back kyphosis deformity is meaningless if it is not correlated to the injury level. In our opinion, this correlation depends on the shape of backs. For backs with low incidence (high thoracic kyphosis or flat), this correlation is not obligatory. According to our study, pelvic incidence is not correlated to the traumatic deformity but it is proportional to the correction and loss. Therefore, the shape of back (pelvic incidence) appears fundamental in the choice of the number of vertebrae to fix above and below the fracture.

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