Double approach in thoraco-lumbar malunions

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Abstract Thoracolumbar fractures (T11–L2) complicated by malunion often need surgery. In our hands two approaches are necessary for release and fusion. Correction is obtained by posterior bending in situ of a screw rod fixation. When the deformity is flexible, first we perform a posterior reduction and stabilization, and secondly an anterior approach for interbody fusion. When spine is rigid an anterior release with waiting bone graft is performed first followed by a second posterior reduction and stabilization. This strategy allows a real correction without the loss of correction in time. This technique is fast and safe as demonstrated in our series of 20 patients.

Keywords Thoracolumbar fractures · Malunion · Surgery · Bending in situ

Introduction

The most frequent site of spinal fractures is the thoracolumbar junction (T11–L2) [1]. This frequency would logically beget a host of malunited fractures, either from failures of understanding, or biology, or technique. In some cases the malunion is a complication of a fracture that does not benefit from therapeutic consideration. These

malunions fall into kyphosis yielding a sagittal imbalance. The spine attempts to correct itself by decreasing the thoracic kyphosis above or increasing the lumbar lordosis below. Often, such deformity is not painful and therefore is well tolerated. Sometimes it may lead to local pain at the malunion by kyphotic stretching but more commonly to pain above or below the injured level where lordosis increases. As the neural elements are stretched across this angular kyphosis, radicular or myelopathic symptoms may appear. Syringomyelia is a rather frequent complication of malunion [2] because the latter results in a difficulty for cerebral spinal fluid (CSF) to flow. Therefore, syringomyelia should be suspected when the delayed non-systematic neurological syndrome occurs after fracture.

Treatment must correct the deformity and achieve a stable, balanced spinal column. Based on our series of 20 malunions (7 surgical treatment failures, 13 brace treatment failures) treated surgically with a follow-up over 1 year, we have developed the following protocol. The spine is approached dorsally and ventrally instrumented and grafted (360° in every case).

The deformity is corrected by in situ contouring [3, 4] and we believe that the optimum correction of the regional deformity is achieved by the posterior approach. The spinal stabilization by means of pedicle screws allows for a global approach of Louis's three-column spine [5]. Corporeal screws stabilize only the anterior column and therefore they are less efficient and the construct is less stable [4].

The standard construct consists of pedicle screws inserted into the subjacent and suprajacent vertebrae with regard to the fractured vertebra. The screws are protected by additional hooks: at the suprajacent level, a pediculo-transverse claw will incorporate the second suprajacent vertebra as well, whereas at the subjacent level sub-laminar hooks will incorporate the same vertebra.

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The spine must be flexible to allow the correction. The reducibility of the deformation can be appreciated on dynamic X-rays (flexion–extension X-rays, billot test). In our series, we retrospectively found a different strategy depending on the flexibility assessed on dynamic X-rays.

- If angular mobility was less than 6° , it was necessary to perform an anterior release with waiting graft, and then a posterior correction. The anterior release is video-assisted: the subjacent and suprajacent discs to the fractured vertebra are removed, the endplates are prepared for the graft, and the bone bridges are sectioned. The inlay graft is made of spongy bone and inserted into the interbody space from the lateral side of the approach within a vertical and lateral trench of the vertebral bodies (Fig. 1). This waiting graft will follow the correction to be performed by posterior approach.
- If mobility is greater than 6° , a posterior approach is done first and an anterior grafting is performed afterwards. Osteotomies are performed upon request to reach mobility around the fractured vertebra. The construct is similar to the aforementioned one. The correction is assessed by simultaneous in situ contouring of both rods, with the implants closed but not secured. It is mandatory to maintain rod sliding within the unsecured implants in order to reach optimum correction while avoiding excessive loads within the spinal segment during the in situ contouring maneuvers. The bending irons are placed between two consecutive screws to reach the fracture reduction and on each side of the upper screw to reach the reduction within the subjacent disc (Fig. 2). These maneuvers allow for the correction of Farcy's sagittal index [6, 7]. The anterior graft is performed after discectomy and vertebral endplate preparation with a bicortical bone graft [anterior lumbar interbody fusion (ALIF)].

Fig. 1 Inlay waiting bone graft with a rip

Fig. 2 In situ contouring maneuvers for deformity reduction

We performed a retrospective study on a series of 20 patients (12 women/8 men), mean age 44.1 years (20–67). Malunion had a traumatic origin in all patients but one who developed malunion following T11–T12 spondylodiscitis. Levels involved were within the thoracolumbar area (T11: $n = 1$, T12: $n = 4$, T11–T12: $n = 1$, L1: $n = 11$, L2: $n = 1$). Thirteen patients wore a brace before the surgery and seven underwent a previous surgery. All patients were operated between 1997 and 2007 by the same surgeon

Fig. 3 Mobility in flexion–extension: posterior reduction first and secondary interbody fusion

(JPS). The minimum follow-up was 12 months after surgery.

In our series we have preferred to perform both procedures during the same anesthesia. The mean durations of the posterior and anterior approaches were 157 (80–360) and 125 mn (60–270), respectively. The poor quality of the bone in three cases required additional corpectomy during the anterior approach and the use of an interbody cage filled with local graft and additional bone substitutes.

Twelve procedures began with a posterior approach and finished with the anterior one (Fig. 3), while eight started with an anterior approach and concluded with a posterior one (Fig. 4). Farcy's sagittal index was 22° pre-operatively (6–36) and 2.5° post-operatively (-10 , $+8.7$). There was no significant loss of correction at final follow-up. The correction of the thoraco-lumbar kyphosis was not associated with pelvic parameters modification. Blood loss averaged 1,022 ml (370–2,320 ml). The VAS (visual

analog scale) pain score was 7.7 (3.5–10) pre-operatively and 4.1 (0–6.5) post-operatively.

The comparison of the techniques and their results with literature is difficult. The thoraco-lumbar junction can indeed extend from T6 to L3 and there is no established relative measurement. Farcy performs the simultaneous double approach in lateral position associated to a corpectomy [7]. This surgery is a little longer with more blood loss with similar results (Table 1).

When the deformity is more severe ($SI > 40^\circ$) this technique is contraindicated. In such cases neurological deficit associated with syringomyelia occurs and hyperkyphosis increases [2]. Therefore, in such cases, we perform surgery with two teams: the neurosurgeon performs a medullary neurolysis to recover the CSF flux and the orthopedic surgeon performs a pedicular subtraction osteotomy. This rather time-consuming surgery allows to treat the cause and the consequences of the disease simultaneously.

Fig. 4 No mobility in flexion–extension: anterior release, waiting bone graft and posterior reduction

Table 1 Comparison of our series with Farcy's one

	Farcy	JPS
Age	27 (15, 56)	44.1 (20–67)
Length op	300 min	282 min (140, 630)
Bleeding	2,000 ml (1,000, 6,000)	1,022 ml (370, 2,320)
Hospital	8–10 days	12 (5, 24) ^a
SI pre-op	35 (18, 52)	22 (6, 36)
SI post-op	4 (10, –2)	2.5 (9, –10)

^a Two patients with 2 staged surgeries

Conclusion

We routinely treat malunions of the thoraco-lumbar junction with systematic combined dorsal and ventral approaches. The sequence of approaches is determined by the pre-operative angular mobility. When spine is mobile we perform a posterior surgery for reduction and stabilization, and a second anterior approach for interbody fusion. When spine is rigid we perform an anterior release with graft insertion followed by a second posterior surgery for reduction and stabilization. The fracture reduction is performed by in situ contouring with posterior instrumentation.

Conflict of interest statement None of the authors has any potential conflict of interest.

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