Review

Clinical and radiological outcome of non-surgical management of thoracic and lumbar spinal fracture-dislocations — a historical analysis in the era of modern spinal surgery

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Context: It is well established that traumatic spinal dislocations (AO Type C injuries) should be surgically treated. However, no recent comparative study of surgical versus non-surgical management of type C injuries was found attesting the superiority of surgical treatment.

Objective: Due to the lack of information about the natural history of non-surgical management of type C injuries, we evaluated the outcome of historical conservative treatment of type C injuries.

Methods: An extensive manual search of articles was performed in the Pubmed Database. We included articles that reported the clinical and/ or the radiological outcome of non-surgical management of thoracic and/ or lumbar spinal fracture-dislocations.

Results: Three well described retrospective studies where fracture-dislocations of the thoracolumbar spine were managed non-surgically were included. Non-surgical management typically consisted in postural reduction and prolonged bed rest (about 10-13 weeks on average). Residual deformity was common, and some studies reported a high rate of post treatment pain syndromes. Some studies reported surgery for gibbus deformity after conservative treatment or persistent instability requiring further bed rest. Neurological deterioration was rare, and some patients had some improvement, although the vast majority of the patients had persistent, severe neurological deficits.

Conclusions: Compared with historical non-surgical care, surgery for type C injuries decreases the chances of post-operative pain, late spinal deformity and also allowed early rehabilitation, once no bed restriction is necessary. Ethical issues based on this historical analysis may preclude performing a comparative study of non-surgical versus surgical management of these injuries in the modern spine era.

Keywords: Fracture, Fracture-dislocations, Dislocations, Spinal fracture, Vertebral injury, Paraplegia, Treatment

Introduction

It is well established that traumatic spinal dislocations should be surgically treated.[1–4] These injuries were recently classified by Vaccaro *et al.* as type C injuries, a classification adopted by the AOSpine Study Group.[2] Surgical treatment has some main objectives: decompress, realign and restore spinal stability, allowing early rehabilitation and decrease secondary complications, such as deep venous thrombosis and infection.[1]

Many modern series reported the results of surgical treatment of traumatic thoracic and lumbar spinal dislocations with improvement in neurological status, avoiding late spinal deformity and decrease post-operative pain.[5–9] However, no recent comparative study of surgical versus non-surgical management of type C injuries exists attesting to the superiority of surgical treatment.

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Given the lack of information about the natural history of non-surgical management of thoracolumbar fracture dislocations, we performed a review of historical literature reporting the outcome of non-surgical management of these unstable injuries. Non-surgical treatment, at the time of these publications, consisted of bed rest and postural reduction as described and popularized by Sir Ludwig Guttmann.[10] The objective of this paper is to evaluate the outcomes of historical non-surgical management of spinal dislocations, and compare them to modern published results of surgical treatment.

Methods

An extensive search of articles was performed in the Pubmed Database (October 2017) using the following entry words, combined or in isolation: "spine", "dislocation", "fractures", "non-surgical", "conservative". Cross-reference articles were also searched and evaluated. More than 2000 titles were reviewed and, when present, their abstracts. No time restriction was used. We included English language articles that reported the clinical and/ or the radiological outcome of non surgical management of thoracic and/ or lumbar spinal fracture-dislocations. Articles were excluded that utilized closed reduction followed by a planned surgical fixation. Furthermore, articles were excluded if clinical and/or radiographic outcomes were not reported. Additionally, we presumed that the non-surgical management of these injuries (bed rest and postural reduction) has not changed much throughout the years, whereas the techniques of spinal reconstruction and fixation have evolved tremendously.

Results

Three articles were identified meeting inclusion and exclusion criteria. We report the results of these three retrospective studies where fracture-dislocations of the thoracolumbar spine were managed non-surgically (Table 1).

Frankel *et al.*, in 1969, reported the results of postural reduction in the initial management of closed injuries of the spine in patients with paraplegia and tetraplegia.[11] Patients with closed spinal injuries admitted within 14 days of injury with adequate plain radiographs were included in their study. A total of 682 patients were evaluated. Excluding patients who died in the first three months and had a previous surgical intervention, 612 patients were evaluated and injuries were classified into four groups, according to their location: 1) cervical fractures and fracture-dislocations (218 patients), 2) dorsal (thoracic) fractures and fracture-dislocations (166 patients), 2) dorso-lumbar (thoraco-lumbar) fractures and fracture-dislocations (T11-L1, 205 patients), and 4) lumbar fractures and fracture-dislocations (23 patients). Injuries were classified according to the proposed system by the same author in Frankel A, B, C, D and E. Two methods of treatment were reported: from 1964-65, all patients were nursed on sorbo packs and turned every three hours under the supervision of a nurse or Sister. After 1965, patients were nursed on the Stoke Mandeville Egerton turning beds, which was turned on at least every three hours. Pillows and rows were used in addition at the appropriate sites to try to reduce the fracture and position was checked with x-rays.

There were 140 fracture-dislocations from T1-10. Anatomical reduction was obtained in eight cases. Residual wedge was reported in 97 patients and partial reduction in 22 patients. Thirteen patients failed reduction. On admission, 117 patients were Frankel A, 12 Frankel B, two Frankel C, nine Frankel D. On discharge, 101 patients were Frankel A, 14 Frankel B, four Frankel C, 13 Frankel D and eight Frankel E. The average time in bed was 11.1 weeks.

There were 163 fracture-dislocations from T11-L1. Anatomical reduction was obtained in 31 cases. Residual wedge was reported in 101 patients and partial reduction in 21 patients. Ten patients failed reduction. On admission, 102 patients were Frankel A, 18 Frankel B, 17 Frankel C, 19 Frankel D and one Frankel E. On discharge, 90 patients were Frankel A, 12 Frankel B, three Frankel C, 37 Frankel D and seven Frankel E. The average time in bed was 12 weeks.

There were 16 fracture-dislocations from L2-L5. Anatomical reduction was obtained in two cases. Residual wedge was reported in eight patients and partial reduction in four patients. Two patients failed reduction. On admission, seven patients were Frankel A, two Frankel B, three Frankel C, and four Frankel D. On discharge, three patients were Frankel A, one Frankel B, two Frankel C, seven Frankel D and three Frankel E. The average time in bed was 12.2 weeks.

Two patients with dorso-lumbar fracture-dislocations were considered as having unstable lesions after being allowed out of bed – one became stable after additional eight weeks in bed and the other had an increase deformity and union after six months in a plastic corset.

Of note, the classic Frankel classification system proposed by evaluate the neurological deficits by the time this paper was published was further supplanted by the ASIA Impairment Scale (AIS) classification, also dividing neurological impairment in A, B, C, D and E.

Table 1 Characteristics of the three historical studies of non-surgical management of fracture dislocations compared with three more recent case series (after 2010) of surgically treated patients with different surgical techniques. Three surgical papers were included for comparison.

Study	Number of patients with fracture-dislocation injuries	Severe Pain at follow-up	Spinal Deformity at follow-up	Fusion rates	Neurological outcome		Neurological deterioration	Confined to the bed (average time)	Complications
					Before	After			
Frankel *et al.*, 1969[11]	319 patients with fracture-dislocations treated with postural reductions (140 T1-10; 163 T11-L1, 16 L2-5)	Not reported	25 patients failed reduction 41 patients had anatomical reduction	2 patients were considered unstable after bed rest	Frankel A - 226 Frankel B – 44 Frankel C – 22 Frankel D – 30 Frankel E – 1	194 27 9 57 18	Not reported	11 weeks for T1-10 12 weeks for T11-L1 12.2 weeks for L2-5	Not reported
Lewis and McKibbin, 1974[12]	14 patients managed non-surgically (12 postural reduction and 2 (posturing on plaster bed – historical treatment abandoned due to severe pressure sores)	2/12 cases (16.7%)	9/12 cases (75%)	67% had anterior interbody fusion	Some degree of recovery was noted in five patients (no more than one spinal segment – authors considered also that it may be an error of initial assessment		No patient had deterioration	13 weeks (91 days)	Multiple pressure sores 2 cases (plaster bed)
Davies *et al.*, 1980[13]	34 patients managed non-surgically treated with postural reduction and immobilization	6/34 patients (17.6%)	2 patients had a external gibbus requiring resection of the spinous process	There was no no-union	Frankel A - 14 Frankel B – 5 Frankel C – 14 Frankel D – 1 Frankel E - 0	11 1 3 17 2	Two patients had transient neurological worsening One patient had a spinal cord infarction with severe worsening	73 days (mean immobilization) (about 10 weeks)	Spinal cord infarction 1 Pain Syndrome 6 Pulmonary embolism 2 Gibbus requiring excision of the spinous process 2 Temporary neural deterioration 2

Continued

Table 1 ***Continued***

Study	Number of patients with fracture-dislocation injuries	Severe Pain at follow-up	Spinal Deformity at follow-up	Fusion rates	Neurological outcome		Neurological deterioration	Confined to the bed (average time)	Complications
					Before	After			
Xiong *et al*., 2012[5]	11 patients surgically treated	None (mean preoperative VAS 8.1)	None	Not described but no patient required revision surgery	All had neurological deficits 8 had no improvement 3 minor improvement (less than 1 AIS grade – partial muscle strength or relieved numbness)		None	Not described	CSF leak – 2 cases (treated non surgically)
Wang *et al*., 2014[9]	30 patients surgically treated by a posterior only approach	Not reported	Mean preoperative kyphosis was 14.4° and reduced to -1.1° after surgery	90% had bone fusion within 1 year Three patients had pseudoarthrosis but were asymptomatic (no local pain)	AIS A – 20 AIS B – 4 AIS C – 3 AIS D – 3 AIS E – 0	20 0 3 4 3	None	Average hospital stay 10.2 days (range from 7-14 days)	Superficial wound infection - 4 cases CSF leak – 5 cases
Hao *et al*., 2014[6]	57 patients surgically treated with two different techniques (27 with transforaminal transthoracic interbody fusion [TTIF]) and 30 with a combined approach [PA])	Mean VAS was 4.1 ± 1.3 in TTIF group and 4.4 ± in the PA group	Surgical correction was 24.7o ± 6.8 in TTIF group and 25.4 ± 5.3 in the PA group, with about 5o of lost correction only during follow-up	100% in both groups	About 20% of recovery in ASIA sensory score after 2 years in both groups and about 25% of recovery in motor score		None	Not described	31.2% in the PA group 10 cases – 3 atelectasis, 1 pleural effusion, 1 pneumothorax, 2 CSF leakage, 3 rebleeding into the thoracic cavity 6.9% in the TTIF group 2 cases with CSF leak

Lewis and McKibbin, in 1974, published a retrospective report of the clinical and radiological outcome of 93 patients with paraplegia and clear posterior ligamentous rupture in plain radiographs treated in two different hospitals.[12] A total of 64 had surgical treatment and 29 were treated conservatively. From these 93 patients, 18 died (19%). An additional 32 patients were excluded by lack of useful information, with a total of 43 patients included in this study. The vast majority of the injuries were at T12/L1 (22 cases – 51.1%), followed by T11/T12 (13 cases), and eight cases in the lumbar spine. The 29 surgically treated patients underwent plate fixation (used in the spinous process) in 27 cases (in two cases surgical treatment was considered impossible due to concomitant spinous process injuries) and, in the 14 cases managed non-surgically, treatment consists of conservative postural reduction (with pillows and packs) in 12 cases or posturing on plaster bed in two cases. The cases of treatment on the plaster bed occurred before 1950, but this treatment was stopped because of a high rate of patients developing pressure sores. The average time of total confinement to bed for postured reduction cases was 13 weeks. With regards to the patients' neurological status, 40 of the 43 had a well-documented neurological exam: 21 had a complete spinal cord injury and 12 had some degree of lumbar root sparing. Finally, three cases had incomplete spinal cord lesions and four had root lesions only. Patients were operated on the first three days after the injury and were confined to bed after operation for about 12 weeks. Complications were higher in surgically treated patients, with nine of the 27 requiring removal of plates some weeks after surgery, but without lost of the reduction (assessed by plain radiographs). Reduction of surgically treated patients was considered excellent (no forward displacement and no residual kyphosis) in 24 patients.

After a minimum follow-up of one year, pain was severe in 2 (16.7%) of the 12 cases treated with postured reduction, compared with no patients surgically treated. Kyphosis over 40 degrees was documented in nine (75%) of the 12 patients treated with postured reduction versus only two (7%) of 27 surgically treated. Anterior interbody fusion occurred in eight (67%) of the patients treated conservatively versus 17 of those operated (63%).

Interesting, no patient had neurological deterioration. Some recovery was documented in 5 (41.7%) of 12 treated non-surgically and 10 (37%) of 27 treated with plates.

Authors concluded that although there were no differences in neurological outcome of the two groups, surgically treated patients had less pain and less severe forms of spinal deformity. By that time, authors recommended surgical treatment with plates in displaced fractures.

Davies *et al.*, in 1980, reported the retrospective results of 34 patients treated with thoracolumbar injuries (from T11 to L2) in one Hospital (Princess Alexandra Hospital).[13] Three patients were excluded because of late referral. All patients were admitted one week after the injury and were treated with postural reduction and immobilization on an Egerton Stoke-Mandeville tilting and turning bed or on an orthopedic bed being turned manually. Clinical and radiological characteristics were evaluated and compared with the results of a surgical case series reported by Dickson *et al.* that had similar methodological assessment. They reported that mean vertebral angulation (degrees) and mean displacement (percent) at follow-up was similar in conservative (18.4° and 6.9%, respectively) versus surgical series (15° and 9%, respectively). Minimum loss of correction was reported during radiological follow-up.

Neurological improvement was assessed using the Frankel grade. Fourteen patients had a Frankel A (3 improved – 21%), and 95% of those with a Frankel B-D had some improvement. Two patients had partial neurological deterioration with recovery and one had a spinal cord infarction losing eight neural segments without recovery.

An external gibbus deformity developed in two patients with complete neurological deficits. Both underwent resection of the spinous process allowing rehabilitation. Six patients had severe pain syndrome and two pulmonary embolisms. There was no no-union. Mean time of immobilization was 73 days, compared with 25 in the Dickson *et al.* series and mean hospitalization time was 163 days, compared with 107 days in the surgical series. The authors concluded that surgery and conservative treatment had similar outcomes, and, therefore, conservative treatment should prevail. Early surgical treatment should be considered when there was an unsuccessful reduction of vertebral displacement, locked facet joints, for irritable and restless patients that cannot be controlled and for separation of the vertebral bodies that soft-tissue interposition between them.

Discussion

Traumatic thoracolumbar spine dislocations are secondary to high-energy trauma, and these injuries are surgically treated in most, if not all spinal trauma centers around the world.[1–9] However, as far as we know, there is no modern study comparing the results of surgical versus non surgical management of these injuries. Because of this, the current studied aimed to report

the treatment outcomes of patients treated non-operatively after an AOSpine C Type Thoracolumbar injury.

Interestingly, in the three evaluated historical series, the rate of neurological deterioration was lower than we expected with non-surgical management.[11–13] Only one patient (with spinal cord infarction) had permanent neurological worsening. It should be taken into account that these patients had a higher rate of severe neurological deficits, especially when real spinal dislocations are documented. In patients with incomplete neurological deficits, 95% of them had some improvement in Davies *et al.* study.[13] Recovery was also documented in patients treated non-surgically in the series of Lewis *et al.* (5 of 12 patients, 34%), without any case of neurological deterioration.[12] Comparatively, in a modern series of 11 patients with thoracic and lumbar spine dislocations treated by a posterior only approach, Xiong *et al.* reported that three of 11 paraplegic patients (27.2%) had some neurological improvement with surgical treatment, but this improvement was mild and without clinical significance.[5] Hao *et al.* reported more promising results with surgical treatment, with a recovery of about 20% of the sensory score and 25% of the motor score.[6] Of note, the vast majority of patients sustained a fracture-dislocation injury are paralyzed and surgery is performed mainly to restore spinal stability, avoid severe deformities and decrease pain.

Additionally, a higher rate of "pain syndromes" was reported in patients treated non-operatively by Davies *et al.*, suggesting that despite fusion/healing at the trauma site (no pseudoarthrosis was reported), deformity and persistent neural tissue compression may leads to pain syndromes and severe pain.[13] The high fusion/healing rate may be secondary to the higher periods of recumbence, allowing bone healing. These results are clearly worse than those reported with surgical treatment where, Xiong *et al.* reported no significant local pain in their series of surgically treated patients in the last follow-up.[5]

In addition to a possible increase in neurologic recovery, and decrease in focal pain, one of the main advantages of modern surgical treatment with spinal stabilization of thoracolumbar spine dislocation is patient mobilization.[14] Currently, spinal fixation systems with pedicle screws and/or anterior plates allow immediate spine stabilization and early rehabilitation.[14] Patients are able to sit and walk, when neurologically able, in the early postoperative period, when pain is controlled. In stark contrast, the mean time of immobilization was described in Davies *et al.* study with 73 days.[13] During this time, hospital costs are tremendous, likely much higher than surgical costs. Additionally, immobilization results in tremendous psychological impact to patients.[13]

Finally, severe spinal deformity is a notorious late complication of fracture-dislocation. It likely that the rate of severe deformity was underestimated in these two included historical studies due to their retrospective nature and lack of surgical treatment for symptomatic deformity by the time the manuscripts were published. Post-traumatic deformities resulted in huge and highly cost procedures. Improvements of radiological parameters in coronal and sagittal misalignment are tremendous with modern spinal implants. Xiong *et al.* reported sagittal displacement reduced from 73% to 2.7% (average) post-surgery, also with reduction maintenance during follow-up.[5] No patient needs surgery for late deformity after spinal reconstruction. The same is reported in other surgical series, were no progressive deformity was reported during follow-up of surgically treated fracture-dislocations.[6–8]

It should be also discussed that, although surgical treatment has many benefits, they are associated with an important surgical trauma and blood loss when compared with old surgical procedures.[5–8] Xiong *et al.* reported a mean blood loss of 1863ml (range from 800-3600 ml), with two dural tears injuries but no obits.[5] Hao *et al.* reported that estimated blood loss, in their series with 27 patients treated with transforaminal thoracic interbody fusion and 30 who underwent a postero-anterior approach was, respectively, 825 ± 115 ml and 1307 ± 181 ml.[6] Complications included pulmonary atelectasis, plural effusion, pneumothorax and hemothorax with no reported deaths.

Finally, although costs were not assessed in the included studies, considering that average hospital stay for surgically treated patients was about 10 days and average bed rest ranged from 10 to 13 weeks in the non-surgically treated group, costs would increase tremendously with non-surgical care.[9,11–13] Siebenga *et al.* evaluated prospectively the costs of non-surgically versus surgically treated AO Type A fractures without neurological deficits.[15] Patients treated non-surgically were treated with six weeks of bed rest in a Rotorest bed and those treated surgically received a posterior fusion with pedicle screws one level above and one below the injured level. The total costs for non-surgical treatment (direct and indirect) were $275,755 dollars versus $101,729 in the surgical group. They concluded that indirect costs of non surgical care made this treatment modality more expensive than surgical treatment. Given that their study was in neurologically intact patients, if we extrapolated these costs for a longer

prolonged bed rest in patients with fracture-dislocation injuries, costs of non-surgical care likely be much higher.

Conclusions

After reviewing the historic literature of non-surgical management of AOSpine Thoracolumbar type C injuries (fracture-dislocations), surgical treatment is strongly recommended, despite the lack of recent comparative studies. Surgery decreases the chances of post-operative pain, late spinal deformity and also allowed early rehabilitation as no bed restriction is necessary. Surgical treatment is potentially much more cost-effective. Additionally, some patients may also have neurological benefits, especially if some residual neurological function is present. The morbidity of surgery can be accepted when outweighed by its benefits. A high quality, randomized study comparing non-surgical versus surgical management of type C injuries nowadays, while ideal, may not be ethically or clinically feasible given this historical data and prevailing clinical decision making.

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