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Vertebral Fractures in Late Adolescense - a 27 to 47 Year Follow-Up

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Running title: thoracic and lumbar vertebral fractures during late adolescence

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Abstract

Background: The long-term outcome of thoracic and lumbar fractures in late adolescence is sparsely described and it is unclear whether a fractured vertebral body in these years, as in young children, can be resituated in height. The purpose of this study was to in late adolescence determine the incidence, the long-term outcome and the modelling capacity in fractures of the thoracic and lumbar region.

Methods: The incidence of vertebral fractures 1950 – 1971 in individuals aged 16 - 18 years was through the radiological archives evaluated in a city cohort of 228 878 citizens, of whom 13 893 were aged 16 – 18. A follow-up, 27 - 47 years after the injury, including subjective, objective and radiological evaluation was conducted in 18 boys and 5 girls.

Results: Twenty-nine boys and 11 girls were registered with a thoracic or lumbar vertebral fracture during the study period conferring an annual incidence of 0.14 ‰. Of the 23 individuals that attended the follow-up, 14 had had a one-column compression fractures, one a Denis type A, six a Denis type B, one a Denis type D and one a Chance fracture, At injury, one had ha a partial paresis in one leg and one developed a transient paraparesis during the first week. All were treated non-operatively. At follow-up, 18 individuals had no complaints while 5 had occasional back pain, 20 were classified as Frankel E and 3 as Frankel D. The radiographic ratio of anterior height to posterior height of the fractured vertebral body was unchanged during the study period.

Conclusion: Thoracic and lumbar vertebral fractures in late adolescence with no or minor neurological deficits have a predominantly favourable long-term outcome, even if no modelling capacity of the fractured vertebral body remains in late adolescence.

Key words: Adolescence, Epidemiology, Vertebra, Fracture, Long-term outcome, Radiological

Introduction

The literature infers that vertebral fractures in young children are rare with an increasing incidence found in late adolescence, so that spine fractures account for 2 – 3 % of all childhood fractures [4, 20, 24]. The fractures in children are evenly distributed in the spine [21], contrary to in adults, where fractures usually occur in the thoracolumbar region [11, 31]. In addition, cases without neurological deficits are usually described with a favourable long-term outcome [13, 14, 18, 20-22, 24, 26]. This could perhaps, at least partly, be explained by the modelling capacity in young children, reducing the deformity and restoring the height of the fractured vertebral body by growth [21], a capacity not found in adults [25, 31]. To our knowledge, no long-term studies exist which report both clinical and radiographic outcome decades after a thoracic or lumbar fracture sustained in late adolescence, at the end of vertebral growth [1], and if there exist a modelling capacity of a fractured vertebral body in these ages**.** By including individuals aged 16 - 18 years, we could specifically evaluate the hypothesis forwarded in a previous paper [21], that a fractured vertebral body could only be modelled in height in young children with a large remaining growth potential**.**

Against this background we hypothesised that thoracic and lumbar fractures in late adolescence (i) are more common than during childhood, (ii) have a fracture distribution resembling the distribution in adults, (iii) have predominantly a favourable, long-term outcome and (iv) have no modelling potential to reduce a deformity of a vertebral body.

Material and Methods

We aimed to re-evaluate all radiographs in individuals aged 16 – 18 years, with a diagnosed thoracic or lumbar vertebral fracture during the period 1950 – 1969, by help of a radiologist. As the radiographs of vertebral fractures sustained during 1954 and 1956 were missing, two years were added (1970 and 1971) to achieve twenty years of fracture epidemiology. The study was performed in a city of 228 878 inhabitants of whom 13 893 were between the age of 16 - 18 years in November 1960. In November 1970 there were 264 937 inhabitants, of whom 13 959 were between the age of 16 - 18 years, that is, a city with a virtually stable population over this period. The mean population aged 16 – 18 years during the study period was estimated to be 13 893.

Virtually all fracture patients attend the trauma unit at the city hospital, as this is the only emergency hospital in the city. Fractures sustained within the population, but out of the city, are referred to the Orthopaedic Department for clinical follow- up, a visit at which the fractures are classified to ensure complete ascertainment. Fewer than 3 % of all fracture patients in the city are estimated to attend a private medical facility for treatment, usually for more insignificant fractures with minor need for treatment. These fractures will not be classified in the hospital archives [15]. Additionally, all radiographs, journals, referrals and reports have been saved in the archives of the city hospital for the past century, leaving the opportunity to identify and reclassify old fractures and evaluate primary treatment and outcome.

Primary treatment and outcome were retrospectively evaluated through old medical referrals, reports, and radiographs. The fractures were classified according to the Denis classification, with the knowledge that this classification is based on fractures in adults [7]. The heights of the discs and the inter-pedicular width were determined at the fractured level and the closest normal cranial and caudal levels. The sagital diameter of the spinal canal was measured at the shortest midline perpendicular distance from the posterior surface of the vertebral body to the inner surface of the neural arch with the knowledge that this method was primarily described for assessing the width in the lumbar spine [12]. The ratio anterior height / posterior height of the fractured vertebral body was used to calculate whether the degree of the compression of the fractured vertebra changed during the study period (figure 1). Local kyphosis was estimated as the angle between the lines drawn through the posterior corners of the cranial and caudal vertebral bodies adjacent to the fractured vertebra [10] (figure 2). Degree of scoliosis was classified by the Cobb angle and any lateral, anterior or posterior displacement of the fractured vertebral body was measured by a ruler.

A clinical and radiological follow-up was performed a mean of 34 years (range 27-47) after the injury. At follow-up 10 subjects were unable to locate, 23 participated in the evaluation while 7 denied full participation, even if they accepted to answer a back pain and disability score. The subjective outcome was evaluated by the Oswestry Score [8] together with a question regarding work capacity. The objective outcome was evaluated by the Frankel classification [9]. The radiographic outcome included anteroposterior (AP) and lateral radiographs of the thoracic and lumbar spine (figure 3), evaluated in the same manner as the primary radiographs. The investigators were uninvolved in the treatment of the patients.

Statistics

Data are presented as mean ± SD or mean and range. Student´s t-test between pairs was used in the comparison of baseline and follow-up data. The Chi square test was used in the comparison of the incidence of individuals with fractures during the first and second decade of the study. A difference of $p < 0.05$ was regarded as a statistically significant difference. The study was approved by the Ethics Committee of Lund University and the Radiographic Committee at Malmö University Hospital, Malmö, Sweden.

Results

Epidemiology

In total we found 40 individuals, 29 boys and 11 girls aged 16 – 18 years with a thoracic or lumbar vertebral fracture during the defined period, conferring an annual incidence of 1.44 / 10 000 individuals (0.14 ‰). The index fracture were in 20 cases (50 %) found in the thoracic region (one in Th 3, Th 4, two in Th 5, Th 6, Th 7, one in Th 8, Th 9, two in TH 10, Th 11 and six in Th 12), and in 20 cases in the lumbar region (twelve in L1, three in L 2, two in L 3, one in L 4 and two in L 5). Twenty-one fractures (52 %) were classified as one-column compression fractures, one as a burst fracture Denis A (location L5), 16 as burst fractures Denis B (location Th 5, Th 7, Th 10, Th 11, three in Th 12, six in L1, two in L 3 and one in L 5), one as a burst fracture Denis D (location Th 6) and one as a Chance fracture (location L 2). Nine individuals had additional, minimal compression fractures in 1 adjacent vertebra, four in 2 vertebrae, three in 3 vertebrae and two in 4 vertebrae. Eighteen individuals sustained the fracture during the first decade and 22 during the second decade of the study (NS)

Baseline data

In the cohort of 23 cases that accepted to participate in the follow-up examination, 18 were boys with a mean age of 17.3 years (range 16 – 18) and 5 girls with a mean age of 17.5 years (range 16 – 18) at the time of the injury. Five individuals (3 boys and 2 girls) had suffered a low-energy trauma, defined as a fall in the same plane, or had sustained a kick, and 17 individuals (15 boys and 2 girls) were exposed to a high-energy trauma, defined as a fall of more than two meters or being involved in a motor-vehicle accident. The type of trauma was unknown in one patient. All cases attended the emergency care unit with back pain. Additionally, one had a partial paresis in the left leg, retrospectively classified as Frankel D and one developed the first week after injury a transient paraparesis, retrospectively classified as Frankel D. However, after 8 weeks this patient was fully recovered according to the medical report. All others were classified as Frankel E. All were treated non-operatively. Three were treated with mobilisation with a truncal plaster for a mean of 8 weeks (range 3 - 16), 4 with immobilisation in bed for a mean of 6 weeks (range 4 - 12), one of whom also had a truncal brace. The reason for the bed immobilisation was in one case a femoral fracture, in one bilateral ankle fractures while the reason for the bed immobilisation was unknown in two cases. Mobilisation as soon as the pain allowed, with no brace or external support, was advocated for 17 patients. The mean period of absence from school or work was 2.3 months (range 0 - 6) (table 1).

The index fracture was in 11 cases (48 %) found in the thoracic region (one in Th 3, Th 4, Th 5, Th 6, Th 7, Th 8, Th 10, respectively and four in Th 12), and in 12 in the lumbar region (six in L1, three in L 2 and one in L 3, L 4 and L 5, respectively).
Fourteen fractures (61%) were classified as one-column compression fractures, one as a burst fracture Denis A (location L 5), six as burst fractures Denis B (location Th 7, two Th 12, two L 1 and one L 3), one as a burst fracture Denis D (location Th 6) and one as a Chance fracture (location L 2). Six individuals had additional, minimal compression fractures in one adjacent vertebra, three in two vertebrae, two in three vertebrae and one in four vertebrae.

At baseline, the inter-pedicular distance at the fracture level was larger than at the level above but not different than the level below (table 1). There were no lower disc height or smaller sagittal spinal canal width at fracture level compared to adjacent levels (table 1). The ratio anterior / posterior height of the fractured vertebra was lower than the ratio of both the vertebra above and below (Table 1). One patient had a 8 millimetres (mm) lateral and a posterior displacement of 12 mm compared to the adjacent vertebrae. Two patients had a 2 and 8 mm posterior displacement of the fractured vertebrae compared to the vertebrae above, respectively.

Changes during the follow-up period

The inter-pedicular distance, the sagittal spinal canal width and the kyphosis increased in absolute values from baseline to follow-up at all levels while the disc heights, the degree of scoliosis, the degree of anterior, posterior and lateral displacements were unchanged (table 1). The ratio fractured level / level above and the ratio fractured level / level below of the interpedicular distance, the disc height and the sagittal canal width did not change during the follow-up period (table 1).

Endpoint data

At follow-up, 18 of the 23 evaluated patients reported excellent results with no back pain or disability. Five cases (two with a compression-fracture at L1 and L2 respectively, two with a fracture Denis type B of Th 7 and L3, respectively, and one with a fracture Denis type A at L5) reported occasional back pain not necessitating analgesics with an Oswestry Score of 6, 8, 8, 8 and 28, respectively. Four of these were in full time work and one in early retirement due to back pain and radicular leg pain that had developed years after the fracture event as a result of a slipped disc and failed back surgery. Nineteen individuals were classified as Frankel E and 3 as Frankel D. The first patient with impaired neurology achieved this at the fracture event. The second developed neurological deficits more than a decade after the fracture after a traffic accident. The third developed weakness in the left leg two decades after the trauma due to a myelopathy in the cervical region, whereas the fracture had occurred in L1.

Radiologically, the inter-pedicular distance at the fracture level was at follow-up larger in absolute values than at the level above but not different than the level below, the spinal canal width was narrower at the fractured level compared to the segment below but no different compared to the level above whereas the disc heights above or below the fractured vertebra were no different compared to adjacent discs (table 1).

The patient with an at baseline combined lateral and posterior displacement of 8 and 12 mm, had now a displacement of 10 and 17 mm. The patient with an at baseline displacement of 8 mm, had now a displacement of 7 mm. The patient with an at baseline posterior displacement of 2 mm, had now no displacement. One patient with at baseline no displacement, had now a posterior displacement of 4 mm compared to the vertebrae below.

Drop-out analyses

Among those 17 individuals who did not participate in the follow-up examination, 11 were boys with a mean age of 17.4 years (range 16 - 18) and 6 girls with a mean age of 17.7 years (range 17 - 18) at injury. Eleven patients were exposed to a high-energy trauma while the type of trauma was unknown in six. One patient was at admission paraplegic. Anterior wedge compression fractures were found in 7 patients and burst fractures Denis type B in 10 (location Th 5, Th 10, Th11, Th 12, four L1, one L3 and one L5). Nine fractures (53 %) were sustained in the thoracic region (Th 5, Th 6, Th 7, Th 9, Th 10 in one case, Th 11 in two and Th 12 in two) while 8 (47 %) were found in the lumbar region (L1 in six, L 3 in one and L 5 in one). Three individuals had additional, minimal compression fractures in one adjacent vertebra, one in two vertebrae, one in three vertebrae and one in four vertebrae. The Oswestry Score was in those7 individuals who answered the questionnaire mean 10 (range 0-36).

Discussion

This study reports an annual incidence of thoracic or lumbar vertebral fractures during late adolescence of 0.14 ‰, with a distribution of fractures more resembling that in adults. The subjective, long-term outcome after a non-operatively treated fracture without or with only minor neurological deficits is predominantly favourable up to half a century after the fracture. The deformity of the fractured vertebral body did not, as is in young children, decrease with age [21], no increase in disc height was seen and the prevalence of back pain up to 47 years after a vertebral fracture was no higher than the expected prevalence of back pain [27].

This study supports the notion that the incidence of thoracic and lumbar vertebral fractures is higher in older than in younger children [4, 20, 24]. The annual incidence of vertebral fractures in children younger than 16 years of age in the same city, has previously been reported to 0.07 ‰ [21], half compared with the incidence in individuals aged 16 – 18 years. The annual incidence in the same city in men aged 50-54 years has previously been reported to 1.4 ‰ and in women 1.2 ‰, with an increasing incidence found with advancing age, so that the incidence in men aged 85-89 years is 11.1 ‰ and in women 12.6 ‰ [16]. In Edinburgh, the incidence of vertebral fractures in children aged 15-19 years is reported to be 0.1 ‰ [30], in Great Britain in boys aged 16-17 years 0.15 ‰ and in girls 0.13 ‰ [5] while in Rochester community in Minnesota, the incidence of vertebral fractures in individuals aged < 35 years is reported to be 2.0 ‰ [23]. However, it is difficult to estimate the true incidence of spine fractures, as some individuals may never seek medical care and as radiographic examination after a minor trauma in the past was rare (personal communication). Therefore, if anything, the epidemiological data presented in the current report probably underestimate the "true" incidence of vertebral fractures in childhood [18, 20].

In adults most spine fractures occur in the thoracolumbar junction [11, 31], a biomechanical weak spot between the stiff thoracic cage and the more mobile lumbar spine. In children below age 16 years, the fractures are more evenly distributed in the spine [21]. Several studies support this when they imply that no more than one third of the fractures in children are located in the thoracolumbar (Th 12 – L2) junction [13, 14]. This is to be compared with the current study, in which a majority of the fractures were found in this region, suggesting that the distribution of the fractures in late adolescence more resembles the distribution of fractures in adults.

Most of the former patients with impaired neurology and subjective symptoms at follow-up had had a long period free of symptoms following the fracture. This implies that the impairment was not an obvious result of the fracture. Additionally, the prevalence of former fracture patients with back pain was no higher than the age-specific prevalence of back pain in a population based cohort [27]. Thus, it seems that non-operative treatment in stable compression fractures without neurological deficits in late adolescence not can be regarded as a risk factor for future back disability. However, as the number of burst fractures and Chance fractures in the current study were low, all conclusions should be drawn with caution. In addition, if other treatment strategies, such as surgery, lead to an even better long-term outcome must be evaluated in future studies.

The outcome in individuals with a thoracic or lumbar fracture in late adolescence seems also more favourable than the outcome following a non-operatively treated, stable vertebral fracture in adults. From studies in adults, back pain has been reported in 21 % out of 24 patients followed for 3 years [3], 25 % out of 73 patients followed for 5 years [29], 51 % out of 41 patients followed for 1 year [25], 70 % out of 20 patients followed for 4 years [2] and 79 % out of 38 patients followed for 4 years [28]. Kraemer et al. also reported that a health-related score, was lower in 24 adult individuals with a thoracic or lumbar burst fracture more than 2 years after the injury, in comparison with individuals with low back pain [19].

In a previous report, including patients younger than age 16 years, there was no reduced disc heights, no increased scoliosis, kyphosis, lateral, anterior or posterior displacement of the fractured vertebra [21]. Younger children also have a modelling potential, restoring the height of the fractured vertebral body with growth [21]. This modelling capacity of a vertebral body must however be separated from the modelling capacity of the spinal canal. Whereas a modelling capacity of the vertebral body only has been reported in young children [15], also adults with an intra-spinal fracture fragment restore the spinal canal area in the post-fracture period [6, 17] A favourable outcome after spine fractures in young children is further supported by Parisini et al. when reporting that 20 children aged below 16 years with a compression-fractures or a two-column burst-fractures without neurological deficits, did not develop a kyphosis or scoliosis exceeding 10 ° in an 18 years follow-up [26]. The data in the present study support the also radiological favourable long-term outcome after this kind of fractures, when reporting that there was no increased scoliosis, displacement or disc reduction in the fractured segment and an increased kyphosis of no biological significance. However, there are also reports describing both the development of kyphosis, displacement and back pain after vertebral fractures in elderly children [22, 24, 26].

The strength of this study is (i) reliable epidemiological data with the existing fracture ascertainment system, (ii) the so longest follow-up period after a vertebral fracture sustained in late adolescence, providing the possibility to address the radiological outcome in regard to growth disturbances, degenerative changes and restoration of the formerly fractured vertebra and (iii) additional radiographic evaluation both at baseline and follow-up. Its weakness is the retrospective design, the inclusion of most stable, one-column compression fractures, the inability to evaluate patients with also neurological deficits and the small sample size, especially as regards unstable fractures.

Conclusion

Thoracic and lumbar vertebral fractures in adolescence with no neurological deficits and treated non-operatively, have a predominantly favourable outcome even if a modelling capacity, restoring the height of the fractured vertebral body, do not occur in these ages.

References

1. Bass S, Delmas PD, Pearce G, Hendrich E, Tabensky A, Seeman E (1999) The differing tempo of growth in bone size, mass, and density in girls is region-specific. J Clin Invest 104:795-804
2. Chan DP, Seng NK, Kaan KT (1993) Nonoperative treatment in burst fractures of the lumbar spine (L2-L5) without neurologic deficits. Spine 18:320-325
3. Chow GH, Nelson BJ, Gebhard JS, Brugman JL, Brown CW, Donaldson DH (1996) Functional outcome of thoracolumbar burst fractures managed with hyperextension casting or bracing and early mobilization. Spine 21:2170-2175
4. Clark P, Letts M (2001) Trauma to the thoracic and lumbar spine in the adolescent. Can J Surg 44:337-345
5. Cooper C, Dennison EM, Leufkens HG, Bishop N, van Staa TP (2004) Epidemiology of childhood fractures in Britain: a study using the general practice research database. J Bone Miner Res 19:1976-1981
6. Dai LY (2001) Remodeling of the spinal canal after thoracolumbar burst fractures. Clin Orthop Relat Res:119-123
7. Denis F, Armstrong GW, Searls K, Matta L (1984) Acute thoracolumbar burst fractures in the absence of neurologic deficit. A comparison between operative and nonoperative treatment. Clin Orthop:142-149
8. Fairbank JC, Couper J, Davies JB, O'Brien JP (1980) The Oswestry low back pain disability questionnaire. Physiotherapy 66:271-273
9. Frankel HL, Hancock DO, Hyslop G, Melzak J, Michaelis LS, Ungar GH, Vernon JD, Walsh JJ (1969) The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. I. Paraplegia 7:179-192
10. Harrison DE, Cailliet R, Harrison DD, Janik TJ, Holland B (2001) Reliability of centroid, Cobb, and Harrison posterior tangent methods: which to choose for analysis of thoracic kyphosis. Spine 26:E227-234
11. Hasserius R, Redlund-Johnell I, Mellstrom D, Johansson C, Nilsson BE, Johnell O (2001) Vertebral deformation in urban Swedish men and women: prevalence based on 797 subjects. Acta Orthop Scand 72:273-278
12. Hinck VC HC, Clark WM (1965) Sagittal diameter of the lumbar spinal canal in children and adults. Radiology 85
13. Horal J, Nachemson A, Scheller S (1972) Clinical and radiological long term follow-up of ventebral fractures in children. Acta Orthop Scand 43:491-503
14. Hubbard DD (1974) Injuries of the spine in children and adolescents. Clin Orthop 100:56-65
15. Jonsson B (1993) Life style and fracture risk. In: Orthopaedic department. University of Lund
16. Kanis JA, Johnell O, Oden A, Sembo I, Redlund-Johnell I, Dawson A, De Laet C, Jonsson B (2000) Long-term risk of osteoporotic fracture in Malmo. Osteoporos Int 11:669-674
17. Karlsson MK, Hasserius R, Sundgren P, Redlund-Johnell I, Ohlin A (1997) Remodeling of the spinal canal deformed by trauma. J Spinal Disord 10:157-161
18. Kerttula LI, Serlo WS, Tervonen OA, Paakko EL, Vanharanta HV (2000) Post-traumatic findings of the spine after earlier vertebral fracture in young patients: clinical and MRI study. Spine 25:1104-1108

19. Kraemer WJ, Schemitsch EH, Lever J, McBroom RJ, McKee MD, Waddell JP (1996) Functional outcome of thoracolumbar burst fractures without neurological deficit. J Orthop Trauma 10:541-544
20. Landin L (1983) Fracture pattern in children. In: Orthopaedic department. University of Lund
21. Magnus KK, Anders M, Ralph H, Jack B, Caroline K, Acke O (2003) A modeling capacity of vertebral fractures exists during growth-an up to 47-year follow-up. Spine 28:2087-2092
22. McPhee IB (1981) Spinal fractures and dislocations in children and adolescents. Spine 6:533-537
23. Melton LJ, 3rd, Atkinson EJ, Cooper C, O'Fallon WM, Riggs BL (1999) Vertebral fractures predict subsequent fractures. Osteoporos Int 10:214-221
24. Mollenhoff G, Walz M, Muhr G (1993) [Compensation behavior after fractures of the thoracic and lumbar spine in children and adolescents]. Chirurg 64:948-952
25. Mumford J, Weinstein JN, Spratt KF, Goel VK (1993) Thoracolumbar burst fractures. The clinical efficacy and outcome of nonoperative management. Spine 18:955-970
26. Parisini P, Di Silvestre M, Greggi T (2002) Treatment of spinal fractures in children and adolescents: long-term results in 44 patients. Spine 27:1989-1994
27. SBU (2000) Neck pain, back pain. The swedish council on technology assessment in health care. In: SBU report nr 145. Stockholm, Sweden
28. Shen WJ, Shen YS (1999) Nonsurgical treatment of three-column thoracolumbar junction burst fractures without neurologic deficit. Spine 24:412-415
29. Singer BR (1995) The functional prognosis of thoracolumbar vertebrae fractures without neurological deficit: a long-term follow-up study of British Army personnel. Injury 26:519-521
30. Singer BR, McLauchlan GJ, Robinson CM, Christie J (1998) Epidemiology of fractures in 15,000 adults: the influence of age and gender. J Bone Joint Surg Br 80:243-248
31. Weinstein JN, Collalto P, Lehmann TR (1987) Long-term follow-up of nonoperatively treated thoracolumbar spine fractures. J Orthop Trauma 1:152-159

Figure legends

Figure 1. Method of measuring the degree of vertebral body compression of the fractured vertebra by calculating the ratio anterior height / posterior height on a lateral radiograph.

Figure 2. Method of measuring the degree of local kyphosis of the injured segment on a lateral radiograph.

Figure 3. Lateral radiograph of boy aged 18 showing fracture of vertebra Th12 and L1 (3A) at the time of the fracture event, (3B) after 30 years.

Table 1: Age, absence from school, study length, subjective, objective and radiographic outcome in individuals aged 16-18 years at injury. Data presented as mean ± SD

Variable	Baseline	Follow-up	baseline vs follow-up	injured vs normal at basline	injured vs normal at follow-up
Age (years)	17.4 ± 0.7	51.6 ± 6.0	---	---	--
Absence from school (months)	2.3 ± 2.2	--- ---	---	---	---
Follow-up (years)	---	34.2 ± 5.8	---	---	---
Subjective outcome					
Oswestry Score	---	2.5 ± 6.3	---	---	---
Objective outcome					
Frankel E (numbers)	21	20		---	---
Radiograpic outcomes – anteroposterior view					
Pedicle width fracture vertebra (mm)	23.5 ± 4.3	25.4 ± 4.6	p<0.001	---	---
Pedicle width vertebrae above (mm)	22.7 ± 4.1	24.2 ± 4.2	p<0.001	p<0.05	p<0.05
Pedicle width vertebrae below (mm)	23.4 ± 4.3	25.8 ± 4.7	p<0.001	NS	NS
Disc height above fracture vertebra (mm)	8.0 ± 4.3	9.7 ± 4.4	NS	NS	NS
Disc height below fracture vertebra (mm)	8.4 ± 3.4	9.4 ± 4.0	NS	NS	NS
Closest normal disc height (mm)	8.2 ± 2.7	9.2 ± 3.7	NS	---	---
Ratio: pedicle width fracture vertebra / pedicle width vertebra above	1.23 ± 0.89	1.06 ± 0.10	NS	---	---
Ratio: pedicle width fracture vertebra / pedicle width vertebra below	1.01 ± 0.06	0.99 ± 0.04	NS	---	---
Ratio: disc height above fracture vertebra / normal disc height	0.95 ± 0.36	1.06 ± 0.36	NS	---	---
Ratio: disc height below fracture vertebra / normal disc height	1.00 ± 0.27	1.04 ± 0.36	NS	---	---
Radiographic outcome – lateral view					
Fracture vertebra anterior height (mm)	24.5 ± 6.6	24.3 ± 6.7	NS	---	---
Fracture vertebra posterior height (mm)	32.6 ± 7.0	33.3 ± 7.3	NS	---	---
Vertebra above anterior height (mm)	27.5 ± 3.8	27.8 ± 3.9	NS	p<0.05	p<0.05
Vertebra above posterior height (mm)	32.1 ± 5.2	34.1 ± 4.6	p<0.05	NS	NS
Vertebra below anterior height (mm)	30.5 ± 6.9	30.3 ± 7.8	NS	p<0.001	p<0.001
Vertebra below posterior height (mm)	33.5 ± 5.7	34.9 ± 5.7	p<0.05	NS	NS
Fracture vertebra canal width (mm)	17.8 ± 4.2	20.0 ± 4.0	p<0.05	---	---
Vertebra above canal width (mm)	18.4 ± 3.4	20.3 ± 4.6	p<0.05	NS	NS
Vertebra below canal width (mm)	18.2 ± 3.1	20.5 ± 4.2	p<0.01	NS	p<0.05
Ratio: anterior height / posterior height fracture vertebra	0.74 ± 0.17	0.72 ± 0.20	NS	---	---
Ratio: anterior height / posterior height vertebra above;	0.87 ± 0.10	0.82 ± 0.10	p<0.05	p<0.01	p<0.05
Ratio: anterior height / posterior height vertebra below	0.91 ± 0.17	0.87 ± 0.25	NS	p<0.001	p<0.001
Ratio: canal width fracture vertebra / canal width vertebra above	0.98 ± 0.17	0.99 ± 0.09	NS	---	---
Ratio: canal width fracture vertebra / canal width vertebra blow	0.97 ± 0.15	0.97 ± 0.06	NS	---	---
Kyfosis (°)	8.8 ± 10.8	12.1 ± 12.9	p<0.05	---	---
Scoliosis (°)	3.4 ± 4.2	3.5 ± 4.2	NS	---	---
Lateral displacement (mm)	0.3 ± 1.7	0.4 ± 2.1	NS	---	---
Anteroposterior displacement (mm)	1.0 ± 2.9	1.2 ± 3.8	NS	---	---

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