Operative treatment of chance injuries in the paediatric population

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Abstract

Purpose Chance fractures are an uncommon spine injury in the paediatric population. As such there is a relative paucity of evidence in the literature to guide management decisions. We present our single centre experience in the operative management of these injuries.

Methods All patients presenting to a tertiary paediatric trauma centre between 2000 and 2008 were included. Retrospective analysis of clinical (SRS-22 and Oswestry) and radiological outcomes was undertaken.

Results Twelve patients underwent operative stabilization of a Chance type injury. Radiological and clinical outcome measures demonstrated excellent outcomes in the majority of patients with no significant complications.

Conclusions Operative management of paediatric chance injuries with instrumentation results in excellent clinical and radiological outcomes.

Keywords Chance · Paediatric · Surgery · Operative · Outcome

Introduction

Flexion distraction injury of the thoraco-lumbar spine was initially described by Chance [1] in 1948. This injury pattern is most commonly associated with motor vehicle accidents and the use of 2-point seat belts. It involves a deceleration with the spine rotating around the fulcrum of the seat belt, leading to failure of the spine commonly at the thoraco-lumbar junction. Associated injuries of the

abdominal viscera are common and may lead to delayed diagnosis of the spinal injury.

Spinal injuries in children are uncommon and there is a relative paucity of literature to aid in management decisions. Paediatric spinal trauma should be treated as a different entity to adult spinal injuries given the differences in anatomy, presence of physes, lack of degenerative change and greater propensity for healing. Given the nature and infrequency of these injuries, evidence to guide management is scarce. Historically, these injuries have primarily been treated non-operatively with cast bracing but this has been reported as having up to a 40 % failure rate [2]. Given the advances in instrumentation and experience with its use, operative management has its advantages in achieving and maintaining reduction and easier management of the trauma patient. We present our experience in the operative management and outcomes of paediatric flexion/distraction injuries in the thoraco-lumbar spine.

Materials and methods

All patients admitted to a tertiary paediatric hospital between 2000 and 2008 with a flexion distraction injury of the thoraco-lumbar spine were included. Medical records were reviewed retrospectively. Data collected included: patient demographics, mechanism of injury, delay in diagnosis, associated injuries and treatment. Pre- and post-operative radiology was reviewed. Type of chance injury, pre- and post-operative measurements were assessed independently by two authors and intra-vertebral and inter-segmental kyphotic measurements taken as the most reliable method [3, 4]. The type of chance fracture was classified according to the MRI system of de Gauzy [1, 5] through the superior physis, 2 through the vertebral body, 3

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through the inferior physis. Functional outcome was measured using SRS-22 and Oswestry Disability Index. Statistical analysis was performed with SPSS version 13.

Results

Thirteen patients were identified. 1 patient was managed non-operatively and excluded. The other 12 were contactable and 10 available for review. Follow-up radiology and notes were available for the 3 patients not reviewed clinically. Their length of follow-up was 2 years for 2 patients and 17 months for the other. There were five males and seven females. Average age was 11.3 years. The predominant mechanism was a motor vehicle accident (Table 1).

The 10 available patients presented for clinical and radiological review. Oswestry and SRS-22 scores were performed and repeat full-length erect X-rays taken. Average length of follow-up was 25 months (5–63) on average.

Eight of the 12 patients were referred from other centres and there was a delay in diagnosis of the spinal injury in 2 of these patients where the primary diagnosis of intra-abdominal injury was made first. This included one patient who presented with a neurological deficit that was an ASIA grade C at an L1 level. The other patients were transferred from the referring centres within 24 h. All patients underwent CT and MRI investigations.

All patients were managed surgically as a primary intent based on the morphology of the injury rather than any degree of deformity. Instrumentation was a mixture of pedicle screws, hooks and interspinous wiring utilised according to the morphology of the injury. Where the fracture pattern compromised a pedicle then interspinous wiring was used. If the pedicles were intact then pedicle screws were utilised. Single level fusion was possible in the

majority of cases where there was ligamentous involvement. The fusion bed was posterior in all cases. One patient age 8 had a purely bony injury and was managed with fixation alone and removal of implants at 6 months. Figure 1 demonstrates instrumentation and fusion with pedicle screws and wiring. Figure 2 demonstrates internal fixation of a bony chance injury with removal of implants without fusion. All cases were managed in a TLSO post-operatively and mobilised as tolerated. All patients demonstrated improvement in intra-vertebral and inter-segmental kyphosis post-operatively that was maintained at follow-up (Figs. 3, 4, 5, 6, 7, 8).

Associated abdominal injuries occurred in 7 of 13 patients. These included two duodenal injuries, two splenic lacerations, two colon lacerations, two pancreatic contusions and one ruptured diaphragm. Associated limb injuries occurred in 5 of 13 patients. There were no synchronous spinal injuries in any of the patients.

Clinical outcome measures were recorded where possible. An Oswestry scale was completed by 9 of 12 with an average score of 5.4 % (0–36). All patients achieved a score of 0 or 2 % except for two patients, 1 of 9 % and 1 of 36 % (the only patient with neurological deficit). An SRS-22 scale was done in 8 of 12 patients with an average score of 4.88 (4.72–5), this did not include the patient with Oswestry score of 36 %. There were no significant surgical complications in any patient. At follow-up, four patients had their instrumentation removed due to prominence or pain.

Discussion

The demographics and injury patterns of this group of patients are consistent with those reported in other series. The average age was 11.3 years with most injuries around

Table 1 Clinical details of patient group

Sex	Age	Mechanism	Level of injury	Type	Intra-vertebral kyphosis	Inter-segmental kyphosis	Duration of follow-up (months)	Treatment
M	13	Car	L3	II	13	8.5	27	L2/3 fusion
F	9	Car	L2	II	17	18	27	L1/2 fusion
F	8	Car	L2	II	15	14.5	16	L1/2 fixation
M	14	Pushbike	T12	I			18	T11/12 fusion
M	8	Car	L4	I	1	–10.5	18	L3/4 fusion
M	11	Car	L1	I	13.5	21	29	T12/L2 fusion
M	13	Car	L2	II	8.5	13	5	L1/2 fusion
F	15	Car	L1	I			17	T11/L2 fusion
F	14	Car	L2	I	23	26.5	4	L1/2 fusion
F	9	Car	L1	I	0	4	56	T12/L1 fusion
F	12	Car	L1	I	20.5	14	27	T12/L1 fusion
F	6	Car	L3	I	13	9.5	63	L2/3 fusion

Fig. 1 **a** Pre-op, **b** Post-op, **c** Follow-up

L1 and L2. 7 out of the 13 patients had a concomitant abdominal injury. 2 of the patients referred from other centres had a delay in diagnosis of the spinal injury.

Operative treatment resulted in significant improvement of deformity in this patient group. Average intra-vertebral kyphosis improved from 13.4° to 5.8° and average segmental kyphosis improved from 11.1° to -0.4° at final follow-up. There were no significant surgical complications or unplanned return to theatre. 4 patients had their instrumentation removed at final follow-up because of preference or prominence.

All patients except one had excellent clinical results as measured by the Oswestry scale and the SRS 22. The one patient with a neurological injury reported 36 % on the Oswestry scale.

All patients were treated operatively as a preference for early correction of deformity and management of associated limb and abdominal injuries. This allowed early mobilisation and prevention of complications. The mean SRS 22 score for this group was 4.87. This compares

favourably with values in normal populations. Verma et al. [6] in 2010 established a mean score of 4.1 in 450 healthy adolescents in an American high school population.

Flexion distraction injuries are uncommon in the paediatric population and usually the result of high energy trauma. In our experience, these can be safely treated surgically with excellent clinical and radiological outcomes. All patients achieved a significant improvement in deformity that was maintained at follow-up radiological examination. Only one patient had a poor clinical outcome and this was associated with a neurological deficit. Reported rates of associated neurological injury in the literature are 11 % [7] and this correlates with our experience.

There are limited data on the outcome of treatment for these injuries. Glassman's series of 12 patients, 11 were initially braced. Of these 11 patients, 4 were deemed to fail bracing and went on to have surgical intervention in the form of a fusion [2]. 3 of these patients had a residual deformity of 15° or greater. In the successfully braced

Fig. 2 a Pre-op, b Post-op, c Follow-up

Fig. 3 Pre- to post-op intravertebral angle

group, the residual deformity was acceptable, and in three patients under 8 years of age, improved measurements were noted at the final follow-up. Gumley et al. [8] reported on a series of 20 chance fractures, of which there were 2 children (11 and 12 years). Both managed non-operatively in braces with one non-union but good clinical outcomes. In an unpublished series, Reilly [9] reports

Fig. 4 Pre- to post-op intersegmental angle

poor long-term outcomes in a series of 27 patients where kyphosis $>15^\circ$ was an indication for surgical management. In a recent multicentre series of 34 patients (20 treated surgically), Arkader et al. [10], found that the operative group tended to better outcomes. three of their patients treated non-operatively developed progressive kyphosis.

Fig. 5 Intra-vertebral kyphosis (pre-op vs. post-op)

Fig. 6 Intra-vertebral kyphosis (post-op vs. F/U)

Fig. 7 Segmental kyphosis (pre-op vs. post-op)

Fig. 8 Segmental kyphosis (post-op vs. F/U)

To our knowledge, this is the largest single centre series of operatively treated paediatric chance fractures. Operative treatment was the primary intention in all patients. Weaknesses of this study include a lack of complete clinical follow-up data and a comparative non-operative arm. This paper looks only at the outcome of a surgically managed cohort of paediatric flexion distraction injuries. The study only illustrates that unstable flexion distraction injuries can be treated safely with a short segment posterior fusion with a good predictable outcome. In absence of a comparative non-surgically managed cohort, we do not claim that our outcomes are superior to the non-surgically treated paediatric flexion distraction injuries. Cases should be treated on an individual basis taking into account the injury, the age of the child and capacity for remodelling and the uncertain long-term impact of fusions in children.

Conclusion

Our case series demonstrates that surgical stabilization and short segment fusion of flexion distraction injuries in the paediatric population is a safe and viable option with excellent clinical and radiological outcomes. Given the advances in spinal instrumentation and techniques, early treatment with surgery has excellent outcomes in our experience.

Conflict of interest None.

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