Fusionless posterior hemivertebra resection in a 2-year-old child with 16 years follow-up

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Abstract

Purpose We present the case of a 2-year-old patient with congenital scoliosis due to a lumbar hemivertebra. The current gold standard treatment of such an abnormality would be hemivertebra resection and short level posterior spinal fusion. However, due to the young age of the patient, we considered that application of a fusionless solution might offer advantages in terms of retaining normal segmental motion and the potential for growth.

Methods The incarcerated hemivertebra was resected and the facet joints of the neighbouring vertebrae were joined to create a new functional motion segment and correct the kyphoscoliotic deformity. Transpedicular screws were

inserted on the convex side in L2 and L3 and a tension band was applied.

Results 16 years after the surgery, the patient was completely pain-free, motion of the lumbar spine was preserved and the physiological curvatures were maintained.

Conclusion To our knowledge a fusionless surgical solution for the treatment of a hemivertebra has never been described before. Although this is only a single case, the good result with a long follow-up suggests the technique is worthwhile considering when planning the treatment of a lumbar hemivertebra in very young children.

Keywords Early onset scoliosis · Congenital deformity · Motion preservation · Non-fusion procedure

Case presentation

We present the case of a 2-year-old patient with scoliosis due to a lumbar hemivertebra. The current gold standard treatment of such an abnormality would be hemivertebra resection and short level posterior spinal fusion. However, due to the young age of the patient, we considered that application of a fusionless solution might offer advantages in terms of retaining normal segmental motion and the potential for growth.

Review of the condition

Congenital scoliosis is usually the result of failure of formation and/or segmentation. A hemivertebra is regarded as a unilateral formation defect, and is one of the most common causes of congenital scoliosis. It is generally assumed that a hemivertebra is a rare congenital spinal

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anomaly; however, according to a recent report by Goldstein et al. [1], based on prenatal ultrasound diagnosis, the incidence of hemivertebra is 0.33 out of 1,000 live born infants. The natural history of hemivertebra is well known [2–5] and if untreated, the deformity will most likely increase throughout childhood and adolescence resulting in structural changes also in the unaffected region of the spine. The probability of progression depends on the type of hemivertebra and whether a combination of developmental failure in formation and segmentation is present [2]. In early reports, Repko et al. [6], reported insufficient correction of the deformity if fusion was performed without resection of the hemivertebra: in situ bony fusion alone resulted in a correction of the scoliosis of just 22.1% compared with 61% after instrumented hemivertebra excision with simultaneous anterior and posterior fixation. The early diagnosis and treatment of these congenital deformities by resection and short level fusion appears to result in better deformity correction [7, 8] than when correction is performed at a later age [9–11]. Furthermore, there is some suggestion that the use of a posterior approach alone results in a better long-term correction compared with a combined anterior/posterior approach [6, 12].

Rational for treatment

The feasibility of early diagnosis and the well known natural history of the disease justify early surgical intervention, preferably below the age of 5 years, to obtain the best possible correction, prevent deterioration of the spinal deformity and retain the normal function and form of the unaffected regions of the spine [7, 8]. Posterior hemivertebra resection and fusion has recently become the gold standard procedure, with the fusion being kept as short as possible. A fusionless solution, however, would theoretically allow for the preservation of growth potential, with the achievement of normal body height and prevention of possible adjacent segment problems in later life.

The presented case of a 2-year-old child suffering from hemivertebra with a scoliotic deformity of 40° (Cobb angle) and kyphotic deformity of 10° at a single segment describes a new method of hemivertebra resection and anatomical reconstruction, with 3 months temporary fixation. Such a method would allow the function of the motion segment to be retained. However, such a solution is only possible if the orientation of the articular facet joint surfaces and the condition of the disc/endplate complex allow such a reconstruction after complete resection of the hemivertebra.

If considered a therapeutic option, the diagnostic work-up should include conventional radiographs in AP and lateral projections as well as CT scans with 3D reconstruction and MRI (alternatively CT myelography) to assess the neural

structures accordingly. The final decision in favour of a resection without fusion can only be made intra-operatively after the anatomical structures are examined.

Procedure

In November 1991, an 8-month-old girl presented with a right convex lumbar scoliosis due to a hemivertebra hemi-incarcerated in the third lumbar vertebra on the right side, with a preserved disc between the second lumbar vertebra and the hemivertebra. The diagnosis was established under the assumption that the lumbar spine consisted of five vertebrae and one hemivertebra. The fifth lumbar vertebra was hemisacralized, without any influence on alignment. The major curve between L2 and L4 measured 36°. During subsequent observation, slight progression was detected. At the age of 2 years the scoliosis had increased to 40° and was accompanied by a segmental kyphosis between L2 and L3 of 10°. The preoperative radiographs from November 1993 (Fig. 1) showed rotational changes in the compensatory curves above and below the hemivertebra. The intervertebral disc between the second vertebra and the hemivertebra was normal. The preoperative radiographs and the anticipated orientation of the joint surfaces in the

Fig. 1 AP and lateral preoperative radiographs of the 18-month-old girl with hemi-incarcerated hemivertebra between L2 and L3 on the right side

Fig. 2 **a** Anatomical situation of the hemivertebra between L2 and L3 on the right side. **b** After resection of the hemivertebra. **c** Temporary fixation with a pedicle screw and wire tension band construct applied to the reconstructed L2/L3 facet joint

Fig. 3 AP and lateral postoperative radiographs after posterior hemivertebra resection and temporary instrumentation L2–L3

affected region suggested an optimal anatomical situation for resection of the hemivertebra with correction, reconstruction of the facet joint and temporary fixation without fusion.

Fig. 4 AP and lateral radiographs 16 years after hemivertebra resection

Surgical technique

The first author exposed the surgical field on the right side between L1 and L4 and on the left side at the level of L2 and L3. By cutting the fascia on both sides, the interspinous and supraspinous ligaments were preserved. These midline structures are important as part of the posterior tension band, especially in children. The posterior elements

Fig. 5 Dynamic MRI 16 years after resection of the hemivertebra in standing, lateral bending and flexion/extension showing preserved movement in the L2–L3 disc space

including the hemivertebra and its large transverse process were carefully exposed, preserving the periosteum and the integrity of the joint capsules to prevent subsequent spontaneous fusion at the surgical site. This was achieved by careful sharp dissection and the use of only bipolar cautery for haemostasis. The pedicles of L2, L3 and of the hemivertebra on the convex side were first marked using thin needles. Following fluoroscopic control in antero-posterior (AP) and lateral views, the L2 and L3 pedicles on the right side only were drilled with a 1.5-mm drill using the free-hand technique. L-shaped K-wire was used to mark the drill holes, and another fluoroscopic control was carried out. Subsequently, the pedicles were redrilled with a 2.5-mm drill and 3.5-mm diameter AO cortical screws were inserted.

Under microscopic control the articular processes of the hemivertebra were resected, with the corresponding joint capsules being preserved to allow subsequent suturing

(Fig. 2). The hemilamina and the transverse process of the hemivertebra were completely resected including the periosteum using a Kerrison-rongeur. The lateral and the anterior parts of the hemivertebra were then exposed by blunt dissection. As the hemivertebra was located posteriorly, the blunt dissection was performed between the spinal column and the psoas muscle and thus the retroperitoneal space did not need to be opened. A blunt spatula was inserted anteriorly to protect the main vessels. The dura and the nerve roots above (normal nerve root) and below (hypotrophic, probably additional nerve root) the pedicle of the hemivertebra were exposed. The pedicle was then incompletely resected with the aid of a diamond burr, with an initial retention of its medial wall in order to protect the dura and neural structures. After removal of the hemivertebra body pedicle resection was completed leaving the intervertebral disc below L2 intact. The resection proceeded in a manner that spared the cartilage endplate of the

Fig. 6 Clinical picture taken at the last follow-up in 2009

hemivertebra bordering the disc. Compression applied between the L2 and L3 pedicle screws resulted in approximation of the corresponding articular processes; a wire tension band was fixed to the pedicle screws to secure the positioning (Fig. 2). AP and lateral fluoroscopic

controls were carried out to confirm that an anatomically congruent repositioning of the articular surfaces had been achieved (Fig. 3). After the correction manoeuvre, it was checked that no compression or tension of the nerve roots had occurred during the repositioning of the L2 and L3 vertebra (Fig. 3). The final step of the procedure involved the suturing of the remaining joint capsules to construct the new L2/L3 facet joint on the right side. The interspinous ligament, which after hemivertebra resection was excessively long, was shortened with plastic reconstruction.

The operation time was 2 h and 30 min. Under the same anaesthesia a thoracolumbar plaster brace was applied for temporary fixation to allow the joint capsule and the surrounding soft tissues to heal in the subsequent 3 months. The plaster brace, wire and screws were removed 3 months after the operation. During the implant removal the mobility of the segment was confirmed intra-operatively.

Outcome

Clinical and radiological follow-ups were performed at 3 months, 18 months, 9 years, and 16 years post-operatively. Good coronal and sagittal alignment of the spine was observed clinically and radiographically at the first follow-up. A slight lumbar scoliotic deviation of 8° was detected on the radiographs taken at the 9-year and 16-year follow-ups (Fig. 4). The sagittal profile changed from 10° kyphosis between L2 and L3 preoperatively to 14° lordosis in this region at the final follow-up.

At the final follow-up the 19-year-old woman presented clinically with an almost completely normal spine with good range of motion. The dynamic MRI examination from 2009 demonstrated a retained segmental motion of L2/3 with extension of 16 degrees, flexion 11 degrees, left lateral flexion 10°, right lateral flexion 1° (Fig. 5). The patient was completely pain-free and had no restrictions in her daily activities including performing sports (Fig. 6; Table 1).

Table 1 Summary of studies reporting the outcome of hemivertebra resection and fusion

Author	n	Average age	Follow-up	Total scoliosis correction	Total kyphosis correction	Fusion type
Bollini [12]	28	3 years 6 months	7 years 1 months	34.8–17.4°	20–8.6°	Combined
Hedequist [8]	10	4 years 3 months	1 year 4 months	44–8°	44–8°	Posterior
Li [9]	24	9 years 5 months	3 years 7 months	45.2–15.6°	?	Anterior
Repko [6]	22	10 years 2 months	12 years 1 month	51.3–20.3°		Combined
Ruf [7]	4	3 years 5 months	4 years 6 months	45.9–9.9°	22.8–6.8°	Posterior
Shono [10]	12	8 years 2 months	5 years 9 months	49–18°	40–17°	Posterior

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

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