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Hemivertebral Excision for Congenital Scoliosis in Very Young Children

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Study conducted at Walter Reed Army Medical Center, Washington, D.C., U.S.A.

Summary: The present study reports the results of a consecutive series of six very young children who underwent single-anesthetic sequential anterior and posterior hemivertebral excision. The children, all less than 34 months old (mean age 19 months), presented with high magnitude or progressive congenital scoliosis related to an unbalanced hemivertebra. Curve correction required hemivertebral excision, which was accomplished during a single operative event using sequential anterior and posterior procedures. The intraoperative curve correction was maintained with plaster immobilization for 3 months. All patients were followed for at least 24 months. Pre- and postoperative spinal radiographs were analyzed for initial and final curve correction. Excellent correction of preoperative deformity was obtained and maintained throughout the follow-up period. The mean postoperative curve correction (67%; range 52%–84%) compared favorably with the average correction at final follow-up (70%; range 50%–85%). Radiographs revealed a consistently solid arthrodesis with no evidence of curve progression. There were no neurologic or other significant complications. In conclusion, single-anesthetic sequential anterior and posterior hemivertebral excision appears to be a safe and efficacious procedure for the management of congenital scoliosis in very young children. **Key Words:** Children—Congenital scoliosis—Excision—Hemivertebra.

The location and type of congenital vertebral anomaly can have profound effects on the severity and prognosis of congenital scoliosis (9,10,11,14,16). Although large deformities that are present from an early age often require surgical treatment, it is the recognition and surgical management of smaller-magnitude high-risk curves that are generally most successful (2,4). To manage high-risk curves with a poor prognosis, it may be most advantageous to operate at a very young age.

Single-anesthetic hemivertebral excision using combined anterior and posterior approaches for the treatment of congenital scoliosis was originally described by Royle in 1928 (13). The procedure, however, was complicated by an unacceptably high incidence of neurologic injury and was therefore condemned (as a single-stage procedure) by Leatherman and Dickson (6). Subsequently, Bradford and Boachie-Adjei (1) and others (2,5,7) reported excellent results and no neurologic complications using a single-stage combined anterior and posterior approach in a heterogeneous group of children and adolescents. Callahan et al. (2) have also suggested that operative results might be improved if surgery was performed at a younger age.

To our knowledge, there are no published reports that exclusively examine the safety and efficacy of single-anesthetic sequential anterior-posterior hemivertebral excision in very young children. The purpose of this retrospective study was to assess the immediate safety and early follow-up (≥2 years) results of this procedure in an exclusive population of very young children.

METHODS

This retrospective clinical study examines the results of single-anesthetic, sequential anterior and posterior hemivertebral excision in a consecutive series of six very young children. The patients included five boys and one girl with a mean age of 19 months at surgery (range 13–33). All patients had substantial fixed-deformity scoliosis or progressive deformity resulting from an unbalanced fully segmented hemivertebra (Table 1). Curve magnitudes were determined using the method of Cobb on full-length supine films. Additional evaluation revealed visceral anomalies in four children. Spinal magnetic resonance imaging scans showed no evidence of occult intraspinal anomaly.

All surgeries were performed by a single spine-trained orthopaedic surgeon (D.W.P.) at the same institution.

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TABLE 1. *Children undergoing hemivertebral excision for congenital scoliosis*

Patient	Age at surgery (mo)	Spinal anomaly	Associated anomaly	Preop curve	Postop curve (% change)	Curve at last follow-up (change)	Follow-up (mo)	Estimated blood loss (mL)	Time of surgery
1	14	L1 fully segmented hemivertebra	Dextrocardia	48°	8° (84%)	7° (−1°)	29	125	5 h 49 min
2	33	L1 fully segmented hemivertebra		43°	13° (70%)	12° (−1°)	33	450	6 h 35 min
3	19	T6 fully segmented hemivertebra	Rib synostosis	39°	15° (61%)	15° (0°)	39	450	4 h 15 min
4	14	T7 fully segmented hemivertebra; ipsilateral L2 semisegmented hemivertebra		29°	9° (69%)	9° (0°)	48	150	8 h 50 min
5	15	L5 semisegmented hemivertebra	Hydronephrosis	35°	10° (71%)	5° (−5°)	70	300	7 h 40 min
6	20	L2 Fully segmented hemivertebra; contralateral bar	Horseshoe kidney	38°	18° (52%)	19° (1°)	24	700	7 h

Surgery included a single-anesthetic sequential anterior and posterior hemivertebral excision combined with manipulative correction of the deformity. Although determined by the presenting anomaly, arthrodesis generally extended at least one level above and below the anomalous segments. All patients were managed with intraoperative somatosensory evoked potential monitoring and an intraoperative "wake-up" test (12). In all patients, plaster immobilization was used for 3 months. For hemivertebral excision in the upper lumbar spine, the cast included a single upper extremity rather than a lower extremity. This casting technique precludes pistoning of the torso within the cast while allowing the child to ambulate (personal communication, John Hall, M.D.).

Hemivertebral excision was performed using combined single-anesthetic sequential anterior and posterior approaches with the patient in a floppy lateral decubitus position, as described by Bradford and Boachie-Adjei (1). After the removal of anomalous segments, manipulative correction preceded segmental stabilization using a large sublaminar suture tape passed beneath the supra- and subjacent laminae. The suture tape cannot be used as the corrective force because it can easily cut through the laminae. Manipulative forces are applied manually to the convexity of the curve or through a large compression clamp applied to osseous structures above and below the resection. When addressing a thoracic hemivertebra, it is critical to remove the corresponding convex rib to allow closure of the hemivertebral defect. Fusion without instrumentation was subsequently performed.

RESULTS

In this group of very young children, the average age at the time of surgery was 19 months (range 13–33). The average preoperative curve magnitude measured 38°

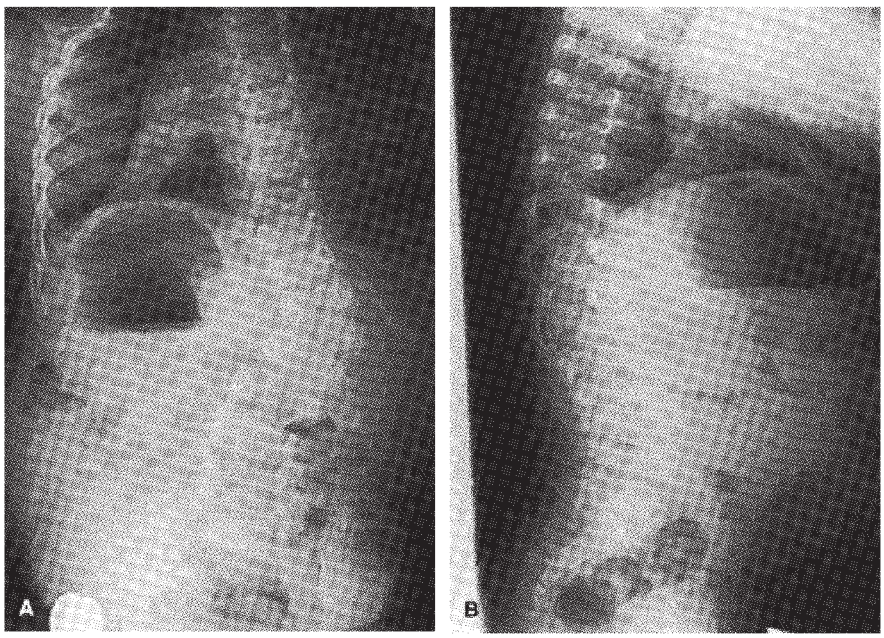

FIG. 1. Preoperative posteroanterior and lateral radiographs showing an unbalanced 48° right thoracolumbar kyphoscoliosis resulting from an L2 fully segmented hemivertebra.

(range 29°–48°) and compared favorably with a mean immediate postoperative curve magnitude of 12° (range 8°–18°). The improvement in curve magnitude averaged 68%. The mean duration of surgery was 435 minutes (range 349–530) and was accompanied by an average blood loss of 362 mL (range 125–700). Four children required transfusion. There were no neurologic complications or complications related to cast immobilization.

At a mean follow-up of 41 months (range 24–70), the average curve magnitude measured 11° (range 5°–18°). There was no radiographic or clinical evidence of pseudoarthrosis and no loss of correction in any patient. Biplanar radiographs showed good spinopelvic balance in all children.

Case example

Patient 1 (Table 1) presented with a high-magnitude congenital scoliosis resulting from a fully segmented hemivertebra at L1. Radiographs showed an unbalanced 48° right thoracolumbar kyphoscoliosis (Fig. 1). Developmental milestones and results of the preoperative neurologic examination were normal. At 14 months of age, the patient underwent an uncomplicated single-anesthetic, sequential anterior-posterior excision of the lumbar hemivertebra. The hemivertebra was easily discernible at surgery (Fig. 2). Postoperative radiographs showed a residual curve of 8°, consistent with a curve correction of 83% (Fig. 3). At the most recent follow-up (29 months after surgery), radiographs showed no loss of correction (Fig. 4).

DISCUSSION

Fully segmented hemivertebrae can have significant unbalanced growth potential (9–11,14,16) and are particularly worrisome in children presenting with high-magnitude curves at a very young age. Although the optimal treatment for these high-risk congenital curves is surgical, the "ideal" surgical timing and methodology are debatable.

FIG. 2. Intraoperative photograph showing the fully segmented hemivertebra. Asterisks denote cartilaginous endplates.

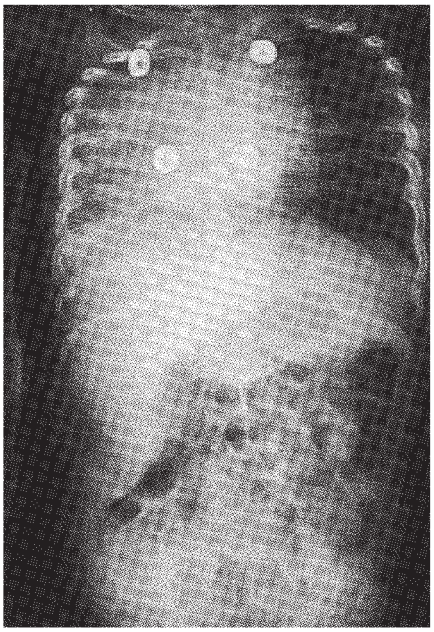

FIG. 3. Postoperative plaster immobilization. Residual curve measures 8°.

In very young children, spinal fusion is typically delayed to the greatest extent possible so that longitudinal spinal growth may occur. However, as shown by Winter's "shortening formula" (15) and by the growth curves of Dimeglio and Bonnel (3), spinal growth in children is an extremely gradual process. For example, a 5-year-old girl fused over five spinal segments will lose approximately 3.5 cm of growth during the 10-year period before skeletal maturity. In addition, unless complicated by high-magnitude compensatory curves, congenital scoliosis is typically managed with short-segment arthrodesis confined to the region of congenital anomaly. Because the overall growth effect of such short-segment arthrodesis is probably not functionally significant, focused attempts to gain spinal length in young children should not ignore the overt implications of progressive deformity.

Despite the recognized growth effects and possible anesthetic risks of spinal surgery in very young children, the potential advantages of early surgery are several. First, and perhaps most importantly, surgery for lower-magnitude curves requires less correction and less surgical aggression (posterior fusion alone vs. hemivertebral excision) and carries less neurologic risk. Second, despite a congenital origin, immature congenital curves may retain some local flexibility and often lack structural compensatory curves. Such curves, therefore, may permit a shorter arthrodesis. Finally, at least one other study on hemivertebral excision has suggested that superior short-term results are obtained in younger patients (2).

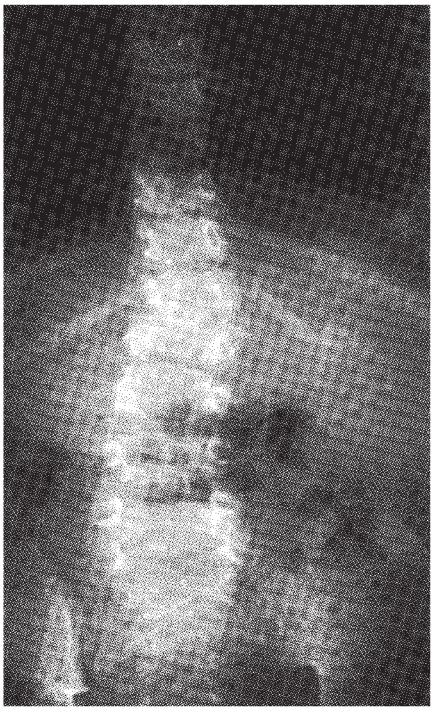

FIG. 4. Follow-up radiograph (at 29 months) showing maintenance of initial curve correction.

Thus, earlier surgery may not only induce a better initial correction but may also enhance the near-term and perhaps ultimate surgical outcome.

We believe that high-risk congenital curves in very young children are best managed through early surgical intervention. In the present study, a group of six children with a mean age of 19 months underwent single-anesthetic sequential anterior and posterior hemivertebral excision. There were no significant complications and specifically no anesthesia-related complications. The risk of general anesthesia in infants appears to decline by 1 year of age (8). When indicated, we prefer to proceed to surgery at 1 year of age or as soon thereafter as surgically permissible.

Due to its inherent risks, combined anterior and posterior hemivertebral excision for congenital scoliosis will likely always incur some controversy. Previous studies in heterogeneous populations of children and adolescents have shown the safety and efficacy of such procedures (1,2,4,7,14). The present study documents similarly favorable results in very young patients. It remains unclear, however, whether the improved surgical outcomes since Leatherman's original report have resulted from advances in surgical or anesthetic techniques or are the direct result of "real-time" intraoperative neurologic monitoring. Most likely, a combination of these advances has contributed to a safer procedure.

CONCLUSIONS

Single-anesthetic, combined anterior and posterior hemivertebral excision and fusion is a safe and efficacious surgical option for the management of congenital scoliosis in very young children. In appropriately selected patients, the technique provides excellent correction of deformity and a balanced spine while fusing as few motion segments as possible.

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