

# Distraction Phenomenon After Lengthening of Spinal Growing Rods

## A Case Report

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The treatment of early-onset scoliosis remains challenging, and growing-rod instrumentation has been shown to be an option for allowing trunk and lung development while partially straightening and controlling spine deformity<sup>1-4</sup>. Initial treatment with single rods had an unacceptable risk-benefit ratio<sup>3-6</sup>, and dual rods are currently preferred, achieving corrections from 30% to 64% at the time of the final spinal fusion<sup>3,7</sup>. Unfortunately, dual-rod systems retain complication rates ranging from 19% to 58%<sup>2,3,8,9</sup> in instrumented patients. The most common complications include wound infections, skin breakdown, proximal and distal junctional kyphosis, and implant-related complications (e.g., rod breakage, implant prominence, and hook and/or screw pullout)<sup>8,10</sup>. Spontaneous fusion rates of 89% were also reported as a potential complication associated with submuscular rod placement and surgical procedures at early ages<sup>7,11</sup>, sometimes requiring osteotomies during the final posterior fusion<sup>7</sup>.

To the best of our knowledge, there is no prior report of distraction phenomenon related to the growing-rod lengthening procedure. The patient's parents were informed that data concerning the case would be submitted for publication, and they provided consent.

### Case Report

A two-day-old girl was urgently transferred to our hospital because of a thoracic mass that grossly resembled arachnoid tissue. Radiographs showed a right thoracic curve measuring 15° from T1 to T10, a localized kyphosis of 57° from T5 to T7, and a global kyphosis of 18° from T2 to T12. Additional image investigation revealed a congenital malformation with butterfly vertebrae from T5 to T7 and a posterior vertebral defect with incomplete laminae extending from T3 to T6. Magnetic resonance imaging showed that the mass had grown out from the spinal cord. The patient underwent neurosurgery, and the final histologic characteristics of the mass were consistent with a mature teratoma.

The patient was followed by the neurosurgery division and, at the age of eight months, presented with a possible recurrence of the teratoma associated with 9° of scoliosis (Fig. 1-A) and a rapidly progressive kyphotic deformity of 65° (Fig. 1-B). The neurosurgical team proceeded with a new biopsy and frozen section, which showed no residual or recurrent teratoma. At this time, the orthopaedic surgeons performed a posterior fusion and instrumentation of the spine from T2 to T9. An anterior approach from T4 to T8 was needed to accomplish discectomies, a kyphectomy with partial vertebrectomies, and the fusion. Rib-grafting was used to support the kyphosis correction, resulting in a residual 30° of kyphosis.

Five months later, the patient presented with implant prominence and a dorsal thoracic bursa. The decision was made to remove the implants. Unfortunately, over the following months, the kyphosis progressed rapidly to 57°, and a left lumbar scoliosis of 30° developed from T12 to L5, with suspicion of teratoma recurrence.

Biopsy at the age of twenty-three months showed no teratoma recurrence. The orthopaedic surgery team carried out Ponte osteotomies above and below the fusion mass to gain kyphosis correction, but did not add any additional anterior osteotomies. Instrumentation with growing rods from T2 to L2 was accomplished, achieving a kyphosis correction to 52° (Figs. 1-C and 1-D).

The patient had three lengthening procedures at six-month intervals, achieving 4.5 mm, 2 mm, and 15.5 mm of distraction, respectively. Six days after the third lengthening procedure at the age of three years and five months, a horizontal calcific linear radiodensity inferior to the T11 vertebral body was seen on a radiograph. The T11-T12 disc space had an 8.3-mm gap and was remarkably wider than the adjacent disc spaces, raising the suspicion of a distraction phenomenon, which was confirmed with computed tomography (Figs. 2-A and 2-B). Following this third lengthening procedure, the patient was able to walk and did not

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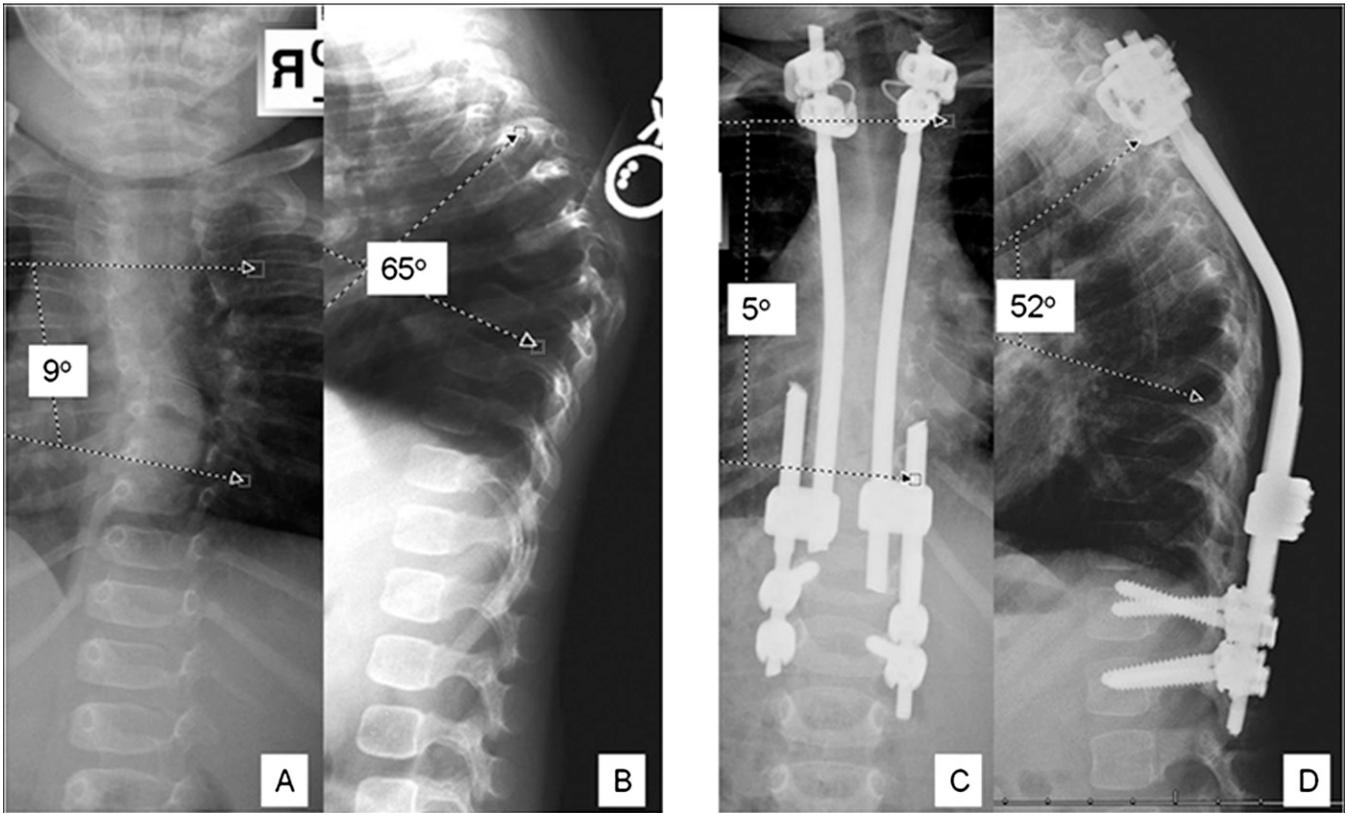


Fig. 1

Posteroanterior and lateral radiographs. At the age of eight months, 9° of scoliosis (**Fig. 1-A**) and 65° of kyphosis (**Fig. 1-B**) were evident. At the age of twenty-three months, postoperative radiographs following instrumentation with growing rods demonstrated 5° of scoliosis (**Fig. 1-C**) and 52° of kyphosis (**Fig. 1-D**).

have unusual postoperative pain. Return to the operating room for release of the distraction was considered, but because she was neurologically intact, we elected to continue to observe and follow her course. She was placed in a thoracolumbar sacral

orthosis for eight months before proceeding to another lengthening procedure.

Subsequently, the patient had four more lengthening procedures, achieving 6 mm, 5 mm, 7 mm, and 4 mm of distraction,

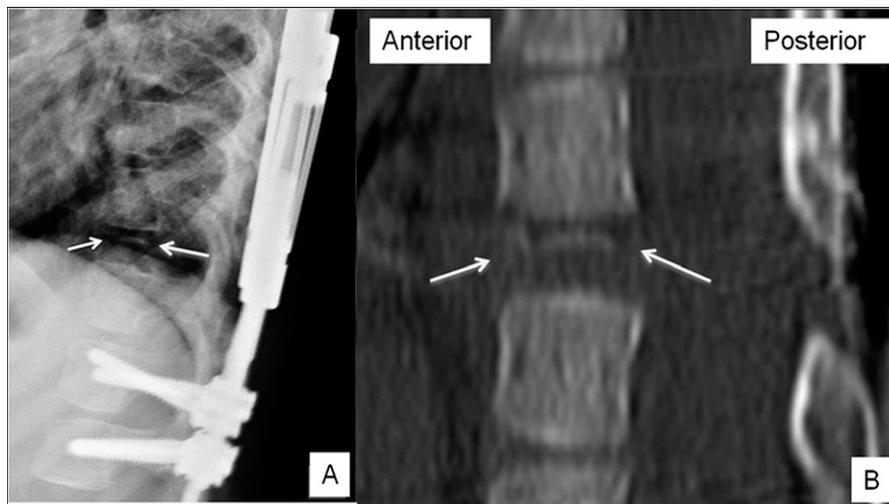


Fig. 2

A lateral radiograph (**Fig. 2-A**) and a sagittal computed tomographic scan (**Fig. 2-B**) showed the T11-T12 gap of 8.3 mm after the distraction phenomenon (white arrows).

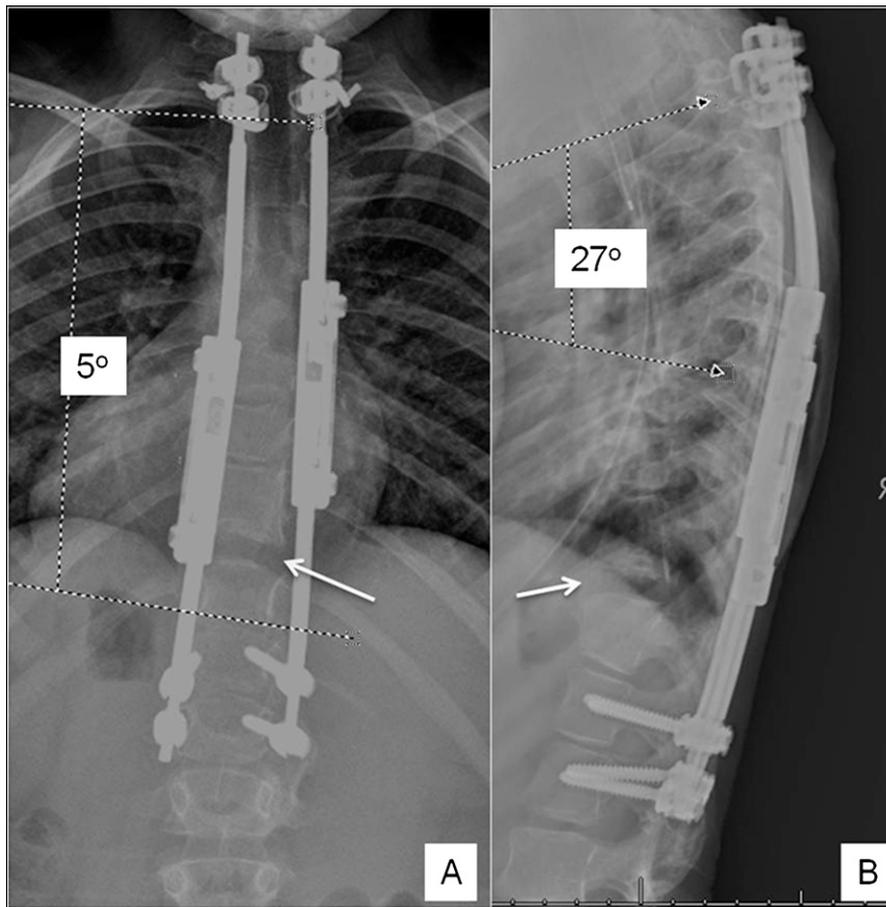


Fig. 3

At the age of seven years, four years after the initial distraction injury that occurred at the third lengthening (white arrows), a posteroanterior radiograph showed 5° of scoliosis (**Fig. 3-A**), and a lateral radiograph showed 27° of kyphosis from T2 to T8 and 48° of kyphosis from T2 to T12. (**Fig. 3-B**).

respectively. The last procedure took place when she was seven years old (Figs. 3-A and 3-B). To the best of our knowledge, there is no clinically established method to quantify the amount of distraction during growing-rod lengthening procedures. The widened disc space following the distraction phenomenon appeared to remain stable during the following lengthenings, and the patient continued to be neurologically intact and pain free. In subsequent lengthenings, we used intraoperative fluoroscopy images to prevent additional overdistrction.

All surgical procedures were carried out with intraoperative neuromonitoring, but since the first procedure, the patient did not show any somatosensory evoked potential signals.

### Discussion

Growing-rod instrumentation is a valuable tool for the treatment of early-onset scoliosis. Dual-rod constructions are currently the standard option but can have a complication rate up to 58%. Fortunately, the majority of these complications can be treated.

This case report depicts a possible new mechanism of spine injury in children during the first two decades of life. The forces are driven longitudinally along the extent of the growing rods, which is different from high-energy flexion-distraction

injuries, where distraction force is associated with a fulcrum in the anterior column. The distraction phenomenon was located at T11-T12 in our patient and occurred in the third lengthening procedure, so we believe that it is unlikely that the prior fusions were solely responsible for the distraction phenomenon. In 2005, Thompson et al.<sup>12</sup> reported higher complication rates following apical fusion in patients with growing rods, which may result in a stiffer spine, but none of the complications were similar to the one in our patient. However, we found that distracting the previous fused mass could have led to stress concentration in the six remaining unfused levels and indirectly increased the risk of having the distraction phenomenon.

We called this “distraction phenomenon” because of the age of our patient at the time of its occurrence. The term “chondrodiastasis” could be applied if an attempt to elongate the vertebra was intended, which was not our objective. Moreover, a chondrodiastasis would be possible only in older children whose secondary ossific nuclei are not completely fused to the vertebral body yet. End-plate disruption can also be used as an explanation in a traumatic context and in older children. By sixteen years of age, the secondary ossific nuclei arise in the cartilages covering the ends of the vertebral bodies, and these epiphyses unite by age twenty-five. In this longitudinal

distraction mechanism, circumferential detachments from the superior or inferior margins of the vertebral body may occur once the central portion of the cartilaginous vertebral apophysis attaches to the vertebra later in development<sup>13</sup>. Although this is presumably a low-energy mechanism, it can distract the spinal cord if lengthening procedures are carried out without proper healing of the lesion, resulting in neurologic injury. It may be possible that anterior and posterior ligamentous integrity play a protective role, which is different from the flexion-distraction injury in which the posterior ligamentous complex may be torn. Fortunately, our case was an osseous lesion, and bracing and resting were sufficient to heal the fracture.

A previous study analyzing 222 monitored rod-lengthening procedures showed a single case (0.5% incidence rate) of neuro-monitoring signal change without clinical neurological injury. This was in a patient with an intracanal tumor<sup>14</sup>. Neurologic deficits are rare in lengthening procedures; concern was raised in our case because the underlying cause of the early-onset scoliosis was an intracanal teratoma and the patient had had a previous apical spinal fusion.

### Conclusion

To the best of our knowledge, this is the first report of a distraction phenomenon following a growing-rod lengthening

not directly related to distracting on previous fusion masses. We advise caution with regard to this phenomenon and the need for careful evaluation after lengthening procedures, even when the patient is neurologically intact. We also reinforce the need for intraoperative neuromonitoring during these procedures in cases of intracanal abnormalities. Continuous distraction on nonhealed vertebral segments potentially can result in spinal cord injury, and we strongly believe that estimating the distraction force needed for a growing-rod lengthening is still a challenge. ■

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