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CASE REPORT

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Unusual presentation of spinal cord compression related to misplaced pedicle screws in thoracic scoliosis

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Abstract Utilization of thoracic pedicle screws is controversial, especially in the treatment of scoliosis. We present a case of a 15-year-old girl seen 6 months after her initial surgery for scoliosis done elsewhere. She complained of persistent epigastric pain, tremor of the right foot at rest, and abnormal feelings in her legs. Clinical examination revealed mild weakness in the right lower extremity, a loss of thermoalgic discrimination, and a forward imbalance. A CT scan revealed at T8 and T10 that the right pedicle screws were misplaced by 4 mm in the spinal canal. At the time of the revision surgery the somatosensory evoked potentials (SSEP) returned to normal after screw removal. The clinical symptoms resolved 1 month after the revision. The authors conclude that after pedicle instrumentation at the thoracic level a spinal cord compression should be looked for in case of subtle neurologic findings such as persistent abdominal pain, mild lower extremity weakness, tremor at rest, thermoalgic discrimination loss, or unexplained imbalance.

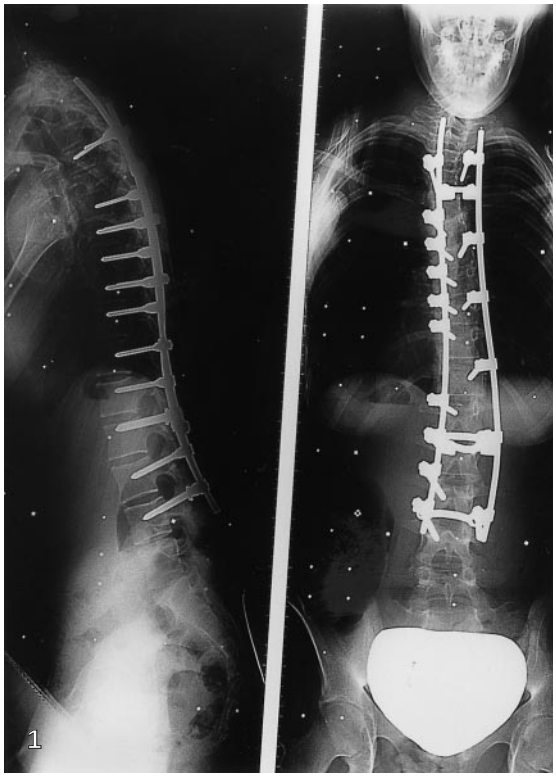
Key words Scoliosis · Thoracic pedicle screw · Surgical complication

Introduction

Roy-Camille et al. [16, 17] were the first to popularize the use of pedicle screws in the treatment of a variety of spinal disorders. Since the introduction of Cotrel-Dubousset instrumentation [4], the utilization of pedicle screws at the lumbar and thoracolumbar levels has become more frequent [1–3, 5, 8, 10, 16]. However, the utilization of thoracic pedicle screws in the thoracic spine is controversial due to the potential neurological complications [7, 22]. The anatomy of the pedicle at the thoracic level [6, 11, 14] makes screw insertion difficult. However, according to Suk et al. [19], segmental instrumentation by pedicle screws for idiopathic scoliosis would permit an important gain of correction. Liljenqvist et al. [12], reporting on 32 patients, found that despite a rate of 8.3% of medial wall pedicle penetration by the screws, no neurologic compromise was observed. We report on one case of spinal cord compression following segmental pedicle instrumentation for adolescent idiopathic scoliosis.

Case report

A 15-year-old girl was referred to our clinic for persistent abdominal pain and imbalance 6 months after correction of a progressive 54° scoliosis done elsewhere (Fig. 1). From the operating report, the surgery had been uneventful and the wake-up test had been normal. The technique of pedicle screw insertion had been performed with a pedicle probe driven by hand. Anteroposterior and lateral intraoperative radiographs with metallic pins inside the pedicle had been done to control their correct location inside the

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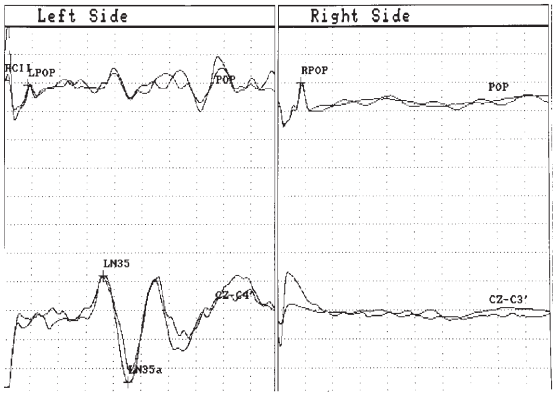
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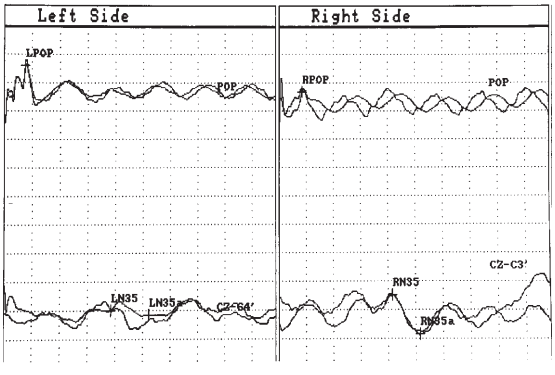
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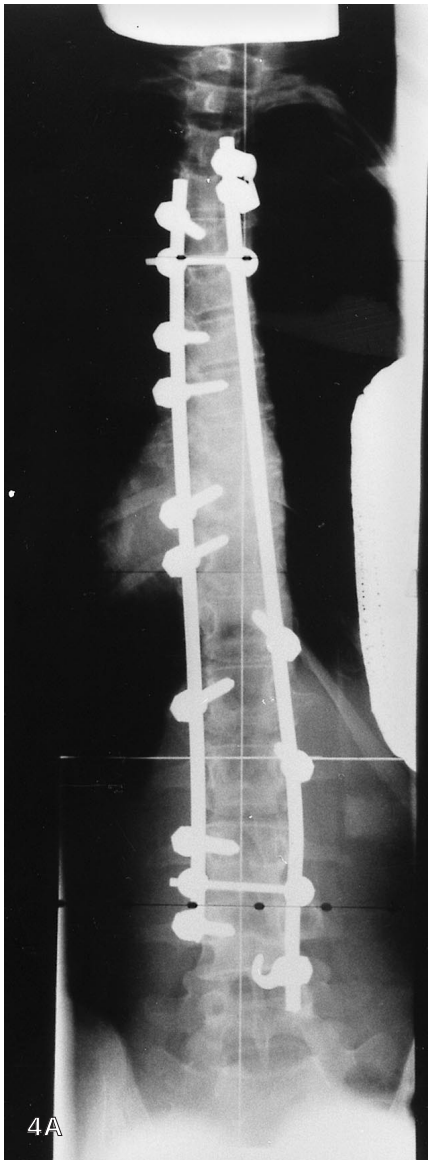

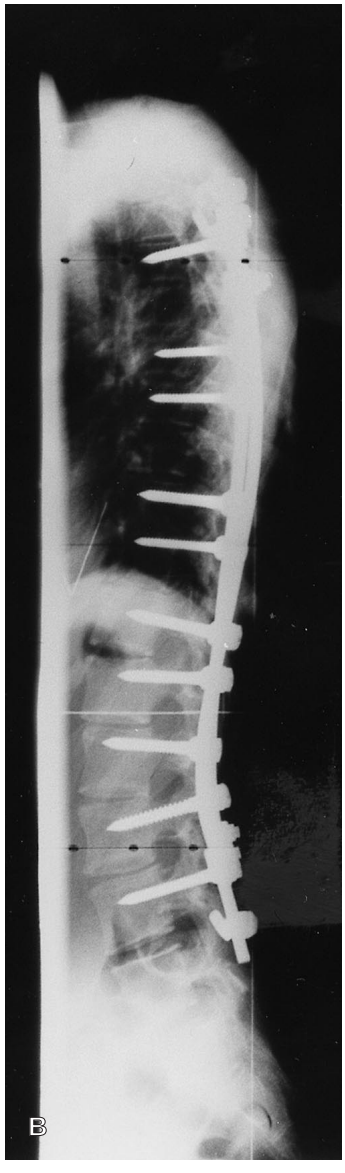

◀ **Fig. 1** Radiographs at 6 months show a sagittal decompensation and misplaced pedicle screws

Fig. 2 The CT scan shows a 4-mm protrusion of the thoracic pedicle screws into the spinal canal

Fig. 3 **A** Preoperative somatosensory evoked potentials show absence of wave on the right side. **B** After removal of the offending screws at T8 and T10, the evoked potentials returned to normal within 45 min

Fig. 4 Postoperative radiographs show that the patient has regained a normal coronal (**A**) and sagittal (**B**) balance

pedicle. Postoperatively the patient complained of severe abdominal and epigastric pain. She therefore had a complementary work-up, including liver function tests, X-rays, abdominal ultrasound "upperGI and small bowel follow through", and gastroduodenal endoscopy. All this came back negative and the patient was discharged home. We saw her 6 months after her initial surgery, for persistent pain. Clinical examination revealed a loss of thermoalgic discrimination under the knees, mild weakness (4 out of 5) of the dorsiflexor of the right foot, of the right psoas muscle, and of the right triceps. The tremor in the right foot was observed at rest and she could stop it on command. There was no Babinski sign and no clonus observed, deep tendon reflexes were normal, proprioception was intact. The abdominal reflexes were normal. The radiographs (Fig. 1) showed a sagittal decompensation and screw malpositioning at different levels. A CT scan showed the convex T8 and T10 screws to be protruding into the spinal canal by 4 mm (Fig. 2). Eight months after her initial surgery, revision surgery was decided on with the objective of removing the offending screws. Re-exploration of the whole instrumentation was carried out. The right T8 and T10 screws were removed and, as the fusion was felt to be non-solid, it was decided to reinstrument the spine with a multiple hook-screw system. During the procedure the SSEP, which did not exist pre-operatively on the right side, returned to normal 45 min after the removal of the two screws (Fig. 3). The wake-up test was normal. Postoperatively, the abdominal pain disappeared as well as the tremor of the foot. The findings of the neurological examination returned to normal, and the patient regained a normal coronal and sagittal balance (Fig. 4).

Discussion

The use of thoracic pedicle screws is controversial. The anatomic studies of thoracic pedicles [6, 11, 13, 14, 17, 23] show a great morphologic variation. In case of scoliosis the pedicle anatomy [15] makes the implantation even more difficult. Vaccaro et al. [20] do not recommend the use of screws at this level except for specific clinical conditions, because of the technical difficulties and the risk of major complications. Twenty-three percent of screws implanted in cadavers by experienced surgeons without radiological assistance penetrated into the canal. Suk et al. [19], reporting on 23 patients operated on for thoracic idiopathic scoliosis, found that only 3% of the screws were malpositioned, none medially. They justify the use of the thoracic screw by a significant improvement in the correction of the deformity. However, its use is judged dangerous for the neurovascular anatomical structures by others [21, 22]. Esses et al. [7], in a review of 617 cases in which the thoracic screw was used, with only 26 cases of patients presenting a deformity, found 5.2% of the screws malpositioned and 2.3% with permanent nerve complications. Gerbstein and Robbins [9], reporting on the use of 5-mm thoracic screws, noted that only two of six patients with an excess of 4 mm of the screw in the canal had neurological signs, and these resolved spontaneously in 6 months. In our case, the two screws penetrated by 4 mm, but the clinical signs did not resolve. One can argue that pedicle insertion can be made safer if one uses fluoroscopy or a three-dimensional navigation system. In thoracic scoliosis, the rotation, the small size of the pedicle, and their distorted anatomy, in our mind, makes fluoroscopy not very helpful. As for 3D navigation systems, they require a preoperative CT scan with thin slices and an intraoperative digitalization of the different anatomic landmarks of the vertebrae [18]. We have no experience in the use of such systems.

The neurologic presentation of this patient is interesting for various reasons. The abdominal pain was so severe that an extensive work-up had to be carried out for fear of a significant gastrointestinal pathology. Epigastric and abdominal pain or referred pain may be due to the compression of the posterior spinal ganglion or the spinothalamic tract at the thoracic level. This can retrospectively be attributed to an injury to the spinal cord at the T8 and T10 levels, where the splanchnic centers are located. There is a constant relationship between the organs and the areas to which the pain is referred. The loss of thermoalgic discrimination can be related to a lesion of the spinothalamic tract, which is anterolateral in the cord, and the tremor to a pyramidal lesion of the corticospinal tract, which is lateral in the cord. Should we have used myelography in view of the cord compression instead of plain CT? One can certainly argue about it. However, for us the screws at T8 and T10 were obviously in the spinal canal and correlated to the patient long tract signs, and they needed to be removed.

The initial indication to use pedicle screws all along the spine down to L4 in this case report is, therefore, very controversial. We definitely agree that their use is beneficial in the lumbar spine to control lumbar curves better [2]. However, in this case a simple thoracic instrumentation sparing most of the lumbar spine would have been enough initially, in our mind.

Conclusion

From this case report we emphasize that the placement of pedicle screws at the thoracic level in scoliosis puts the spinal cord at risk. The wake-up test, if still the gold standard can give false-negatives. Monitoring of the spinal cord must include both evoked potentials and a wake-up test, as both can give false-negative results. Subtle postoperative findings such as epigastric pain, tremor of one extremity at rest, and imbalance of the spine may be the only neurologic findings of spinal cord compression between T8 and T10.

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The introduction of pedicle screws has greatly improved the versatility and stability of spinal instrumentation. The insertion of screws, however, is a difficult task due to the variability of human anatomy. They should be used only by experienced spine surgeons. But even in experienced hands pedicle screw application is not free of risks. This has been repeatedly shown under laboratory as well as under clinical conditions. If one takes into account all minor pedicle cortex perforations, in the lumbar spine the miss rate is about 15 to 20% in a clinical setting using 2-D imaging (ap- and lateral radiographs or image intensifier). The rate of "dangerous" screws interfering with nerve structures is estimated to be one to two percent. In scoliotic thoracic spine the risk is even higher. Besides that a lesion to the spinal cord is a much more serious event than cauda equina or nerve root damage.

The two papers by Suk et al. and Liljeqvist et al. reporting on a total of 55 scoliosis patients operated on using pedicle screws in the thoracic spine without neurological damage should not be misinterpreted. Despite favorable outcome for the patients in those two series the basic problem of pedicle screws insertion remains unsolved. it is impossible to follow the direction of the screw track with sufficient accuracy by means of 2-D imaging only.

If there is a defined risk in a procedure one has to correlate this risk to the seriousness of the condition to be treated and to the benefit gained by applying this method.

Adolescent idiopathic thoracic scoliosis is a relatively benign condition. Untreated it is neither life threatening nor causing neurological problems. The benefit of using pedicle screws along the whole instrumented area in the thoracic spine has been shown to be a gain in curve correction of about 10% points as compared to other methods. Until now it has not been demonstrated that a Cobb angle improvement of this magnitude is of any practical importance in the long run. And I personally believe that this will never be shown. Therefore considerable doubt remains that it is justified to use pedicle screws in the thoracic spine for treatment of adolescent idiopathic scoliosis unless 3D-image-based tracking is available. Scoliosis correction should not be seen as a competition for the highest possible percentage of curve correction. Otherwise the patient may be the looser. Primum nil nocere.

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