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PII: S1529-9430(15)00549-5
DOI: 10.1016/j.spinee.2015.05.027
Reference: SPINEE 56349

To appear in: *The Spine Journal*

Received Date: 11 March 2014
Revised Date: 20 March 2015
Accepted Date: 19 May 2015

Please cite this article as: De Iure F, Amendola L, Corghi A, Cappuccio M, Costotransverse screw fixation in a severe cervicothoracic deformity due to a type-1 neurofibromatosis: case report, *The Spine Journal* (2015), doi: 10.1016/j.spinee.2015.05.027.

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The authors declare that they have no conflict of interest related to the publication of this manuscript and no funds were received in support of this work. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

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ABSTRACT

Background Context. Spinal implant placement may be challenging in cases of severe cervicothoracic spinal deformities and anatomical anomalies as in type 1 neurofibromatosis. Intralaminar screwing of the thoracic spine has been described in few cases in which pedicles were hypoplasic. The costovertebral joints have never been used before as an anchorage point for screws.

Purpose. To describe a new thoracic fixation technique to be used in severe deformities whenever the posterior arch (laminae and pedicles) is not available due to anatomic abnormalities.

Study design. Case report.

Methods. An 18-year-old female with progressive tetraparesis caused by increasing deformity of cervicothoracic spine underwent evaluation and surgical treatment: procedure and techniques were described. The clinical features, the radiological findings and the outcome were assessed. Complications and local recurrences were also recorded.

Results. Costotransverse joint screwing was successfully used in one case of severe cervicothoracic spine deformity with major hypoplasia of the pedicles. The posterior arch of one thoracic vertebra became mobile soon after periosteal stripping probably due to iatrogenic fracture of the only existent pedicle. The four-cortical trajectory of the screws resulted in a good bone purchase allowing the surgeon to complete the procedure. No local or general complications were recorded during two years of follow-up.

Conclusion. The procedure was used as a salvage technique during a difficult surgery where a local complication forced a change of strategy. Although the implant remained stable long enough to achieve fusion, it still consists in placing a screw through a joint that remains slightly mobile. This could possibly result in a screw loosening in the long period if fusion is not achieved. We suggest the use of this technique when all the other options have been explored and excluded for anatomical reasons.

Key words: costotransverse screws; thoracic spine; neurofibromatosis; cervical kyphosis.

INTRODUCTION.

Surgery of severe kyphotic deformities of the cervical and thoracic spine in Type I neurofibromatosis remains challenging even for experienced surgeons. Simulated surgery on custom-made plastic models may help the surgeon in surgical planning[1]. Depending on patient age, severity and stiffness of deformity, surgeon expertise, only anterior, only posterior or anterior-posterior fixation systems are used to correct and stabilize the spine. During a posterior approach both bone quality and anatomical variation makes a stable fixation difficult to achieve. Recently, intralaminar screw fixation has been extended to the thoracic spine with good results[2-3]. Nevertheless in cases of severely dystrophic deformities, pedicles can be very thin or even interrupted at one side[4-5]. So intralaminar fixation of posterior implants may be unreliable due to the fact that the connection between the posterior arch and the vertebral body is weak. For the same reason the use of laminar hooks will not make a difference in terms of stability. To our knowledge, screw implantation through the costotransverse joints has never been described before, although the surgical approach to the entry point is available during the normal exposure of the thoracic spine. This single case experience shows the effectiveness and feasibility of the technique, requiring only a normal knowledge of thoracic spine anatomy and standard instrumentation.

CASE REPORT.

An 18 year old girl who had been diagnosed type 1 NFH for many years showed a rapidly progressing weakness in four limbs which, in one month, rendered her unable to walk without a stick. A standard x-ray examination showed a 100° cervical kyphosis with fulcrum in C5 which was posteriorly dislocated into the spinal canal (Fig.1). A similar severe lordosis was found in the upper thoracic spine and the two curves provided a compensation of the sagittal alignment so that clinically the head resulted in a normal position related to the trunk. CT-scan and MRI were immediately taken to complete imaging and showed a severe cord compression at the apex of kyphosis (Fig.2). Flexion extension x-rays were also obtained demonstrating the stiffness of the curves. Besides the complexity of the deformity, pedicle hypoplasia in the thoracic spine was also noted and the connection between posterior arch and vertebral body through pedicles was found to be unilateral in T3 and T5. In the meantime, the patient was put in a halo-jacket to try to gradually correct the kyphosis, but after one month of treatment, the result was extremely poor. Therefore a three stage procedure was planned: anterior release and decompression by C5-C6 corpectomy, posterior correction and fusion from C2 to T7, and anterior reconstruction and fusion by titanium mesh and cervical plating. Main concerns during the surgical planning were how to achieve an adequate decompression without overcorrecting kyphosis, as it was already compensated by the thoracic lordosis, and how to get a reliable fixation in the thoracic spine in case the usual techniques were ineffective. We thought a double corpectomy could achieve an adequate decompression without requiring an overcorrection of the sagittal alignment. After a deep examination of the CT imaging we realized that a screw fixation through the four cortices of a costotransverse joint could achieve an adequate bone purchase to make the fixation stable for the time usually required to achieve a safe fusion (Fig.3). We planned to use this technique in case hook fixation proved to be unfeasible. Possible pleural space violation during surgery was discussed with the thoracic surgeon but was not considered a major issue, as it occurs quite frequently during thoracic pedicle screws standard placement with no clinical consequences. Neuromonitoring was used during surgery. After anterior decompression the curve became correctible so anterior fusion was performed in the same step. The cervical plate had to be bent in kyphosis to follow the anatomy of the cervical spine. During the posterior approach the posterior arch in T3 was found to be loose, probably due to an iatrogenic pedicle breakage during the periosteal stripping. Therefore six screws were easily placed in the costotransverse joint, with a length ranging from 18 to 24 mm, and the bone purchase was considered adequate for all of them. Post-operative CT scan, compared to the preoperative one showed adequate decompression of the spinal canal (Fig.4c). Postoperative course was uneventful, the patient required standard pain medication for 5 days after surgery mainly to control aching in the cervical area of the surgical wound. Chest x-rays showed no pleural effusion or pneumothorax. She was discharged from hospital after 10 days and was sent to a rehabilitation institute wearing a soft collar for two weeks. After three months rehabilitation the patient almost completely regained neurologic function and both clinical and radiologic results remained stable at one year follow-up with acceptable sagittal alignment and effective decompression (Fig.4). At final follow up the ASIA Motor score improved from 64 to 83 points out of 100, while on SF-36 evaluation scale PCS score improved from 28,6 to 43.2 and MCS score improved from 29,1 to 54,2 points. The 28 months follow up CT scan showed a sound fusion of the anterior graft through the cage (Fig.5). Nevertheless initial signs of posterior screws mobilization appeared (Fig.3c), and this was probably due to deficiency of posterior grafting that was only placed in the central area of the instrumentation during the posterior surgery.

Surgical technique.

Preoperative planning by CT is mandatory when dealing with severe deformities[6-7]. CT-scan (completed by a 3D reconstruction) helps the surgeon in locating both entry point and drilling trajectory as the rib head, that is supposed to accept second half of the tread, is not visible from posterior. The transverse processes are exposed completely during the posterior approach as usually required in scoliosis surgery[7]. The entry point is in the middle of the process in the midpoint between upper and inferior border (Fig.3a,b). To avoid lung injury, drilling is carried out progressively until the last layer of bone is crossed using a pedicle tester to verify when the pleural space is reached. Tapping is performed in the first two-thirds of the hole and then the screw is placed. Xu et al[8] found the screw length with this type of fixation ranging from a minimum of 13.9 to a maximum of 19.7 mm in a normal cadaveric spine. Screw length in our case ranged from 14 up to 20 mm and bone purchase could be achieved on an average length of 16 mm. Due to the medial location of the screw head in the thoracic spine, rod connection with the cervical part becomes easier. The final fixation in our case resulted asymmetrical as we found difficult to place the left T4 screw as it was too close to the one below so we decided to extend fixation one level below on that side.

DISCUSSION.

Instrumentation placement in the thoracic spine may be challenging in cases of severe deformities and anatomical anomalies as frequently seen in type 1 neurofibromatosis[9]. Whenever pedicle screw placement is precluded by spine anatomy, the surgeon is forced to use hooks or laminar wires even though the primary stability of the result implant may be suboptimal[2-3, 9]. Intralaminar screwing is a viable alternative recently introduced by some authors. It is a promising new technique which should become part of every spine surgeon's expertise. Unfortunately, due to size of the thoracic laminae, a screw can be placed only at one side and the whole implant finally relies on the strength of the connection between posterior arch and vertebral body. If, due to anatomical abnormality, one of the pedicles is absent, incomplete or eroded by a neurofibroma, then fixation through the posterior arch becomes unreliable[10]. Costotransverse screw placement is relatively easy from a technical point of view; surgical landmarks are lateral, medial, upper and lower border of the transverse process and are normally exposed during the posterior approach to the thoracic spine. If required, the corresponding part of the rib in front can be approached as well. Compared to pedicle and laminar screwing the risk of cord injury is nonexistent with this technique, and primary stability is guaranteed by a four cortical purchase. Biomechanical tests in a cadaveric model on this type of fixation proved that axial resistance to pull-out is moderate compared to pedicular screws[11]. On the other hand, although the mobility of the costovertebral joint is minor it is nonetheless present and putting a screw through a joint that is not prone to fuse may lead to a mechanical failure. The slight but continuous movements between the rib head and the transverse process induced by breathing will additionally stress the screw compared to a conventional placement in a pedicle or in a lamina. In our case thoracic screws are still in place after 28 months which is a time long enough to achieve a sound fusion both anteriorly and posteriorly. Nevertheless signs of posterior screws mobilization are now appearing, demonstrating the need for posterior grafting all along the construct in order to achieve a solid fusion to support the implant. Even a previous laminectomy will not preclude the costotransverse screwing so it could be a further option in case of revision surgery. In conclusion, costotransverse screwing should be considered as a salvage technique to be employed when standard techniques are impracticable due to anatomical anomalies or previous laminectomy. A complete preoperative workout is necessary before using the technique.

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LEGENDS

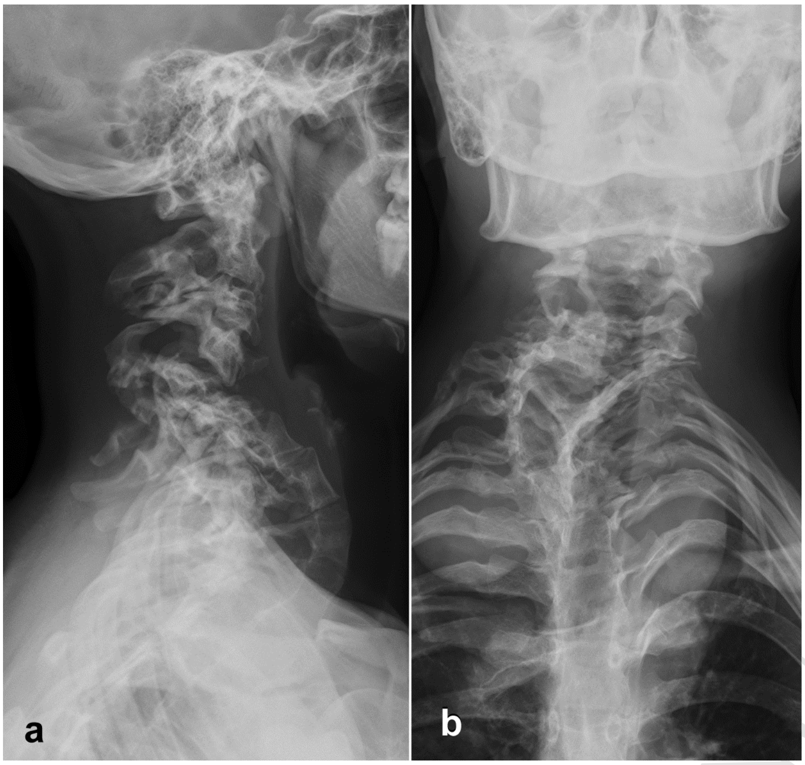
Fig.1: Severe kyphosis with posterior dislocation of C5 and C6 shown on X-ray lateral view (a). Anterior-posterior view shows deformity extended to the upper thoracic spine (b).

Fig.2: Sagittal plane MRI (a) and CT scan (b) demonstrate spinal canal stenosis and cord compression at C5 level.

Fig.3: Landmarks and entry point are shown on a specimen transverse process (a). Postoperative CT scan showing the screw trajectories through the four cortices of a costotransverse joint (b). Twenty-eight months follow-up CT scan showing possible mobilization of the screws (c).

Fig.4: One year follow up X-rays and CT scan showing both acceptable sagittal alignment of the spine and satisfactory decompression of the spinal canal

Fig.5: A 28 months follow-up multiplanar CT scan reconstructions along the cage shows a solid fusion of the anterior bone graft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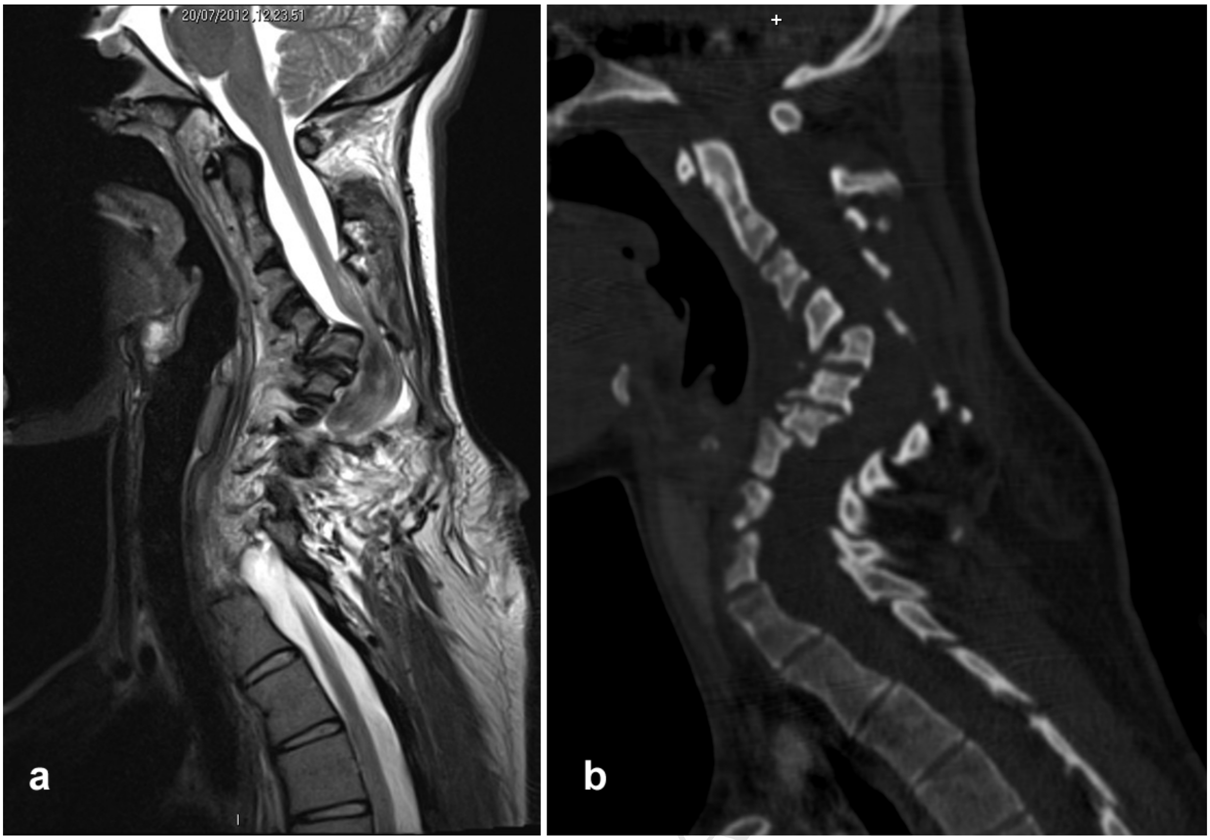
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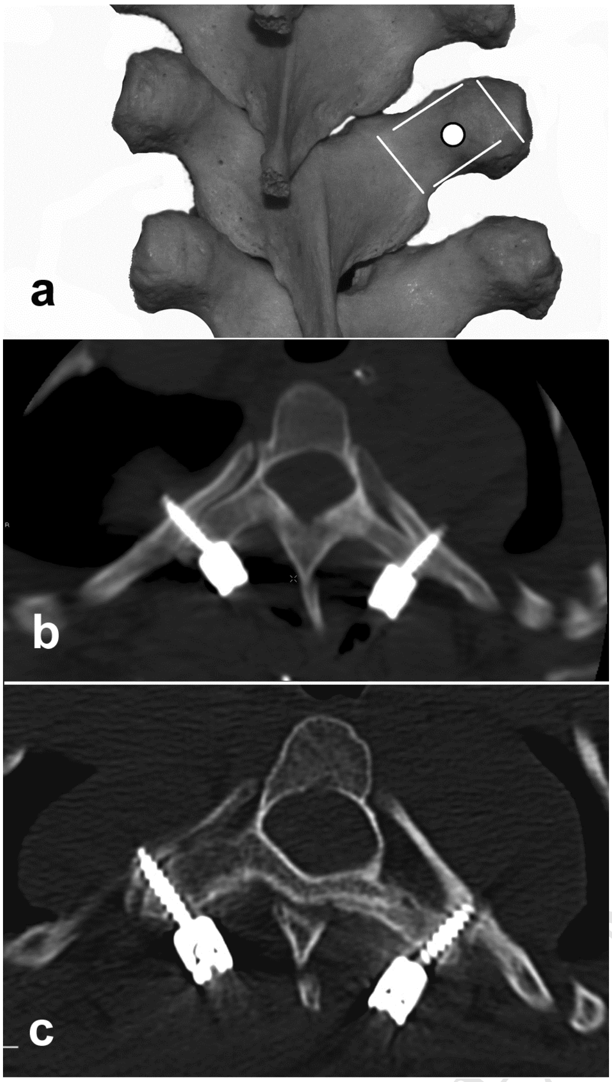
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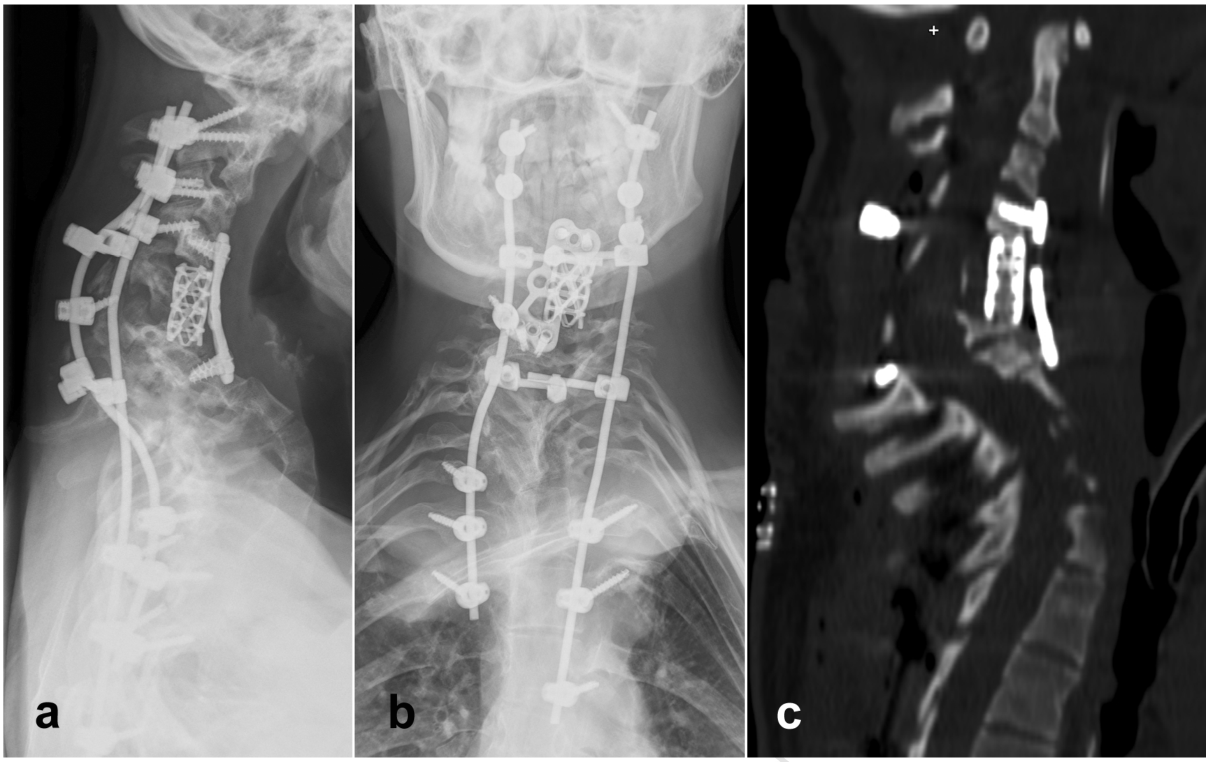
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