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Less invasive surgery in idiopathic scoliosis: a case report

G. BARBANTI BRODANO[1], K. MARTIKOS[2], F. VOMMARO[2], T. GREGGI[2], S. BORIANI[1]

[1]Department of Oncological and Degenerative Spine Surgery, Rizzoli Orthopedic Institute, Bologna, Italy
[2]Department of Spinal Deformity Surgery, Rizzoli Orthopedic Institute, Bologna, Italy

Abstract. – BACKGROUND: Minimally invasive spine surgery (MISS) has become popular during the last decade due to continuous evidence in favor of lesser soft tissue damage, faster recovery, higher patient satisfaction and reduced health costs. During the last years, surgical ambition for better results as well as most detailed knowledge of spinal anatomy, have resulted in the continuous and successful expansion of indications of MISS, covering already successfully a wide range of degenerative spinal pathologies as well as adult spinal deformities.

AIM: We describe here a case report of a patient with adolescent idiopathic scoliosis (AIS) treated by minimally invasive posterior pedicle screw instrumentation.

MATERIALS AND METHODS: We report the case of an 18 years old female patient affected by AIS, Lenke type 1AN, with a 65 degree right thoracic curve and severe rib hump. Posterior pedicle screw instrumentation as well as corrective manoeuvres were performed exclusively by minimally invasive procedure, through three small midline skin incisions.

RESULTS: We obtained a good clinical and radiographical correction of scoliosis, which was maintained during the follow-up period. We also observed a limited intra-operative blood loss, a limited operative time, limited pain, earlier mobilization and limited hospital stay.

CONCLUSIONS: A minimally invasive technique can be used for the surgical treatment of AIS, showing satisfying deformity correction and multiple perceived advantages, although long-term data are needed before this kind of surgery can be recommended for routine use.

Key Words:
Adolescent idiopathic scoliosis, blood loss, hospitalization, minimally invasive surgical technique.

Introduction

Although spinal instrumentation for adolescent idiopathic scoliosis (AIS) correction has dramatically changed over the past decades, since modern concepts of three-planar correction have been introduced[1-3], little efforts have been made towards the direction of less invasive approaches.

Surgical correction by posterior traditional open approach instrumented arthrodesis requires a long intervention under continuous monitoring of the motor and sensory potentials, lasting from 3 to 5 hours, depending on curve severity, patient BMI and fusion area. Standard posterior surgical access requires wide muscular exposure with significant blood loss followed by blood transfusions and a long postoperative recovery time.

Minimally invasive spine surgery is becoming more common for the treatment of multilevel pathology, including adult lumbar degenerative diseases and adult deformities[4-6]. The next challenging step is to try to apply minimally invasive surgical techniques to the treatment of AIS. However, there are significant technical challenges of performing minimally invasive surgery on this patient population. In contrast to adult degenerative scoliosis, the curves in AIS patients are more severe (usually 45-60° or more), the number of levels to treat is greater (from 7 to 13 levels), deformity is three-planar and vertebral rotation can be significant. Placement of percutaneous pedicle screws (from 14 to 26 screws) also increases radiation exposure for both the patient and the surgeon. The ultimate goal of AIS surgical management is to obtain adequate fusion and therefore it is imperative that any surgical technique for AIS allows for adequate facet joint arthrodesis. In the context of minimally invasive surgery, obtaining sufficient surface area for fusion can be challenging. Two other important issues in considering minimally invasive approaches for AIS are the length and type of skin incision as well as the reduction manoeuvres employed for deformity correction. The standard incision for placement of minimally invasive or

Corresponding Author: Giovanni Barbanti Brodano, MD; e-mail: giovanni@barbantibrodano.com

percutaneous pedicle screws cannot be utilized in adolescent patients, as fourteen to twenty six stab incisions in the back can be quite disconcerting for a young patient. Additionally, surgeons treating spinal deformities by standard posterior approach typically have the ability to utilize multiple reduction manoeuvres, including rod translation, rod derotation, in situ bending, direct vertebral rotation, and spine translation. Only limited reduction manoeuvres can be carried out with the present minimally invasive spine surgery instrumentation systems.

Aim

In this study we describe a case of AIS treated by a less invasive posterior spinal fusion technique.

Case Report

We report the case of an 18 year old female patient affected by progressive AIS Lenke type 1AN: right 65th main thoracic structural major curve with non-structural lumbar curve. She presented a significant rotation resulting in a 16th rib hump (scoliometer TM) (Figure 1). Spinal deformity was noted soon after menarche and progression occurred despite brace treatment and constant physical exercise. Pulmonary spirometry showed slight respiratory failure of restrictive pattern, which however did not compromise common daily activities.

Figure 1. Patient 18 years old. Anteroposterior and lateral pre-operative radiographs, showing the Lenke type 1AN thoracic scoliosis, 65 degree to the right.

We performed surgical correction by posterior minimally invasive pedicle screw instrumentation. The technique we present allows standard deformity reduction manoeuvres through three small midline skin incisions. This technique allows easy passage of contoured rods, placement of pedicle screws and adequate facet osteotomy to enable fusion. SSEP and transcranial MEP monitoring were employed throughout the case.

Two midline skin incisions of 4 cm each were performed at the two extremities of the previously planned selective fusion area (respectively from T12 to L1 and from T5 to T6) and another small incision was performed at the apex of the curve (from T8 to T10). Bilateral Wiltse-like approaches were performed in order to reach the required articular segments. Midline ligamentous elements were left intact. Once the articular facet plane was reached, Gelpi retractors were placed and a clear minimally invasive working zone was successfully created. Facetectomy was performed at exposed levels with a quarter-inch chisel, and upper facet cartilage curettage for future bone fusion was performed with a high speed drill. Ponte release was completed by upper facet removal with a Kerrison rongeur at the 4 apical levels bilaterally. Two pairs of proximal polyaxial pedicle screws were placed in T5 and T6 and two pairs of distal polyaxial pedicle screws were placed in T12 and L1. Afterwards, two monoaxial reduction screws were placed in T8 and T10 on the concave side. Fluoroscopic images were obtained only for correct vertebral level identification and all screws were placed in a hands-free anatomic landmark fashion. Reduction screws were used at the apex, because of their advantage to allow easy reduction of the rod while achieving deformity correction through spinal translation to the rod at the same time. With reduction screws, the rod can be passed under direct visualization and the screw heads can be manipulated for easier passage. Before placement of each pedicle screw, bone graft obtained from facet osteotomy as well as homologous bank bone graft was placed locally at each articular facet.

Two 5.5 mm rods, of appropriate length, were suitably contoured to reproduce desired sagittal plane thoracic kyphosis with a very slight touch of distal lordosis. Rod insertion was carried out following precise steps as previously described by Sarwahi et al[7]. The rods were inserted from cephalad to caudad. This is an important safety

Figure 2. Patient 18 years old. Anteroposterior and lateral post-operative radiographs, showing the T5-L1 instrumentation performed by minimally invasive technique.

step, as the overlapping laminae in the thoracic spine prevent an inadvertent entry into the spinal canal. The first rod was inserted on the concave side. The reduction screws are capped as the rod advances, and the screw heads can be manipulated for rod passage. As the rod passes from one incision to the next, one must confirm that the rod is lying beneath the fascia. The rod can be manually palpated in the distal incision, which helps to properly direct the rod. Once the rod is seated in all pedicle screw heads, the rod is derotated in order to reach desired sagittal orientation. Caution must be given to prevent over-rotation of the rod, as the sagittal contours of the rods are difficult to appreciate through small skin incisions. The set screws are now sequentially tightened, and the rod is formally seated. The second rod was then inserted. Compression and distraction manoeuvres were carried out only at the distal and proximal end of the instrumentation in order to obtain adjacent disc alignment. This can be easily accomplished through the midline skin incisions. A direct vertebral rotation manoeuvre is then carried out off the concave-side screws, by applying counter-force on the apical screws bilaterally.

Closure was fairly rapid and was carried out in a layered fashion. We did not place any blood drains. While the patient was still on the operating table, anteroposterior and lateral X-rays were taken to confirm adequate correction in both planes. The duration of the surgery was three hours and the intraoperative blood loss was 550 ml, which is a low/moderate loss for a scoliosis surgery. The patient started the assisted ambulation and physical rehabilitation without restraints the day after surgery and she was discharged on the fifth post-operative day. We obtained a satisfactory correction of the main curve, with Cobb angle of 21 degrees ad a satisfactory rib hump reduction (Figures 2, 3). The correction was maintained after one year of follow up and radi-

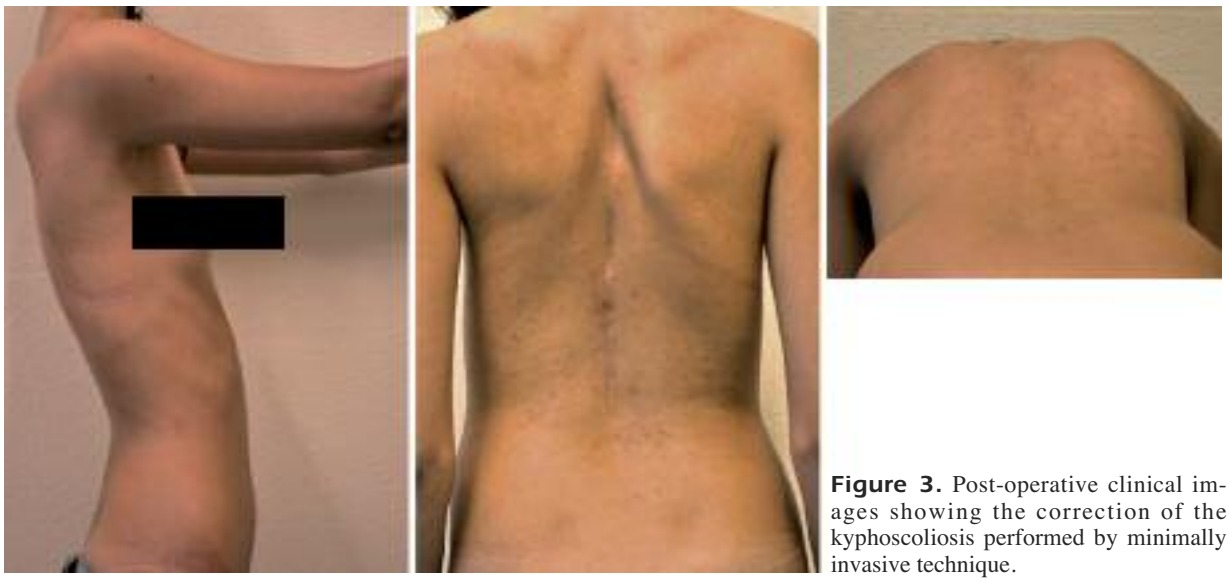

Figure 3. Post-operative clinical images showing the correction of the kyphoscoliosis performed by minimally invasive technique.

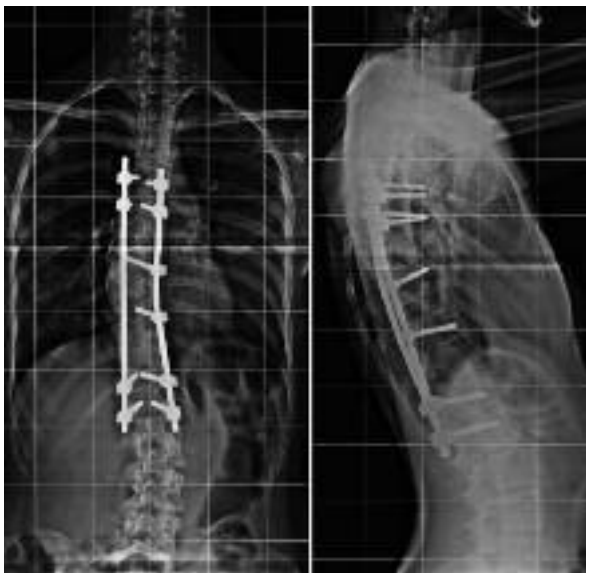

Figure 4. Anteroposterior and lateral radiographs performed at 12 months follow-up, showing the maintenance of the scoliosis correction and the bone fusion.

ographic images showed an apparent callus of bone fusion (Figure 4).

Discussion and Conclusions

Advantages and limits of minimally invasive techniques in fracture stabilization, degenerative pathologies, spinal tumours and infections have widely been described in recent years, since the introduction of less invasive concepts in spinal surgery[8]. Surgical techniques for adolescent spinal deformities have reached considerable corrective knowledge through the recent decades, but efforts for performing such corrections through less invasive approaches have been relatively silent[9; 1-3]. In the literature there is limited evidence regarding surgical treatment of spinal deformities with minimally invasive procedures or minimally invasive instrumentation and they are mainly focused upon adult rather than adolescent deformities that require totally different surgical corrective strategies[4-6].

Previous reports by Sarwahi et al[7] indicate that comparable correction of scoliosis can be achieved by a minimally invasive technique both in the coronal and sagittal planes with respect to traditional posterior instrumented arthrodesis. In flexible curves, correction may be achieved up to 75-80%. In addition, minimally invasive surgical techniques offer a series of other advantages that our case-report confirmed. These advantages include limited operative time, limited blood loss, shorter hospital stay, earlier mobilization, as well as less pain and need for pain medication. During our operation, only 7 fluoroscopic images were obtained, exclusively for identification of correct vertebral level during exposure, while screw placement was performed in a hands-free manner based on un-confoundable anatomic landmarks identified thanks to an adequate minimally invasive muscle retraction that permitted adequate visualization of articular facets and correct pedicle screw entry points.

A limited muscular and skeletal exposure, a consequent reduced muscle fibrosis and necrosis and a smaller surgical wound reduce the hospital stay of the patient as well as the time needed for returning to common daily activities. Also the cosmetics is improved, because of the absence of a long scar running throughout the back. Obviously, this technique can be applied only to not-overweight patients with mild deformities and moderate vertebral rotation. The facetectomies at exposed levels and the Ponte-like facet removal at the apex, associated to the limited implant density permit an adequate corrective capacity for the mild deformity that we chose to treat in this case. Nevertheless, we do acknowledge that more severe curves necessitate a more aggressive release with facetectomies at all levels, true Ponte osteotomies at 5 or 6 apical levels including midline ligaments release and higher implant density that may need to reach 100% of treated levels. Therefore we clearly state that the technique described in our case report is destined for the surgical correction of scoliosis that do not exceed 60-65° of Cobb angle. The limit of the minimally invasive technique is represented by a lower surface of fusion, which is outlined from the end of the fusion and the apex of the curve. We think that this limit could be accepted in cases of scoliosis that are not severe and in patients that have completed or are near to completion of their growth potential. The modern on the other hand instruments for pedicle fixation avoid the risks of pseudo-arthrosis and hardware mobilization.

The term “mini-open surgery” could be more appropriate rather than “minimally-invasive” for describing our case, because of the three small incisions at the extremities and the middle of the tract which is planned to be stabilized. This technique could be a valid alternative to the classical technique of vertebral exposure for the correction of moderate adolescent idiopathic scoliosis. The benefits are certainly related to a minor exposure

of soft tissues, a reduced blood loss and a lower postoperative recovery time. Although there are multiple perceived benefits in the application of the minimally invasive approach for the treatment of AIS, long-term data are needed before it can be recommended for routine use.

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Conflict of Interest

The Authors declare that there are no conflicts of interest.

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