

nal of s

Open Access

Innovative Method of Gradual Temporary Distraction Using Magnetic Growing Rods (MCGR) for Surgical Treatment of Severe Kyphoscoliosis: Mini-case Series

Greggi T¹, Maredi E^{1*}, Vommaro F¹, Lolli F¹, Martikos K¹, Giacomini S¹, Di Silvestre M¹, Baioni A¹, Scarale A¹, Morigi A² and Bacchin MR² ¹Spinal Deformity Surgery Department, Rizzoli Orthopaedic Institute, Italy

²Anesthesiology Department, Rizzoli Orthopaedic Institute, Italy

Abstract

Introduction: Surgical treatment for severe scoliosis has been characterized by a combined approach and gradual distraction before final arthrodesis; pedicle screws have reaffirmed the role of posterior approach.

Materials and Methods: Three female patients were treated for severe scoliosis using transient magnetic rods for internal distraction followed by magnetic rod removal and definitive PSF.

MCGR: Case A: 12-year-old female with severe thoracic scoliosis of 120°. First Stage: release (Ponte's osteotomies), pedicle screws T3-L4 with MCGR, then daily ultrasound guided lengthening with external magnet controller for 3 weeks followed by second stage posterior arthrodesis and thoracoplasty.

Case B: 15-year-old female with thoracic kyphoscoliosis of 115°. The same technique as in case A was performed: pedicle screw instrumentation from T3 to L4.

Case C: 21-year-old female with Noonan syndrome. Thoracic kyphoscoliosis of 130°, the same technique as in case A was performed: pedicle screw instrumentation T4-L3.

Results: A. First stage: Scoliosis decreased to 75°. After the second operation it was equal to 42° with a total correction of 65%. No neurological complication.

B. First stage: Scoliosis decreased to 72°. After the second stage it was 45° with a total correction of 60%. No neurological complication.

C. First stage: Scoliosis decreased to 80° (correction of 38%). The patient showed reduced bone mineral density and developed respiratory distress: she was admitted to an Intensive Care unit. Last x-rays revealed a scoliosis and kyphosis correction in Cobb degrees equal to 59° (correction rate of 49%) and 43° (correction rate of 48%), respectively. Follow-up at two months showed scoliosis and kyphosis in Cobb degrees of 59° and 44°, respectively.

Conclusion: The MGCR is a valid alternative when the use of halo is contraindicated in the presence of myeloradicular malformations or halo traction is not well tolerated by the patient or their family. Results are comparable in terms of correction and the psychological effect of MGCR elongation is favorable. All of the data are available in literature.

Keywords: Severe kyphoscoliosis; Magnetic rod; Halo-traction; AIS; Anterior release

Abbreviations: MCGR: Magnetically Controlled Growing Rod

Introduction

Classical surgical treatment for severe scoliosis has been characterized by a combined approach (anterior release and posterior fusion); pedicle screws have reaffirmed the role of posterior approach alone. The goals of scoliosis treatment are to stop curve progression, to correct the curve while achieving a balanced and solid fusion, and to minimize complications, especially the neurological ones.

A significant correction of severe scoliosis brings about an increased risk of neurologic damage, generally due to mechanical (traction) or pressure damages. The presence of pre-existing neurological lesions increases the risk and danger (i.e. Chiari malformation, syrinx, diastematomyelia) [1,2]. Subsequently, these cases (scoliosis associated with severe neurological lesion) require gradual treatment of the deformity, usually a two-stage procedure, to allow for a slow stretching of the spine and vessels of the spinal cord; a number of techniques, such as halo-traction devices, anterior release, vertebrectomy (spine shortening avoiding traction), are available to stretch the spine and minimize the risk of neurological damages.

The standard treatment (gradual stretching) of severe deformities

includes halo-traction for 3-4 weeks before posterior surgery. The use of preoperative halo-gravity traction has demonstrated up to 38% average correction of scoliosis in deformities exceeding 100°. Halorelated complications can also be observed [3]; moreover, patients have to be hospitalized for halo-traction throughout the procedure [4] which means high costs in terms of money and time supported by them and their families.

The aim of preoperative traction and stretching of severe curve is to obtain a gradual adaptation of surrounding soft tissues to the new corrected position, to minimize neurological and ischaemic risks of fusion and, useless to say, to obtain a better result in terms of correction [4].

*Corresponding author: Elena Maredi, via Pupilli 1 40136 Bologna (BO) Italy, Tel: +39 3486650558; Fax: 0516366188; E-mail: elena.maredi@gmail.com

Received November 23, 2015; Accepted January 30, 2016; Published February 02, 2016

Citation: Greggi T, Maredi E, Vommaro F, Lolli F, Martikos K, et al. (2016) Innovative Method of Gradual Temporary Distraction Using Magnetic Growing Rods (MCGR) for Surgical Treatment of Severe Kyphoscoliosis: Mini-Case Series. J Spine 5: 280.doi:10.4172/2165-7939.1000280

Copyright: © 2016 Greggi T, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Over the past few years the current authors have started using magnetically controlled rods (MAGEC system) for severe idiopathic infantile scoliosis instead of the traditional growing rod technique. These new rods seem to provide distraction of the spine with no need for repeated lengthening surgeries before definitive fusion [5-7]. Therefore, we have applied this distraction technique in adult patients to obtain gradual lengthening of the spine by posterior access alone, thus avoiding the anterior access and vertebrectomy related risks, as well as halo-traction discomfort.

Two surgical procedures were performed in all of the cases: first, an open incision to apply pedicle screws and the magnetically controlled rod without arthrodesis; after 3 weeks, a second surgery to achieve final correction and arthrodesis with two pre-bent rods. The 3-week lengthening period is totally arbitrary, this time interval being required to lengthen the rod by about 2-3 mm per day (maximum rod length is 48 mm, which divided by 21 days makes about 2,2 mm per day). We arbitrarily decided three weeks as the acceptable time for costs hospitalization and long enough to ensure traction of few centimeters (maximum extension allowed: 8 cm). In the future it's not excluded to continue the elongations up to the complete elongation of the rod, the gently and gradually as possible to reduce the risks of traction on the myeloradicolar structures. Once decided the waiting time between the two surgeries (3 weeks), we have arbitrarily decided as 3 mm stretching to perform a total acceptable elongation $(3 \times 21 : 62 \text{ mm}, \text{maximum})$ elongation 80 mm) and at the same time so gradually; our experience of pediatric growing rod (MAGEC) showed us that patients feel some discomfort over 3 mm elongation and, in any case, the machine seems to have difficulties to stretch more than 4-5 mm at time (perhaps for muscular tension); in any case, all data are experience based, we decided arbitrarily and data need further study.

Material and Method

Mini-case series: 3 case reports

Three girls affected with severe kyphoscoliosis were treated by the current authors using magnetic rods for internal distraction.

MCGR magnetically controlled growing rod (MAGEC; Ellipse Technologies, Inc., Orange County, CA, USA)

Case A: 12,5-year-old female, affected with severe thoracic kyphoscoliosis and kyphosis of 120° and 90° Cobb, respectively (Figure 1), Lenke 1A+ [8], without any brace treatment in her childhood. She was also affected with C5-C7 syringomyelia and T3-T9 and Chiari I malformation treated by occipitocervical decompression about 2 months before spinal surgery. Preoperative bending radiographs (with traction Risser cast) were taken to assess curve flexibility [9] and revealed a flexibility index of 16% (100°Cobb). MRI confirmed Chiari I malformation and syrinx (Figure 2a and 2b), as well as good result from decompression (Figure 2c); no bone malformation was found on CT scans. Preoperative pulmonary function was 81%.

First stage: posterior release with Ponte's osteotomies and pedicle screws was performed from T3 to L4. A magnetically controlled rod MCGR (MAGEC; Ellipse Technologies, Inc., Orange County, CA, USA) was inserted into the left side, and a little lengthening was performed during the operation. Two pieces of rod were inserted into the right side from L1 to L4 and from T3 to T6 (Figure 3). No neurological damage was observed: the patient had normal SSEPs and MEPs during surgery. Operative time: 4 hours; blood loss (intra- and post-operative): 1100 cc; ICU stay: 3 days. The postoperative Cobb angle was 79° for scoliosis (correction rate of 34%).

An external remote controller was used daily for 3 weeks after implantation to lengthen the rod by 2-3 mm on average, thus reaching a total of 38 mm; X-ray monitoring enabled to check progression of lengthening. Over this time the patient showed no neurological problems, reported no symptoms and no pain during the procedures.

Last X-rays showed scoliosis and kyphosis were corrected to 73 (correction rate of 39%) and 66 Cobb degrees (correction rate of 27%), respectively (Figure 4).



Case A:

Figure 1: preoperative x-rays and clinical.



Figure 2: Chiari malformation and Syryngx.



Figure 3: Ponte's osteotomies and pedicle screws from T3 to L4.



Figure 4: during the daily lengthening.

Second stage: Surgery was performed after 21 days and posterior arthrodesis achieved with two titanium pre-bent rods and thoracoplasty (5 ribs removed). No neurological damage was observed and the patient had normal SSEPs and MEPs during surgery. No respiratory complications occurred in the postoperative except for a pleural effusion treated conservatively. **Operative time:** 2, 5 hours; blood loss (intra- and post-operative): 600 cc; ICU stay: 3 days out of a total of 14 at the hospital.

Last X-rays showed scoliosis and kyphosis were corrected to 56 (correction rate of 54%) and 50 Cobb degrees (correction rate of 45%), respectively (Figure 5).

X-rays at a 2-month follow-up revealed a scoliosis of 56° Cobb and kyphosis of 53° Cobb (Figure 6).

Case B: The patient was a young female of 19 years, affected by Noonan syndrome, surgically treated in her childhood for cardiopathy (*ostium secundum* defect and pulmonary stenosis corrected; presenting right ventricular dilatation), showing severe respiratory insufficiency treated with preoperative mechanical ventilation during the night for 2 weeks.

She was also affected with rigid severe thoracic scoliosis of 130° and hypokyphosis (Figure 7) Lenke 1A- [8]. Brace treatment in her childhood was not constant. Preoperative bending radiographs were taken to assess curve flexibility [9] and the flexibility index was found to be 20% (103°Cobb). MRI confirmed the absence of myeloradicular malformation. No malformation was found on CT scans. Preoperative PFT was 23%, height 141 cm and weight 29 kg.

First stage: Posterior release with Ponte's osteotomies and pedicle screws was performed from T4 to L3. A magnetically controlled rod MCGR (MAGEC; Ellipse Technologies, Inc., Orange County, CA, USA) was inserted into the left side and a little lengthening was performed during the operation. Two pieces of rod were inserted into the right side from L1 to L3 and from T4 to T6 (Figure 8). No neurological damage was observed: the patient had normal SSEPs and MEPs during surgery. Operative time: 3, 5 hours; blood loss (intra- and post-operative): 900 cc; ICU stay: 7 days. The postoperative Cobb angle was 81° for scoliosis (correction rate of 37%).

An external remote controller was used daily for 3 weeks after implantation to lengthen the rod by 2-3 mm on average, thus reaching a total of 25 mm; X-ray monitoring enabled to check progression of lengthening. Over this time the patient showed no neurological problems, reported no symptoms and no pain during the procedures.



Figure 5: Post-operative view.

J Spine, an open access journal

ISSN: 2165-7939

Ga

Figure 6: Follow up.



Case B

Figure 7: preoperative x-rays and clinical.



Figure 8: Intraoperative x-rays, first surgery.

Last X-rays showed scoliosis was corrected to 75 Cobb degrees (correction rate of 42%) (Figure 9). Postoperative pulmonary function improved to 27%.

Second stage: surgery was performed after 20 days and posterior arthrodesis achieved with two titanium pre-bent rods. No neurological damage was observed and the patient had normal SSEPs and MEPs

Page 3 of 6

Page 4 of 6

during surgery. The patient experienced a postoperative pleural effusion treated conservatively.

Operative time: 2 hours; blood loss (intra- and post-operative): 550 cc; ICU stay: 7 days.

Last X-rays showed scoliosis was corrected to 69 Cobb degrees (correction rate of 47%) (Figure 10).

X-rays at a 2-month follow-up revealed a scoliosis of 69° Cobb.

Case C: The patient was a young female of 15 years, affected with severe thoracic kyphoscoliosis (scoliosis of 115° and kyphosis of 85° Cobb) (Figures 11), type Lenke 1A+ [8]. Brace treatment in her childhood was not constant. She also had severe psychological problems due to the deformity and the brace. Preoperative bending radiographs were taken to assess curve flexibility [9], and the flexibility index was found to be 20% (91°Cobb). MRI confirmed the absence of myeloradicular malformation. Preoperative pulmonary function was 58%.

First stage: posterior release with Ponte's osteotomies and pedicle screws was performed from T3 to L4. A magnetically controlled rod MCGR was inserted into the left side and a little lengthening was performed during the operation. Two pieces of rod were inserted into the right side from L1 to L4 and from T3 to T6 (Figure 12). No neurological damage was observed: the patient had normal SSEPs and



Figure 9: evaluation during the lengthening.



Figure 10: post-operative x-rays.



Case C

Figure 11: Preoperative x-rays and clinical.



Figure 12: Intraoperative control.

MEPs during surgery. Operative time: 3,5 hours; blood loss (intra- and post-operative): 1100 cc; ICU stay: 5 days. The postoperative Cobb angle was 80° for scoliosis (correction rate of 20%).

We performed elongation for 3 weeks after implantation to lengthen the rod by 2-3 mm on average, thus reaching a total of 33 mm; X-ray monitoring enabled to check progression of lengthening. Over this time the patient showed no neurological problems, reported no symptoms and no pain during the procedures.

Last X-rays showed scoliosis and kyphosis were corrected to 71° (correction rate of 35%) and 45 Cobb degrees (correction rate of 47%), respectively (Figure 13).

Second stage: Surgery was performed after 22 days and posterior arthrodesis achieved with two titanium pre-bent rods thoracoplasty (5 ribs removed). No neurological damage was observed and the patient had normal SSEPs and MEPs during surgery. No respiratory complications occurred in the postoperative except for a pleural effusion treated conservatively.

Operative time: 2 hours; blood loss (intra- and post-operative): 1050 cc; ICU stay: 4 days.

Last X-rays showed scoliosis and kyphosis were corrected to 59 (correction rate of 49%) and 43 Cobb degrees (correction rate of 48%), respectively (Figure 14).

X-rays at a 2-month follow-up revealed a scoliosis of 59° Cobb and a kyphosis of 44° Cobb.

Discussion

The 3 cases presented show a gradual distraction procedure in severe idiopathic scoliosis using magnetically controlled growing rods; the patients' severe and rigid scoliosis needed traction before definitive correction to minimize neurological risks.

There are different kinds of traction and surgical techniques to treat severe scoliosis and avoid the problem "neurological tissues are shorter than the spine".

Literature Review

Posterior only instrumentation

In the series of Benjamin et al. posterior instrumentation with pedicle screws (PSF/TPS) was significantly superior to anterior fusion (ASF) in terms of instrumented correction of main thoracic curve and



Figure 13: x-ray control during the lengthening.



Figure 14: post-operative x-rays .

spontaneous thoracolumbar/lumbar curve correction in Lenke type 1 curve [8]. PSF/TPS also resulted in a significantly greater improvement in vertebral rotation and thoracic torsion as demonstrated by improvement in the rib hump deformity [10].

It goes without saying that posterior instrumentation with pedicle screws ensured better results in terms of correction if compared with hybrid (pedicle screws and hooks) techniques [11].

In adolescent idiopathic scoliosis Suk reported a correction rate of 70% without any anterior release, but in his series preoperative curve flexibility is unknown.

Arlet et al. achieved a correction rate of 54% in the treatment of severe scoliosis using posterior pedicle screws alone; however, such a result was obtained in adolescent idiopathic scoliosis with thoracic curves of about 85° or less and flexibility equal to 35% or more, whereas the same authors recommended open anterior release, followed by posterior instrumentation [12,13] in the presence of stiffer deformities (more than 90° or with side bending less than 65°).

Anterior release and posterior fusion

Correction rate increases when anterior plus posterior series are evaluated: a lot of series report a correction rate between 47% and 60%. Recently, Lenke has published a report describing thoracoscopic spine release for curves averaging 82° (range, 42 to 125°) with a rate of correction equal to 70% [12].

In these studies the indications for adding a thoracoscopic anterior release to posterior instrumentation in the treatment of scoliosis were the presence of a large, stiff curve or prevention of the crankshaft phenomenon

Niemeyer *et al* reviewed 17 patients with idiopathic scoliosis and stated that the indication for anterior surgery in 11 was insufficient flexibility, with mean flexibility of 26.7% [14].

However, the current authors do know that anterior release brings about some notable complications. In a meta-analysis an incidence of complications equal to 18% was observed following anterior thoracoscopic release, most of which were pulmonary complications requiring prolonged ventilatory support [13].

Anterior fusion also may offer greater potential for spontaneous correction and is a good technique to leave more levels unfused; however, its potential advantages should be evaluated along with its potential disadvantages, such as increased postoperative kyphosis, pseudarthrosis development, implant failure, loss of correction and perioperative morbidity including significant immediate and minor long-term injury to pulmonary function [10]. In the current authors' opinion anterior release is a good technique to be used for deformities, such as NF1 scoliosis and severe hyperkyphosis where the risk of implant failure is very high; on the contrary, it is not recommended in case of severe pulmonary insufficiency.

Vertebral resection (PVR Posterior Vertebral Resection)

Vertebral resection is a demanding surgical technique reserved for severe and rigid spinal deformities. In some series, the overall incidence of complications of PVR was reported to be 40.3% (94/233). A postoperative neurologic deficit, including transient and permanent neurologic deficits, was found in 33 patients (33/233, 14%) [15]. Indication for vertebral resection should be the need to remove an entire vertebral (i.e. in case of tumours), this approach being so demanding and involving such a high complication rate. Citation: Greggi T, Maredi E, Vommaro F, Lolli F, Martikos K, et al. (2016) Innovative Method of Gradual Temporary Distraction Using Magnetic Growing Rods (MCGR) for Surgical Treatment of Severe Kyphoscoliosis: Mini-Case Series. J Spine 5: 280.doi:10.4172/2165-7939.1000280

Page 6 of 6

Halo traction

A 3 to 4-week halo-traction has historically been the standard of care of severe deformities. Preoperative use of halo-gravity traction has been shown to produce average correction of scoliosis deformity up to a rate of 38% when deformities exceed 100°. Halo-related complications, such as pin-site infection and loosening, and neurological damage, have been encountered. A recent review of the literature has reported a rate of 53%, with 10% requiring surgery and 31% suffering from transient halo-related neurologic compromise [16,17]. In other series, a 31% incidence of complications can be found, including cranial nerve injuries, Horner syndrome, extremity weakness and bradycardia [3]. In addition, patients have to be hospitalized for halo-traction throughout the procedure [4] which means high costs in terms of money and time supported by them and their families.

Traditional growing rods have also been used for temporary distraction [18,19], but they involve multiple lengthening surgeries under general anaesthesia and long-term hospitalization.

Gradual lengthening before arthrodesis is known to be mandatory for severe scoliosis to reduce procedure-related neurological risks.

The use of this innovative method allows for a gradual stretching of the spine by posterior approach alone, thus avoiding the risks related to anterior approach (anterior release) and vertebrectomy, as well as halo-traction discomfort.

Moreover, the use of magnetically controlled rods results in patients reporting great satisfaction rate (from 47 to 54%) in terms of correction; problems related to multiple surgeries and anaesthesia are avoided and the nervous system can be assessed thanks to lengthening in awake patient.

Finally, hospitalization can be shorter than with halo-traction and, above all, all halo-related psychological and nutritional problems are overcome. The lengthening procedure can be safely performed on an outpatient basis and the patient remains completely awake.

Conclusion

The magnetically controlled rod is a safe and useful method for temporary distraction of the spine in severe adolescent idiopathic scoliosis, and the treatment of choice when halo-traction is contraindicated (Arnold-Chiari decompression), in psychologically low-tolerance patients, if major and aggressive surgery like vertebrectomy is too risky or in case the double approach is needed (severe respiratory insufficiency). These kinds of patients, of course, need a multidisciplinary approach for respiratory, neurological, cardiac pathology [20]. Thanks to this technique, the risks related to anterior release or long and demanding surgeries, such as vertebrectomy, can be avoided. Hospitalization costs are difficult to calculate because all cases were treated inside the hospital for safety as they were preliminary cases; actually the patients could be treated ambulatory after the first surgery.

The good preliminary results obtained in the present series lead the authors to consider MAGEC rods as an excellent choice for surgeons to achieve spinal distraction in children and adults.

Further randomized clinical trials are mandatory to compare different surgical techniques in case of severe rigid vertebral deformities.

References

1. Akhtar OH, Rowe DE (2008) Syringomyelia-associated scoliosis with and without the Chiari I malformation. J Am Acad Orthop Surg 16: 407-417.

- Delank KS, Delank HW, König DP, Popken F, Fürderer S, et al. (2005) latrogenic paraplegia in spinal surgery. Arch Orthop Trauma Surg 125: 33-41.
- Limpaphayom N, Skaggs DL, McComb G, Krieger M, Tolo VT (2009) Complications of halo use in children. Spine (Phila Pa 1976) 34: 779-784.
- Cheung JP, Samartzis D, Cheung KM (2014) A novel approach to gradual correction of severe spinal deformity in a paediatric patient using the magnetically-controlled growing rod. The Spine Journal 14: e7-e13.
- Akbarnia BA, Cheung K, Noordeen H, Elsebaie H, Yazici M, Dannawi Z, et al. (2013) Next Generation of Growth-Sparing Techniques Preliminary Clinical Results of a Magnetically Controlled Growing Rod in 14 Patients With Early-Onset Scoliosis. SPINE 38: 665-670.
- Karol LA (2011) Early definitive spinal fusion in young children: what we have learned. Clin Orthop Relat Res 469: 1323-1329.
- Hickey BA, Towriss C, Baxter G, Yasso S, James S, et al. (2014) Early experience of MAGEC magnetic growing rods in the treatment of early onset scoliosis. Eur Spine J 23: S61-S65.
- Lenke LG, Betz RR, Harms J, Bridwell KH, Clements DH, et al. (2001) Adolescent idiopathic scoliosis: a new classification to determine extent of spinal arthrodesis. J Bone Joint Surg Am 83-83A: 1169-81.
- Cheung KM, Luk KD (1997) Prediction of correction of scoliosis with use of the fulcrum bending radiograph. J Bone Joint Surg Am 79: 1144-1150.
- Potter BK, Kuklo TR, Lenke LG (2005) Radiographic Outcomes of Anterior Spinal FusionVersus Posterior Spinal Fusion with Thoracic Pedicle Screws for Treatment of Lenke Type I Adolescent Idiopathic Scoliosis Curves. Spine (Phila Pa 1976) 30(16): 1859-66.
- Di Silvestre M, Bakaloudis G, Lolli F, Vommaro F, Martikos K, et al. (2008) Posterior fusion only for thoracic adolescent idiopathic scoliosis of more than 80 degrees: pedicle screws versus hybrid instrumentation. Eur Spine J 17: 1336-1349.
- Arlet V, Jiang L, Ouellet J (2004) Is there a need for anterior release for 70-90 degrees masculine thoracic curves in adolescent scoliosis? Eur Spine J 13: 740-745.
- Arlet V (2000) Anterior thoracoscopic spine release in deformity surgery: a meta-analysis and review. Eur Spine J 9 Suppl 1: S17-23.
- Burton DC, Sama AA, Asher MA, Burke SW, Boachie-Adjei O, et al. (2005) The Treatment of Large (>70°) Thoracic IdiopathicScoliosis Curves With Posterior Instrumentation and Arthrodesis: When is Anterior Release Indicated? Spine (Phila Pa 1976) 30(17): 1979-84.
- Kim SS, Cho BC, Kim JH, Lim DJ, Park JY, et al. (2012) Complications of posterior vertebral resection for spinal deformity. Asian Spine J 6: 257-265.
- Garabekyan T, Hosseinzadeh P, Iwinski HJ, Muchow RD, Talwalkar VR, et al. (2014) The results of preoperative halo-gravity traction in children with severe spinal deformity. J Pediatr Orthop B 23: 1-5.
- 17. Koller H, Zenner J, Gajic V, Meier O, Ferraris L, et al. (2012) The impact of halo-gravity traction on curve rigidity and pulmonary function in the treatment of severe and rigid scoliosis and kyphoscoliosis: a clinical study and narrative review of the literature. Eurospine 21(3): 514-529.
- Buchowski JM, Bhatnagar R, Skaggs DL, Sponseller PD (2006) Temporary internal distraction as an aid to correction of severe scoliosis. J Bone Joint Surg Am 88: 2035-2041.
- Buchowski JM, Skaggs DL, Sponseller PD (2007) Temporary internal distraction as an aid to correction of severe scoliosis. Surgical technique. J Bone Joint Surg Am 89 Suppl 2 Pt 2: 297-309.
- 20. Ciccone MM, Aquilino A, Cortese F, Scicchitano P, Sassara M, et al. (2010) Feasibility and effectiveness of a disease and care management model in the primary health care system for patients with heart failure and diabetes (Project Leonardo). Vasc Health Risk Manag 6: 297-305.

J Spine, an open access journal ISSN: 2165-7939