

Evaluation of Posterior-Only Approach Using Ponte and Fusion Mass Osteotomies in Management of Revision Spinal Deformities

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ABSTRACT

Background: Revision surgeries of spinal deformity are difficult and technically demanding with high rate of complications. Combined anterior and posterior approaches are usually required in such cases. Decreased quality of life, pain, physical limitations, and dissatisfaction with self-image are the main sequelae of revision spinal deformities. Durability of interventions for deformity treatment is the main concern for surgeons, as the revision rate is considered high.

Purpose: The aim of this study is evaluation of the short-term outcomes of posterior-only approach in correction of revision spinal deformities.

Study Design: Case series, prospective.

Patients and Methods: Twenty patients with revision spinal deformities were included in this study between February 2015 and December 2017. The mean age was 16 ± 5.9 (16–35) years. The patients were assessed radiologically and clinically using Visual Analogue Scale (VAS) of pain and Oswestry Disability Index (ODI). Clinical diagnosis was failed spinal deformity correction of different etiologies in patients aged more than 15 years old. All patients treated via Ponte osteotomies and fusion mass osteotomies with pedicular screw fixation through posterior approach.

Results: The mean follow-up time was 27 ± 6.2 months. The mean estimated blood loss (EBL) was 1829 ± 388.7 ml (range, 1300–2600). The mean coronal Cobb angle showed 75.64% correction. The Visual Analogue Scale (VAS) of back pain showed 75.97% improvement. There was statistically significant improvement of the clinical scores and all radiological parameters at the end of the follow-up period. There were seven complications without serious morbidities (3 dural tears, 1 **postoperative** ileus, 1 delayed extubation, 1 superficial wound infection, and 1 anemia).

Conclusion: Revision deformity surgeries are technically demanding procedures and should be done by well-trained spine surgeons. The posterior-only approach is an effective and safe option in management of deformity correction and achieves good union even in cases of pseudoarthrosis without serious complications. (2019ESJ183)

Keywords: Posterior-only; Revision surgery; Spinal deformities

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INTRODUCTION

Failed spinal deformity surgeries will result in fixed decompensated coronal and sagittal deformities.¹¹ Combined anterior and posterior approaches are usually needed to achieve sagittal and coronal balance and to obtain solid union especially in presence of multiple levels of pseudoarthrosis.³ Spine imbalance due to sagittal deformities leads to compensatory postures that place the body at a biomechanical disadvantage and an inefficient use of muscle energy resulting in strain, fatigue, and pain.¹⁸ Posterior-only approaches for surgical correction of spinal deformities are gaining popularity in the recent years among spine surgeons. This is due to the advent of polysegmental 3-column fixation through the use of pedicle screws along with posterior osteotomies which can correct greater curves without the need for anterior approaches either releases or corpectomies.^{7,10,15}

The technique of Ponte osteotomy includes excision of the posterior ligaments (supraspinous, interspinous, and ligamentum flavum) and facets to produce a posterior release, thereby aiding in coronal correction and sagittal plane realignment.⁵ Compression of the osteotomy results in deformity correction that necessitates a mobile disc space anteriorly. Additionally, compression results in narrowing of the neural foramina, so a preceding wide facetectomy is needed to prevent nerve root impingement.¹⁶ Coronal plane deformities are less common and may require a lateral convexity-based wedge osteotomy tapering towards the concavity with resection of the anterior cortex to achieve good correction.¹

Revision surgery of spine deformity is considered a salvage operation which carries many challenges to spine surgeons. Meticulous attention is required for both adequate preparation of the preplanned fusion bed and the stabilization of the corrected deformity with implants. There are technical considerations regarding osteotomies and subtotal vertebrectomies which are quite difficult, so

they should be performed by well-trained spine surgeons.² Revision spinal deformity is a common pathology that may lead to decreased quality of life, pain, physical limitations, and dissatisfaction with self-image. Durability of interventions for deformity treatment is of great importance to surgeons, as revision rates are considered to be high.⁷

The goal of this study is evaluation of the short-term results of posterior-only approach in management of revision spinal deformities.

MATERIALS & METHODS

Patient Demographics:

This prospective study was done on 20 patients with revision spinal deformities treated at Zagazig University Hospitals between February 2015 and December 2017. All patients underwent operation through the posterior-only approach using Ponte and fusion mass osteotomies fixed with pedicle screws. Patients who are more than 15 years old with previously failed spinal deformity correction surgery of different causes were included in this study. Patients presenting with infection and failure of instrumentation as a cause of revision without associated deformity were excluded.

This study was approved by Zagazig University Institutional Research Board (IRB) ethical committee and informed consent was taken from the patients. The mean age was 16 ± 5.9 (range, 16–35) years old with 4 males and 16 females. The pathology before the primary surgeries was 16 with adolescent idiopathic scoliosis; one with neurofibromatosis; and three with congenital spinal deformities. The indications for revision surgeries were 7 cases with pseudoarthrosis diagnosed clinically by the presence of disabling pain and radiologically with computerized tomography (CT) scan, 10 cases presenting with coronal decompensation and cosmetic concern, 2 with degenerative changes presenting mainly with progressive pain associated with persistence of deformity but not including junctional

deformities, and one case presenting with crankshaft phenomena with excessive rotation and cosmetic concern. Five cases had been previously instrumented with unilateral fixation: 4 of them had been fixed with Harrington rod and the other case with unilateral pedicle screws system. Otherwise, bilateral transpedicular screw fixation was used in the primary surgery.

Preoperative Evaluation:

The Visual Analogue Scale (VAS) for back pain and Oswestry Disability Index (ODI) were assessed preoperatively and at the follow-up visits. Also, Scoliosis Research Society (SRS) 22 questionnaire (Arabic version)⁸ was documented at the end of follow-up. Radiologically, the preoperative main coronal Cobb angle, sagittal vertical axis (SVA), and coronal balance were measured using the whole spine X-ray posteroanterior and lateral views (Figure 1A–D) and (Figure 2A). CT scan was used for diagnosis of pseudoarthrosis (Figure 3).

Operative Technique:

The procedure was done under general anesthesia and in prone position. A posterior midline skin incision was carried out and deep surgical dissection was done down to the posterior elements of the affected segments of the spine. In most cases, the previous instrumentation of the primary surgery had been extracted. Only in few cases, some pedicle screws were left as they appear both radiologically and intraoperatively in good alignment and there was not any sign of screw loosening.

Multiple Ponte osteotomies around the apex of the deformities were done (Figure 2D). In presence of fusion mass or pseudoarthrosis, fusion mass osteotomies were done using the costal ends and the transverse processes in the lumbar regions as landmarks if the usual anatomical landmarks were unidentifiable due to the previous surgeries. Burrs and Kerrison rongeurs had been used to remove all the interspinous, interlaminar ligaments, and fibrous tissues. Under fluoroscopic guidance, the osteotome was directed further laterally and anteriorly to cut the fusion mass, excising the pedicle and part of body in the convex side of the

deformity allowing mobilization and correction of the deformity. Pedicle screws were applied at both sides of the deformity to the planned level of fixation (Figure 1F).

Afterwards, the precontoured rods were applied at both sides; then, correction of the deformity was achieved using different reduction maneuvers including (a) segmental rotation and derotation, (b) compression and distraction, and (c) in situ bending of the rods (Figure 2C). The fusion bed for arthrodesis was prepared carefully to allow for solid fusion. The bone graft was taken from the posterior part of iliac crest through the same posterior approach. The wound was closed in layer after insertion of one or two suction drains.

Postoperative management: All patients received parenteral broad-spectrum antibiotic for the first 3 days postoperatively and then oral antibiotic for one week later. Suction drains were removed after 48 hours. The patients were allowed weight-bearing immediately. Thoracolumbar brace was used for 4–6 weeks after surgery.

Follow-up: All cases were followed up clinically using VAS and ODI. Radiological assessment was done by whole spine X-ray posterior-anterior and lateral views. Serial postoperative X-rays were taken at 0, 6 weeks, 6 months and at the latest of the follow-up time to assess union and deformity correction (Figure 1E and Figure 2 B, E).

Statistical Analysis:

Statistical analysis was done using SPSS Microsoft program version 25. The numerical data were presented as mean \pm standard deviation. Paired *t*-test was used to compare the preoperative and postoperative means. P-value < 0.05 was considered statistically significant.

RESULTS

The mean follow-up period was 27 ± 6.2 (range, 14–37) months. The mean number of the Ponte osteotomies per case was 6.05 ± 1.32 (range, 4–9). The total number of performed osteotomies was 121 (range, 4–9) including; 111 Ponte osteotomies

(N=20) and 10 fusion mass osteotomies (N=7). The mean estimated blood loss (EBL) was 1829±388.7 ml (range, 1300–2600). The mean of blood transfusion units intraoperatively was 4.15±0.8 (range, 3–6) units. The mean operative time was 7.8±1.1 (range, 6–10) hours. The mean hospital stay was 4.1±1.11 (range, 3–7) days (Table 1).

Clinically, the Visual Analogue Scale (VAS) of back pain showed 75.97% improvement at the last visit as it changed from 7.35±1.18 (range, 5–9) preoperatively to be 1.8±.77 (range, 1–3) at the end of follow-up which was statistically significant (P< 0.001). The Oswestry Disability Index (ODI) improved from 76±7.5 (range, 60–90) to 29.5±8.3 (range, 20–50) with 61.2% improvement at the last follow-up visit (P< 0.001) (Figure 4). At the end of follow-up, SRS questionnaire 22 (Arabic version) was measured in points with the total score being 4.16; function, 4.23; pain, 3.96; self-image, 4.33; mental health, 4.36.

Radiologically, the mean coronal Cobb angle showed 75.64% correction as it was improved

from 67.2°±8.38° (range, 52°–80°) to become 16.55°±5.08° (range, 9°–26°) at the last follow-up which was statistically significant (P< 0.001). The sagittal vertical alignment (SVA) improved from 4.6±1.8 cm (range, 0.5–7.2) preoperatively to be 2.14±0.8 cm (range, 0.7–3.5) at the last follow-up with 30.7±78.2% correction.

The coronal alignment (CA) improved from 5.3±1.2 cm (range, 3–7.3) preoperatively to be 0.67±0.6 cm (range, 0–2) cm at the last follow-up (Table 2).

All cases showed good fusion mass and solid union which was detected by X-rays at the last follow up. The complications of our study were as follows: three dural tears were repaired intraoperatively, one case presented with postoperative ileus managed with nasogastric tube and nothing by mouth for 2 days, one case complicated with postoperative superficial wound infection was treated by local dressing and antibiotics, one case had a complication with delayed extubation, and one case presenting with postoperative anemia was treated with 3 units of packed RBCs.

Table 1. Summary of operative data of this study

Parameters	Results
Operative time	7.8±1.1 (6–10) hours
Estimated blood loss	1829±388.7 (1300–2600) milliliters
Blood transfusion	4.15±0.8 (3–6) units
Hospital stay	4.1±1.11 (3–7) days
Follow up	27±6.2 (14–37) months
Time interval between primary and revision surgery	135.8± 88.67 (36–264) months

Table 2. Preoperative and final clinical and radiological results

Parameters	Preoperative	Last follow-up	% of correction	Paired t-test	P-value
Back pain VAS	7.35±1.18 (5–9)	1.8±.77 (1–3)	75.97±8.18 (62.5–87.5)	17.61	<0.001**
Main coronal Cobb angle	67.2±8.38 (52–80)	16.55±5.08 (9–26)	75.64±5.66 (66.2–85.53)	23.16	<0.001**
Sagittal Vertical Alignment (cm)	4.6±1.8 (0.5–7.2)	2.14±0.8 (0.7–3.5)	30.7±78.2 (-200–82.1)	5.42	<0.001**
Coronal alignment (cm)	5.3±1.2 (3–7.3)	0.67±0.6 (0–2)	85.1±16.2 (33.3–100)	15.33	<0.001**

*P value < 0.05 is statistically significant.



Figure 1. A 16-year-old female patient with back pain and cosmetic concern secondary to loss of correction and pseudoarthrosis may be due to unilateral rod fixation. (A) Preoperative posterior-anterior view, (B) bending to left, (C) bending to right, and (D) sagittal view [main coronal Cobb: 53°; right bending: 43°; correction: 13%; thoracic kyphosis (TK): 67; SVA: +5 cm; CA: 4 cm]. (E) The last follow-up X-ray [coronal Cobb: 8°; correction rate: 85%; TK: 42°; SVA: +2 cm; CA: +1 cm]. (F) Intraoperative multiple posterior osteotomies fixed with pedicle screws.

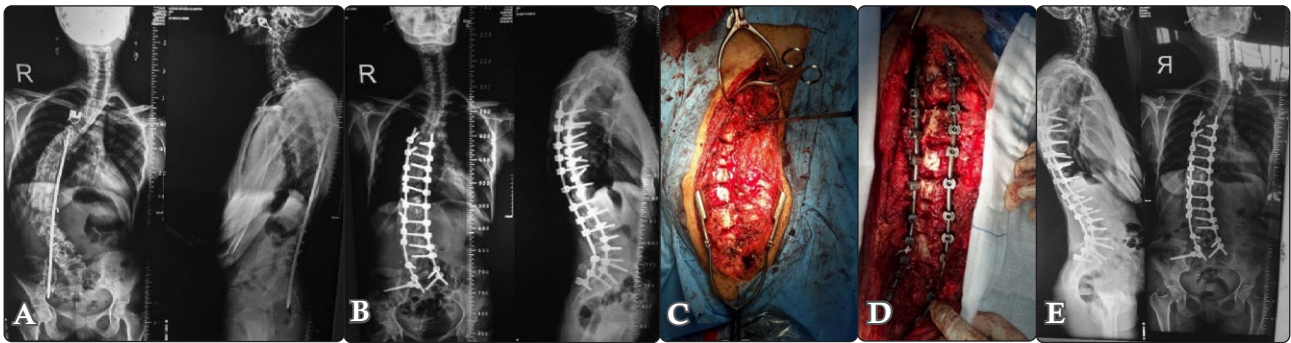


Figure 2. A 33-year-old female patient with back pain and cosmetic concern secondary to loss of correction and coronal decompensation fixed with unilateral Harrington rod. (A) Preoperative whole spine X-rays [main coronal Cobb = 715°; CA: +6 cm; SVA: - 4 cm; TK: 37°]. (B) Immediate postoperative X-ray views show coronal Cobb: 24° and correction rate: 64%. (C, D) Intraoperative photo of multiple posterior osteotomies fixed by pedicle screws. (E) Last follow-up (24 months). X-ray [main coronal Cobb: 26°; correction rate: 63%; CA: +2 cm, sagittal; SVA: +1 cm; TK: 45°].



Figure 3. CT scan shows pseudoarthrosis in patient with unilateral rod fixation.

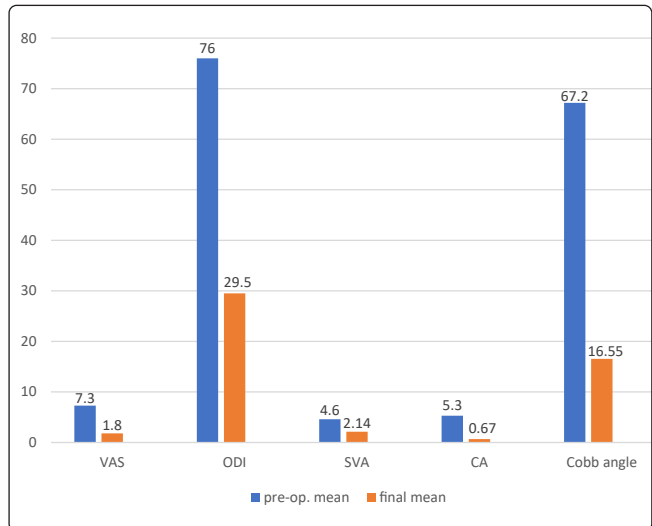


Figure 4. Shows the preoperative and final means of the clinical and radiological parameters.

DISCUSSION

Combined anterior and posterior approaches are commonly used in surgical treatment of severe spinal deformities and in revision surgeries.¹⁴ However, Suk et al.¹⁷ concluded that severe scoliosis can be corrected using pedicle screws in all segments, so the anterior release is not needed. Also, Luhman et al.¹² stated that large thoracic curves between 70° and 100° usually need two-staged approach in case of using thoracic hook constructs to achieve adequate correction rate, but this is not needed when using all-segment thoracic pedicle screw constructs.

We compared our results with the results of both; the studies using the posterior-only approach, and the studies using the combined approaches in primary and revision surgeries of spinal deformities.

The mean operative time in our study was 7.8±1.1 (6–10) hours which is longer than the time in study by Kurt et al.¹¹, Hero et al.⁹, and Mitsuru et al.¹³ (5.85± 1.6, 4.3±4.4, and 4.6±1.8 hours), respectively, but it is comparable to the combined approach group in the study of Mitsuru et al.¹³ which was 7.3±2.2 (4.5–14) hours. The time interval from the primary surgery in our study was 135.8± 88.67 (36–264) months which is longer than the study of Mitsuru et al.¹³ (34.3, range 11–166 months). This may explain the prolonged operative time due to more soft tissue fibrosis, bony overgrowth, and more difficulties in the approach itself. The studies by Kurt et al.¹¹ and Hero et al.⁹ were performed on primary surgeries which is another reason for their shorter operative time.

The mean percentage of correction of the main coronal deformity Cobb angle at the last follow-up was 75.64 %±5.66 with a range of 66.2–85.53% which is better than that in studies by Kurt et al.¹¹ (40%, range 5–81%), Hero et al.⁹ (65.9% in posterior-only approach group and 69% in the combined approaches group), and Mitsuru et al.¹³ (65.6% correction in the posterior approach

and 68.3% in combined approaches group). The increased correction rate may be explained by the relatively small starting preoperative main Cobb angle which was 67.2°±8.38 (52°–80°) and also the relatively increased number of posterior osteotomies per case in our study (6.05±1.32, range 4–9), which was more than the number of osteotomies in the study of Kurt et al.¹¹ (4.6, range 1–10).

The difference between the preoperative and the last follow-up SVA was 2.46 cm which is less than that in the study by Kurt et al.¹¹ (6.5 cm). However, the CA difference in our study (4.63 cm) is more than that shown in a previous study as it was only 2.5 cm at the last follow-up.

Clinically, the VAS of back pain was improved from 7.35±1.18 preoperatively to become 1.8±.77 at the end of the follow-up period. Additionally, the ODI showed 61.2% improvement at the last follow-up visit. We attributed that to the adequate correction of the coronal alignment, sagittal alignment, and good fusion achieved in most cases.

The final SRS outcomes in our study are comparable to the results by Mitsuru et al.¹³ and to the outcomes of primary scoliosis surgeries in adolescents.⁴

The EBL in our study was 1829±388.7 (1300–2600 ml) which is more than the EBL in study by Kurt et al.¹¹ (1024±498 ml), as surgeries in this study were done on primary cases but there was less blood loss in the posterior-only approach group in study by Mitsuru et al.¹³ (2093±1.973, range 400–8000 ml).

The mean hospital stay in our study was 4.1±1.11 (3–7) days which is shorter than that in the reviewed studies. In study by Hero et al.⁹, it was 18.6±7.1 days in the posterior-only approach group. Moreover, it was less than the recorded values in all groups of patients present in the study by Mitsuru et al.¹³, which was 9.4±2.1 (6–13) days in the anterior approach group, 8±2.8 (6–10) days in the posterior-only approach group, and 12.8± 3.6 (7–24) days in the staged anterior and posterior approaches group.

Both the surgeon and the patient should be oriented to the risks and complications of spinal deformity revision surgeries, as they are significantly higher than those of primary surgeries. However, successful results can be achieved with careful preoperative evaluation.⁶

Our study included seven complications without serious neurological or mortality complications. Kurt et al.¹¹ included nine complications in the form of five hardware failures (19%), three pseudoarthroses (11%), and one transient neurologic deficit (4%).

Mitsuru et al.¹³ showed 14% complications (7 of 50 patients): two patients had complication with decompensations, two presented with deep wound infections, one patient had pseudoarthrosis, one case suffered from permanent retrograde ejaculation, and one case presented with proximal junctional kyphosis.

The limitations in our study were the short follow-up period, small number of patients, and absence of the control group comparing this technique with other methods of treatment. In addition, it is difficult surgery and should be performed by specialized spine surgeons in well-equipped centers.

CONCLUSION

Revision deformity surgeries are technically demanding procedures and should be done by well-trained spine surgeons. The posterior-only approach is an effective and safe option in management of deformity correction and achieves good union even in cases of pseudoarthrosis without serious complications.

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الملخص العربي

تقييم النهج الخلفي فقط باستخدام القص العظمي من نوع بونتي وقص عظمي للعظم الملتحم في تصحيح تشوهات العمود الفقري المرتجة.

البيانات الخلفية: فشل جراحة تشوه العمود الفقري يمكن أن يؤدي إلى تشوهات الإكليلية أو السهمي الثابتة اللا تعويضية. عادة ما تكون هناك حاجة إلى نهج الأمامي والخلفي مجتمعة لتحقيق التوازن السهمي والإكليلي وللحصول على اتحاد قوي وخاصة في وجود مستويات متعددة من التهاب المفاصل الزائف.

الغرض: الهدف من هذه الدراسة المرتجة هو تقييم النتائج قصيرة المدى للنهج الخلفي فقط باستخدام القص العظمي من نوع بونتي وقص عظمي للعظم الملتحم في تصحيح تشوهات العمود الفقري المرتجة.

تصميم الدراسة: دراسة مرتجة للحالات.

المرضى والطرق: تم تضمين عشرين مريضاً يعانون من تشوهات العمود الفقري المرتجة في هذه الدراسة بين فبراير 2015 وديسمبر 2017. وكان متوسط العمر 5.9 ± 16 (16-35) سنة. تم تقييم المرضى الإشعاعية والسريية باستخدام مقياس التناظرية البصرية من الألم VAS ودرجة العجز ODI. تم تقييم فروق ذات دلالة إحصائية بين ما قبل المنطوق ووسائل المتابعة النهائية باستخدام اختبار t تفرق. قيمة $P < 0.05$ ذات دلالة إحصائية.

النتائج: متوسط وقت المتابعة كان 6.3 ± 18.5 أشهر. كان هناك تحسن كبير من الناحية الإحصائية للنتائج السريية وجميع المعلمات الإشعاعية في نهاية فترة المتابعة. وكانت القيم $P < 0.001$. كان هناك سبعة مضاعفات بدون مراضة خطيرة (3 دموع الجافية، 1 العلبة بعد العملية الجراحية، 1 نزع الأنبوب المتأخر، 1 إصابة الجرح السطحي وفقر الدم 1).

الاستنتاج: كان للنهج الخلفي فقط باستخدام العظم العظمي الشامل بونتي والانصهار نتائج مرضية قصيرة الأجل الوظيفية والإشعاعية دون مضاعفات كبيرة في التصحيح الجراحي لتشوهات العمود الفقري المرتجة بشرط أن يتم ذلك من قبل جراحي العمود الفقري المدربين تدريباً جيداً.