Investigating Radiological Criteria and Clinical Findings in Patients Before and After Smith-Peterson Osteotomy to Correct Adult Spine Deformity

Abstract

Introduction: The aim of this study is to investigate the radiographic and clinical findings in patients before and after Smith-Peterson osteotomy to correct adult spine deformity.

Materials & Methods: This is a case series study. Data be prepared and extracted retrospectively from patients' records. Inclusion criteria were age >18 years, American Society of Anesthesiology (ASA) risk class III or less, and sagittal spine deformity within three years. All the patients had pre-operative full standing digital spine radiography. Radiographic and clinical parameters were extracted from the patients' files before the operation and 1 month after the operation. Demographic and surgical and clinical information: information was obtained for each patient. The information from the questionnaire was coded and entered SPSS software. The level of significance was considered less than 5%.

Results & Discussion: A total of 10 patients met the conditions for entering the study and were examined. The amount of change in SAV before and after correction of deformity post-surgery decreased significantly (P<0.0001), the amount of Pelvic Incidence increased from 51.7 to 52.5 after surgery, which is not statistically significant(p=0.269). Pelvic tilt decreased from 28.7 to 23.5 after surgery (P=0.002). Sacral slope increased from 23.5 to 29.4 (p=0.002). Lumbar Lordosis also increased from 8.5 to 42.1 after surgery (p<0.0001). The rate of Thoracic Kyphosis also increased significantly from 24.4 to 25.2 after surgery (P=0.003). There was a significant decrease in VAS from 7.7 to 3.1 after surgery (P<0.00001).

Conclusion: The spinal deformity correction by the Smith-Peterson osteotomy method can improve the radiographic as well as clinical parameters in short term.

Keywords: Spine, Osteotomy, Radiography.

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Introduction

Adult spinal deformities (ASDs) arise from diverse etiologies and are frequently associated with disability and a decline in health-related quality of life (HRQoL)[1,2]. With an aging population and advancements in medical and surgical practices, the frequency of spinal deformity surgery has steadily increased[3–5]. The decision to pursue surgical correction is usually driven by functional limitations and clinical symptoms rather than the radiographic severity of the deformity[6]. Achieving sagittal alignment on radiographs has been linked to favorable clinical outcomes[7], and age-adjusted correction values have been suggested based on correlations between radiographic findings and patient-reported outcome measures (PROMs)[1]. Although the primary objective of surgery is restoring spinal alignment, maintaining sagittal balance over time can be difficult, as age-related changes and mechanical complications may compromise initially successful results. Compared to hip or knee arthroplasty, outcomes following ASD surgery are less predictable[8]. Furthermore, patient satisfaction after surgery remains underexplored, and the relationship between radiographic improvements and PROMs has been debated.

In recent decades, progress in patient selection criteria and the development of risk stratification models have improved surgical planning[9,10]. Similarly, minimally invasive procedures have been introduced, although complication rates remain significant[11].

Historically, spinal osteotomies were performed only in specialized centers, but they are now widely available thanks to broader surgical training and fellowships. Commonly used osteotomy techniques include Smith-Petersen osteotomy (SPO), pedicle subtraction osteotomy (PSO), bone-disc-bone osteotomy (BDBO), and vertebral column resection (VCR), with each representing a step up in technical difficulty and correction potential.

The present study aims to evaluate radiographic parameters and clinical outcomes in patients undergoing Smith-Petersen osteotomy for the correction of adult spinal deformities.

Materials & Methods

In this case series study, data was prepared and extracted retrospectively from patients' records. Inclusion criteria of our study were: age above 18 years, ASA risk class III or less, and Candidate for elective Smith-Peterson osteotomy surgery with the main indication of correction sagittal spine deformity in the last three years.

All radiographs and questionnaires related to clinical treatment are included at that time. All patients underwent full standing digital spine radiography before surgery. Radiographic and clinical parameters, including the following items, are extracted from the patients' files before the operation and 1 month after the operation from the patients' files and faxes. Demographic and surgical information: Demographic and clinical information was obtained for each patient. First, the information from the questionnaire is coded and entered into SPSS software. Mean±SD was used to display quantitative data and frequency was used to display qualitative data. A significance level of less than 5% was considered. Parametric analyzes were used to analyze variables with normal distribution and non-parametric analyzes were used to analyze variables with non-normal distribution. Paired t-test was used to check the relationship between radiological criteria and clinical findings before and after transplant. The effect of background variables on OUTCOME is used from regression analysis according to the type of variables. The less than 0.05 level considered as significance. The data was entered into SPSS software and analyzed by relevant statistical tests.

Results

In this study, the number of 10 patients who met the conditions for entering the study was examined (Figure 1); the clinical and demographic information of the patients is reported in Table 1.

The amount of change in SAV before and after correction of deformity after surgery has decreased significantly (P<0.0001), the amount of Pelvic Incidence has also increased from 51.7 to 52.5 after surgery, which is not statistically significant. (0.269). Pelvic tilt decreased from 28.7 to 23.5 after surgery (P=0.002).

Sacral slope increased from 23.5 to 29.4 (p=0.002). Lumbar Lordosis also increased from 8.5 to 42.1 after surgery (p<0.0001).

The rate of Thoracic Kyphosis also increased significantly from 24.4 to 25.2 after surgery (P=0.003). There was a significant decrease in VAS from 7.7 to 3.1 after surgery (P<0.00001) (Table 2).

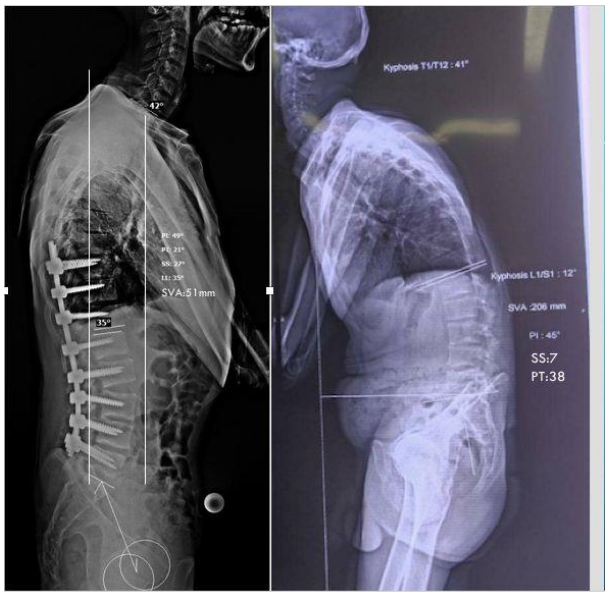

Figure 1: A 56-year-old male patient with a severe deformity in the sagittal plane, who underwent a four- Levels Ponte osteotomy and obtained a very good correction; S.V.A, Pelvic Incidence, Pelvic Tilt, Sacral Slope, Lumbar Lordosis, Thoracic Kyphosis, Cervical lordosis, PI – LL and SRS-22r before and after surgery

Table 1: Examining the level of characteristic demographic status in the examined patients		
Variables		Frequency (Percent)
Gender	F	4(40.0)
	M	6(60.0)
Number of Levels fused	5.00	2(20.0)
	7.00	3(30.0)
	9.00	5(50.0)
Number of levels osteotomy	3.00	1(10.0)
	4.00	7(70.0)
	5.00	1(10.0)
	6.00	1(10.0)
Levels of osteotomy	l1.l2.l3.l4	1(10.0)
	L1.L2.L3.L4	1(10.0)
	L2.L3.L4.L5	2(20.0)
	L3.L4.L5	1(10.0)
	L3.L4.L5.S1	1(10.0)
	T11-T12.L1.L2.L3	1(10.0)
	T12.L1.L2.L3	2(20.0)
	T12.L1.L2.L3.L4.L5	1(10.0)
Hardware. Failure	NO	10(100.0)
Pseudo arthritis	NO	10(100.0)
Complications	NO	8(80.0)
	neurologic	1(10.0)
	superficial infection no	1(10.0)
Readmission	NO	9(90.0)
	YES	1(10.0)
Pjk .djk	NO	10(100.0)
Age		53.5±12.24
BMI		28.2±3.39
Blood. loss		660.0±123.01
F.U		17.20±9.35
OR. Time		171.5±29.06

Table 2: Examination of the level of clinical characteristics before and after surgery in the examined patients		
P value	Mean±Std. Deviation	Variables
0.0001	15.40±3.83	SVA Pre OP
	4.30±2.21	SVA Post OP
0.269	51.7±8.32	Pelvic Incidence Pre OP
	52.50±8.80	Pelvic Incidence Post OP
0.002	28.70±5.81	Pelvic Tilt Pre OP
	23.50±3.68	Pelvic Tilt Post OP
0.002	23.50±9.48	Sacral Slope Pre OP
	29.40±7.73	Sacral Slope Post OP
0.000	8.50±14.68	Lumbar Lordosis Pre OP
	42.10±7.03	Lumbar Lordosis Post OP
0.003	24.40±14.50	Thoracic Kyphosis Pre OP
	35.20±7.43	Thoracic Kyphosis Post OP
0.0001	7.70±1.05	VAS Pre OP
	3.10±.87	VAS. Post OP

Discussion

When conservative management fails, surgical intervention may be considered for patients experiencing persistent back or leg pain. Severe or progressive deformities with significant trunk imbalance are typical indications for corrective instrumentation and spinal fusion[5,6]. In cases of marked scoliosis with sagittal malalignment, procedures such as Smith-Petersen or Ponte osteotomy are often selected if the intervertebral spaces remain mobile, whereas more rigid deformities may require pedicle subtraction osteotomy (PSO)[7].

Previous studies have demonstrated that surgical correction of adult scoliosis can improve long-term quality of life[8]. Nonetheless, choosing the appropriate surgical approach requires individualized planning that accounts for age, comorbidities, and the three-dimensional characteristics of the deformity[9]. Over the past decade, the rate of ASD surgeries has risen, despite the relatively high risks in older patients. Reported complication rates range from about 13% at one-year follow-up to 30% at five years[8,10]. Mechanical complications—such as nonunion, rod fractures, proximal junctional kyphosis (PJK), and loosening of pedicle screws—are the leading reasons for revision surgery and account for 30–40% of all complications[11,12]. These issues can undermine surgical outcomes, particularly in patients requiring multiple operations, highlighting the importance of careful preoperative planning and risk–benefit assess[13].

ASDs can stem from several underlying conditions, including idiopathic scoliosis, degenerative or neoplastic changes, all of which disrupt spinal stability and balance[1,2]. Normal upright posture relies on the harmonious interaction of spinal curves, pelvic orientation, and muscular support[1–4]. Dubousset's "cone of economy" concept describes the stable zone of energy-efficient standing posture, a framework often used to evaluate balance in patients with deformities[5].

Although the definition of optimal spinal balance remains debated, radiographic parameters are widely used to guide surgical correctio[6]. Thoracic kyphosis (TK) and lumbar lordosis (LL), usually measured with Cobb angles, are commonly analyzed to assess regional alignment. More recently, pelvic parameters have been recognized as essential in evaluating sagittal balance, with the sagittal vertical axis (SVA) — defined as the distance between the C7 plumb line and the posterior superior sacral endplate — being one of the most reliable indicators[7–10]. An SVA of less than 50 mm is often considered an achievable target for maintaining functional global alignment, ensuring a stable standing posture and forward gaze[4,11]. In many cases, osteotomies become necessary to restore this global balance[11]. The selection of osteotomy type depends on factors such as bone quality, spinal rigidity, surgeon experience, deformity magnitude, and overall spinopelvic alignment[12,13].

Among available osteotomy techniques, Smith-Petersen osteotomy (SPO) and pedicle subtraction osteotomy (PSO) are the most frequently employed[14–16].

While SPO generally provides about 10° of correction per level, PSO achieves larger segmental corrections of 30–40°. SPO has the advantages of shorter operative time, reduced blood loss, and lower neurological risk compared to more invasive options, though it offers less sagittal correction and may increase compensatory changes in the coronal plane. In contrast, PSO is often reserved for rigid sagittal or combined sagittal–coronal deformities, such as flat-back syndrome, but carries higher risks and complication rates[16–25].

Our findings indicate that correction achieved with SPO led to meaningful improvements in both radiographic alignment and clinical outcomes, supporting its role as an effective option in selected patients with adult spinal deformities.

Conclusion

It is possible to use milder osteotomies such as Ponte or Smith-Peterson in several levels where only the posterior column of the spine is osteotomies without the need for more severe osteotomies such as PSO, which are associated with more complications such as more bleeding, longer operation time, and the possibility of neurological complications. Severe deformities in the sagittal and coronal planes can be corrected.

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