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Understanding the pros and cons of spine surgery for ankylosing spondylitis: experience from a single institution study

Mohammadreza Chehrassan[1,2*], Mohammadreza Shakeri[1,2*], Farshad Nikouei[1,2*], Saeed Sabbaghan[1,2*], Behnam Sour[1,2], Ebrahim Ameri Mahabadi[1,2] and Hasan Ghandhari[1,2]

Abstract

Introduction Ankylosing Spondylitis (AS) presents a complex inflammatory condition with significant impact on patients' lives. Despite advancements in understanding its pathogenesis, comprehensive elucidation remains elusive. This study investigates the outcomes of corrective spine surgery in AS patients, aiming to optimize management strategies.

Methods A retrospective cohort study was conducted, including 28 AS patients undergoing corrective surgery from 2016 to 2021. Surgical procedures primarily targeted realignment of the spine to alleviate deformities.

Results Radiological evaluations pre- and post-operatively revealed substantial improvements in sagittal balance and kyphosis correction. The mean correction of local kyphosis at the osteotomy site was 30.9 degrees. Minor surgical complications, though present, were managed effectively.

Conclusion While acknowledging surgical complexities and potential complications, meticulous patient selection and appropriate techniques mitigate risks. This study emphasizes the pivotal role of surgical intervention in improving quality of life, particularly by addressing sagittal vertical axis and forward gaze disorders.

Keywords Ankylosing spondylitis, Spine, Corrective surgery, Sagittal alignment

Introduction

Ankylosing Spondylitis (AS) represents a challenging chronic inflammatory disease within the spectrum of spondyloarthropathies [1]. Despite strides in understanding its inflammatory mechanisms, the pathogenesis remains incompletely elucidated, with contributions from both inflammatory and autoimmune processes. With an estimated prevalence ranging from 9 to 30 cases per thousand people, AS profoundly impacts various facets of individuals' lives [2, 3]. From debilitating stiffness and pain to fatigue, sleep disturbances, and concerns about appearance, AS imposes significant burdens, amplifying anxieties about the future compounded by potential drug side effects. Early diagnosis coupled with

*Correspondence:
Mohammadreza Chehrassan
morchehrasan@yahoo.com
Mohammadreza Shakeri
mshakeri3116@gmail.com
Farshad Nikouei
farshadnikouei@yahoo.com
Saeed Sabbaghan
saeed.sabbaghan@gmail.com
[1]Bone and Joint Reconstruction Research Center, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran
[2]Department of Orthopedic Surgery, School of Medicine, Iran University of Medical Sciences, Tehran, Iran

effective treatment strategies is paramount to mitigate the disease's socio-economic toll [4].

While medical interventions predominantly target inflammation control, the progressive nature of AS can culminate in debilitating deformities, significantly impairing personal and social functioning [5, 6]. Notably, sagittal balance disorder and subsequent horizontal vision impairment pose formidable challenges for AS patients. Surgical interventions, particularly corrective osteotomies, offer promising avenues for deformity alleviation. Various osteotomy techniques, including open wedge, polysegmental wedge, and closed wedge osteotomies, have been explored to rectify sagittal imbalance [7–9]. However, concerns persist regarding surgical complications. Central to osteotomy objectives is aligning the head with the pelvis to restore gaze alignment, thereby enhancing functional outcomes [10, 11]. Regardless of osteotomy type or extent, the degree of kyphosis improvement and sagittal vertical axis correction directly correlate with enhanced quality of life and psychological well-being, evidenced by reductions in depression and anxiety levels [12].

Although prior research has explored various osteotomy techniques and their outcomes, gaps remain in understanding the reproducibility of these surgical techniques across different settings and patient populations.

This study endeavors to scrutinize the outcomes of spinal corrective surgery in AS patients while delving into potential surgical complications. By shedding light on the efficacy and safety profile of these interventions, we aim to provide insights crucial for optimizing AS management strategies and ultimately enhancing patient outcomes.

Methods and materials

A retrospective cohort study was conducted to assess patients with AS who underwent corrective spine surgery at our institute between 2016 and 2021. Patients meeting the inclusion criteria, including a confirmed diagnosis of AS by a rheumatologist, being in the silent phase of the disease, presenting with kyphosis deformity and gaze disorder, and having a minimum 12-month follow-up, were included. Before being referred to us for osteotomy, all patients were evaluated by their rheumatologist to assess for osteoporosis. Additionally, pulmonary function was thoroughly checked preoperatively to ensure the patients were fit for surgery. Exclusion criteria comprised prior spinal surgery, spinal fracture history. The cohort consisted of 28 patients, comprising 23 males and 5 females, with an average age of 39 years (range 34 to 52). Main surgical indications included forward-looking disorder, deformity, sleep disturbance due to forward head posture, sagittal balance disorder, progressive back pain, digestive issues, and respiratory problems.

Surgical procedures

All surgeries were performed with patients positioned on a universal table in the prone position. To accommodate rigid deformities, the bed was initially flexed for patient positioning. The osteotomy site was determined and placed precisely on the flexible part of the bed for optimal surgical correction. Pedicle screws (two to four) were inserted proximally and distally to the planned osteotomy level, based on bone quality and screw fixation. Osteotomy techniques employed included pedicle subtraction osteotomy (PSO) or corner osteotomy. Closure of the osteotomy site involved compression and extension of the bed position. Intraoperative neuromonitoring (IONM) was utilized for all patients to ensure neurologic safety during surgery. To standardize its application across patients, a consistent protocol was followed, employing modalities such as somatosensory evoked potentials (SSEPs) and motor evoked potentials (MEPs). These techniques were monitored continuously by a trained neurophysiologist in collaboration with the surgical team. Baseline signals were established prior to surgical manipulation, and any significant deviations were communicated immediately to the operating surgeons to mitigate potential risks. This standardized approach ensured consistent monitoring and response to intraoperative neural changes, enhancing patient safety. Complications were classified into major and minor categories to provide a structured assessment of postoperative outcomes. Major complications included death, neurological deficits, thromboembolic events, and deep surgical site infections. Minor complications encompassed superficial surgical wound issues, device failure, intraoperative dural tears, and persistent postoperative pain.

Radiological evaluation

Pre- and post-operative lateral whole spine X-rays were used to assess radiological evolution, including sagittal vertical axis (SVA), lumbar lordosis (LL), thoracic kyphosis (TK), and local kyphosis (LK) at the level of osteotomy. Local kyphosis measurement was determined by the Cobb angle between the upper and lower endplates of the osteotomized vertebra (Fig. 1). Statistical analysis was conducted using SPSS 23 software to analyze demographic, radiological, and surgical outcome data.

Results

Patient demographics and baseline characteristics are summarized in Table 1 for clarity. The cohort comprised 28 patients, with a mean age of 39 years (range: 34–52 years), including 23 males and 5 females. Before surgery, the mean degree of thoracic kyphosis was 72 degrees (ranging from 25 to 115 degrees). A total of 33 osteotomies were performed across the cohort, with five patients undergoing two-level osteotomies due to severity of

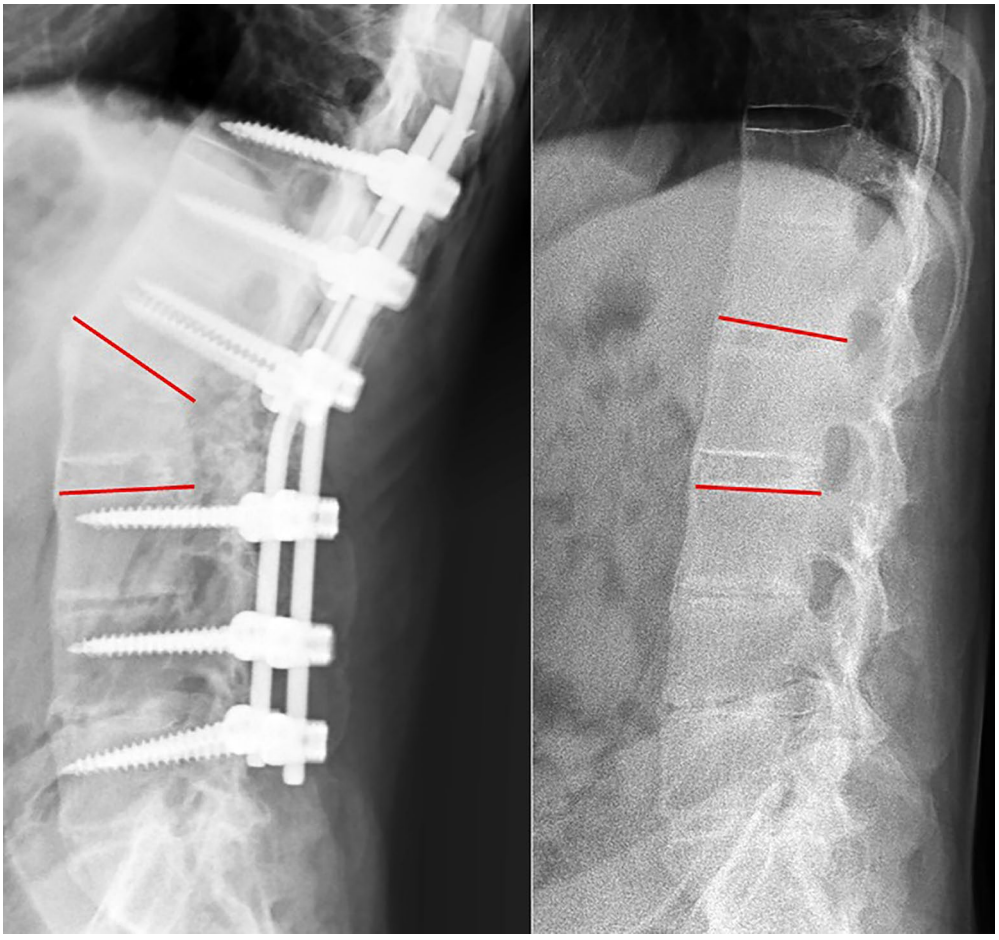

Fig. 1 Local kyphosis measurement was determined by the Cobb angle between the upper and lower endplates of the osteotomized vertebra

Table 1 Patient demographics

Characteristic	Value
Number of patients	28
Ages (years), Mean (range)	39 (34–52)
Gender (Male/Female)	23/5

their deformities. Among the single-level osteotomy patients, one was at the L1 vertebra, thirteen at the L2 vertebra, eight at the L3 vertebra, and one at the L4 vertebra (Fig. 2). The mean correction of local kyphosis at the osteotomy site was 30.9 degrees (ranging from 20 to 48). For the five patients with two-level osteotomies, in three cases osteotomies were performed on the L1 and L3 vertebrae and in two cases osteotomies were performed on the T12 and L3 vertebrae and the average correction of local kyphosis was 52.6 degrees for the sum of two-level correction. Before surgery, the mean SVA was 179.3 mm (ranging from 79 to 331 mm), which significantly improved to 65 mm (ranging from 50 to 210 mm) following the procedure (Table 2).

During surgery, two cases experienced iatrogenic dural tears, promptly repaired without complications. Additionally, screw pullout was observed three months postoperatively in distal screws in one patient, necessitating revision surgery. In one patient, transient neuromonitoring disorder occurred during correction, promptly resolved after nerve root release. No instances of irreversible nerve damage or vital vessel injury were recorded.

Despite analyzing potential correlations between patient factors, such as age, gender, and severity of deformity, and surgical outcomes, no significant relationships were identified. Due to the nature of the fixed spine in ankylosing spondylitis, where spinal mobility is significantly reduced, the primary focus of assessment and evaluation is limited to correction at the osteotomy site and the sagittal vertical axis (SVA). The limited sample size may have contributed to the absence of detectable patterns, emphasizing the need for larger studies to explore such associations further.

Fig. 2 Preoperative and postoperative lateral x-ray of a 40 years old female with AS who underwent corrective surgery with corner osteotomy of L2 vertebra

Table 2 Radiological parameters. SVA (Sagittal Vertical Axis)

	Minimum	Maximum	Mean	Std. Deviation
Thoracic Kyphosis	25	115	72.45	22.545
LL	-18	26	9.00	25.803
Pre-op SVA	79	331	179.35	75.816
Post-op SVA	9	210	65.80	50.104

Discussion

One of the primary goals of corrective spine surgery in ankylosing spondylitis (AS) is to address spinal deformities, such as kyphosis and loss of lumbar lordosis, which can severely impact a patient's quality of life. Traditional approaches, such as spinal osteotomy, have been effective in realigning the spine, but they often entail significant blood loss, lengthy hospital stays, and prolonged recovery periods [4, 7, 8]. As the deformity progresses, the body's center of gravity shifts forward, impacting horizontal vision and causing disturbances in sleep, walking, and digestion due to pressure on internal organs [12–14]. Consequently, patients often experience a significant decline in their quality of life, leading to psychological consequences like depression and anxiety. Studies

indicate a direct correlation between the improvement of depression indices and sleep quality with the correction of SVA, underscoring the importance of addressing spinal deformities surgically. Furthermore, research highlights enhancements in cardiac and pulmonary conditions, as well as improvements in quality of life and sexual function post-kyphosis correction surgery [15–17]. While our study did not evaluate the latter factors, the improvement in SVA can indirectly predict an increase in the quality of life in these patients.

While medical treatments remain vital for disease management, surgical intervention becomes imperative in cases of debilitating deformities [18, 19]. Surgical approaches vary depending on disease activity, deformity type and severity, and patient condition. Our study demonstrates notable improvements in kyphosis, lumbar lordosis restoration, and reduced SVA, leading to enhanced sagittal balance and horizontal vision, consistent with findings from previous research [19]. Similar studies have reported significant improvements in sagittal alignment and kyphosis correction with corrective osteotomies, aligning well with our results [5, 8, 9]. These improvements, in turn, have been associated with better pulmonary, digestive, and cardiac function, as well as enhanced psychological well-being, validating the importance of these surgical interventions.

However, AS patients are predisposed to increased surgical complications, including higher intraoperative bleeding, technical challenges with intubation, and elevated risks of cardiopulmonary and renal issues. The use of NSAIDs, a primary treatment for AS, further exacerbates kidney problems and increases bleeding risks during surgery [20]. While our study demonstrated improvements in kyphosis and SVA, we acknowledge several limitations that impact the generalizability and robustness of our findings. The absence of a control group restricts our ability to draw definitive conclusions about the causal relationship between surgical intervention and outcomes. Additionally, our small sample size of 28 patients limits statistical power, and the variability of surgical techniques employed across patients adds further complexity to comparing outcomes.

These limitations highlight the need for future research, particularly prospective studies with larger, more homogeneous cohorts to establish clearer causal links and assess the reproducibility of outcomes. Larger, multi-center studies would also allow for a better understanding of potential patient-specific factors, such as age, disease severity, and comorbidities, and their impact on surgical outcomes. Prospective randomized controlled trials (RCTs) are essential to provide more definitive evidence regarding the optimal surgical techniques, long-term efficacy, and safety profile of corrective spine surgeries in AS.

Conclusion

Corrective spine surgery improves the quality of life in patients with ankylosing spondylitis (AS), particularly by enhancing sagittal vertical axis (SVA) alignment and forward gaze. While associated with challenges, meticulous patient selection and appropriate techniques can minimize complications. Our study confirms findings from previous research, with complication rates similar to other spine surgeries.

However, limitations such as the retrospective design, small sample size, and lack of a control group highlight the need for future prospective studies. Larger cohorts with control groups and comparisons to other surgical approaches are necessary to validate our findings and optimize patient outcomes in the long term.

Abbreviations

AS	Ankylosing Spondylitis
PSO	Pedicle subtraction osteotomy
SVA	Sagittal vertical axis
LL	Lumbar lordosis
TK	Thoracic kyphosis
LK	Local kyphosis

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Author contributions

1. Mohammadreza Chehrassan: made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data; or the creation of new software used in the work; 2. Mohammadreza Shakeri: drafted the work or revised it critically for important intellectual content; 3. Farshad Nikouei: drafted the work or revised it critically for important intellectual content; 4. Saeed Sabbaghan: made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data; or the creation of new software used in the work; 5. Behnam Sour: Data collection and data analyzing; 6. Ebrahim Ameri Mahabadi: approved the version to be published; 7. Hasan Ghandhari: Agree to be accountable for all aspects of the work in ensuring that questions related to the accu.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All statements made in this manuscript have been reviewed and approved by the Institutional Review Board (IRB) at Iran university of medical sciences in Tehran, Iran, with the approval number IR.IUMS.REC.1403.283. Informed consent was obtained from all participants prior to their inclusion in the study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent for publication

Not applicable.

Clinical trial number

Not applicable.

Competing interests
The authors declare no competing interests.

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