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Application of combined anterior and posterior approaches for the treatment of cervical tuberculosis with anterior cervical abscess formation and kyphosis using a Jackson operating table: a case report and literature review

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Abstract. – BACKGROUND: There have been insufficient reports to date regarding the treatment of cervical spinal tuberculosis, and the optimal surgical approaches to treating this condition have yet to be established.

CASE REPORT: This report describes the treatment of a case of tuberculosis associated with a large abscess and pronounced kyphosis through the use of a combined anterior and posterior approach with the aid of the Jackson operating table. This patient did not exhibit any sensorimotor abnormalities of the upper extremities, lower extremities, or trunk, and presented with symmetrical bilateral hyperreflexia of the knee tendons, while being negative for Hoffmann's sign and Babinski's sign. Laboratory test results revealed an erythrocyte sedimentation rate (ESR) of 42.0 mm/h and a C-reactive protein (CRP) of 47.09 mg/L. Acid-fast staining was negative, and spine magnetic resonance imaging revealed the destruction of the C3-C4 vertebral body and a posterior convex deformity of the cervical spine. The patient reported a visual analog pain score (VAS) of 6, and exhibited an Oswestry disability index (ODI) score of 65. Jackson table-assisted anterior and posterior cervical resection decompression was performed to treat this patient, and at 3 months post-surgery the patient's VAS and ODI scores were respectively reduced to 2 and 17. Computed tomography analyses of the cervical spine at this follow-up time point revealed good structural fusion of the autologous iliac bone graft with internal fixation and improvement of the originally observed cervical kyphosis.

CONCLUSIONS: This case suggests that Jackson table-assisted anterior-posterior lesion removal and bone graft fusion can safely and effectively treat cervical tuberculosis with a large anterior cervical abscess combined with cervical kyphosis, providing a foundation for future efforts to treat spinal tuberculosis.

Key Words:
Jackson table, Cervical tuberculosis, Kyphosis, Bone graft fusion, Large abscess.

Introduction

Spinal tuberculosis is one of the most prevalent forms of osteoarticular tuberculosis, accounting for half of such cases[1]. As it initially exhibits a gradual insidious onset, affected patients generally only present with lower back pain that may or may not coincide with systemic symptoms. In contrast to most other forms of spinal infection, roughly 95% of spinal tuberculosis cases begin anteriorly in the vertebral body, with the infection spreading from the arteries in the paravertebral region or from the vertebral venous plexus to the central vertebral body[2]. As it progresses, this disease can lead to the severe destruction of bone tissue and overall spinal destabilization, often causing severe kyphosis or scoliosis. Patients also often present with paravertebral and intervertebral abscesses that can compress the spinal canal and proximal nerves, resulting in a range of neurological symptoms. The most serious of these neurological complications, paraplegia affects 10-30% of these patients[3,4].

Spinal tuberculosis primarily impacts the musculoskeletal system, and when it is not effectively treated patients generally experience severe sequelae. Roughly 3-5% of all spinal tuberculosis cases are of the cervical tuberculosis subtype[5-8]. Spinal tuberculosis can be diagnosed based on clinical examination, diagnostic imaging, antimicrobial bacilli (AFB) smears, mycobacterial culture, molecular methods, histological analysis, cytological examination, and drug sensitivity

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testing, with *Mycobacterium tuberculosis* cultures serving as the gold standard diagnostic tool. However, a combination of clinical data is needed to support a final diagnosis[2]. Following the destruction of the vertebral body, cervical tuberculosis is highly likely to cause kyphosis and spinal cord injury, resulting in a high rate of disability[9]. While anti-tuberculosis chemotherapy and improvements in patient nutrition can lead to better functional outcomes among individuals free of neurological symptoms or deformities, conservative treatment often results in spinal instability, kyphosis, and neurological impairment[10]. Surgical treatment is generally required for patients with vertebral lesions, severe kyphosis, neurological deficits, and progressive clinical symptoms[1]. However, intraoperative repositioning for patients with severe cervical tuberculosis and kyphosis is challenging, with a high risk of spinal cord injury that complicates these treatment efforts[11].

The goal of surgical treatment is to relieve progressive spinal deformity, delay the onset of neurological abnormalities, alleviate spinal instability, and mitigate any disabling pain. Hodgson et al[12] designed a modified anterior approach referred to as the "Hong Kong approach" that allows for adequate lesion debridement, although further research is needed to evaluate the ability of this approach to correct deformities and maintain the appropriate spinal sequence. The posterior approach offers a key advantage in that it allows for adequate lesion debridement while enabling the fixation of multiple spinal segments to enable more control over the correction of spinal deformities[13]. In a study, Cui et al[14] compared the anterior and posterior approaches to treating spinal tuberculosis patients, and determined that the posterior approach was better suited to achieving and maintaining deformity correction. As it is associated with greater simplicity and better functional recovery, the posterior approach is thus the preferred treatment for spinal tuberculosis. However, additional research is necessary to more firmly establish the optimal individualized treatment approaches for different patients suffering from this disease.

Here, we describe a rare case of spinal tuberculosis in a patient with a large anterior cervical abscess combined with cervical kyphosis. This patient was successfully treated through an advanced, comprehensive surgical approach consisting of Jackson table-assisted anterior-posterior debridement and fusion. Reports pertaining to the Jackson table-assisted treatment of spinal tuberculosis are lacking, and the unique characteristics of this patient make this a very rare case. The aim of this article is thus to discuss the indications for surgery, summarize intraoperative considerations, and analyze postsurgical outcomes as a means of providing a reference for future efforts to treat cervical TB with kyphosis.

Case Report

A 62-year-old male presented with dyspnea and hoarseness that had been present for approximately 1 month. Physical examination revealed physiological curvature of the spine and a palpable deep cervical sternocleidomastoid mass that was cystic in nature. The patient reported a visual analog pain score (VAS) of 6 and exhibited an Oswestry disability index (ODI) score of 65. Laboratory examinations revealed an erythrocyte sedimentation rate (ESR) of 42.0 mm/h, a C-reactive protein (CRP) level of 47.09 mg/L, and negative Acid-fast staining. Magnetic resonance imaging (MRI) scans of the cervical spine revealed destruction of the C3-C4 vertebral body and the posterior convex deformity of the cervical spine. The Ethics Committee of China-Japan Union Hospital approved this study, and the patient provided written informed consent for the publication of this case report (Figure 1).

Preoperative Management

Based on these initial findings the patient underwent emergency ultrasound-guided puncture to drain ~50 mL of caseous abscess and exudate. This led to improvements in the patient's symptoms of dyspnea such that he was able to eat and drink. Cephalic traction was performed beginning at 2 kg and increasing to a maximum of 6 kg, resulting in the restoration of the cervical spine sequence (Figures 2-3).

Surgical Treatment Approach

The patient underwent surgical treatment under endotracheal general anesthesia. For this procedure, the patient was placed in the prone position on the Jackson table while connected to neurophysiological monitoring equipment, connected to cranial traction, with mild hyperextension of the neck. The patient was carefully transferred supine to a fat-top Jackson frame using a standard spine board. Residual bone was removed to the posterior longitudinal ligament and the lesion was then fully removed and covered with gauze packing. Iliac osteotomy was then performed,

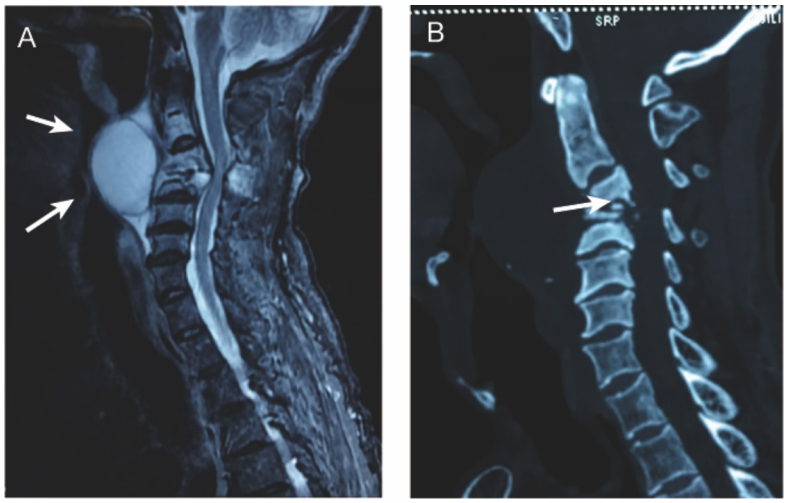

Figure 1. MRI and CT scans of the cervical spine before treatment. **A**, Massive anterior vertebral mass, trachea and esophagus compression, and vertebral body destruction (MRI). **B**, Vertebral collapse, narrowing of the intervertebral space, and C3C4 vertebral destruction (CT scans).

and the removed iliac bone was trimmed with the C2-C5 segment of the neck being shaped into a tongue-and-groove structure into which the iliac bone block was then implanted after assessing the stability of this bone graft. Another frame was installed, sandwiching the patient between two Jackson frames. Padding was added, the Jackson frames were secured together with belts, and multiple tapes were placed across the frames to secure the lines and chest tube. Then, the apparatus was carefully rotated 180°, positioning the patient prone. The first fat-top Jackson frame was removed. The Jackson table was then turned *in situ* to enable operation on the posterior cervical spine. The cortical bone was removed from the screw entry point and an open cone was placed along the left C2 pedicle, with a C2 pedicle screw being placed after probing. The right pedicle screw was placed using the same technique, the bone graft was osteotomized, and the bone graft

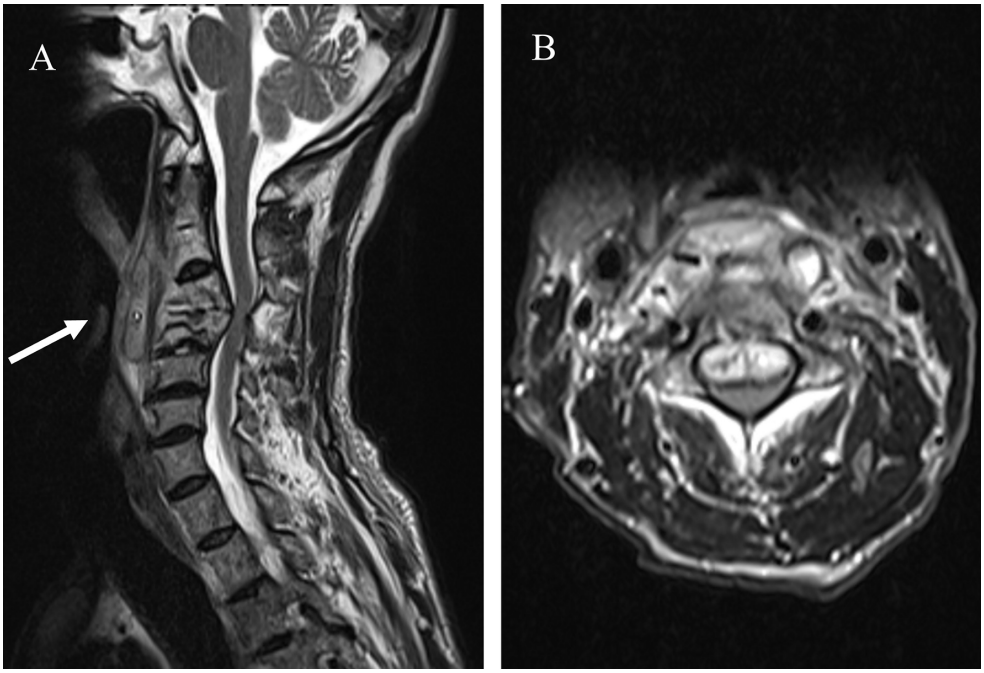

Figure 2. MRI of the cervical spine following ultrasound puncture and abscess reduction. **A**, Sagittal view. **B**, Axial view.

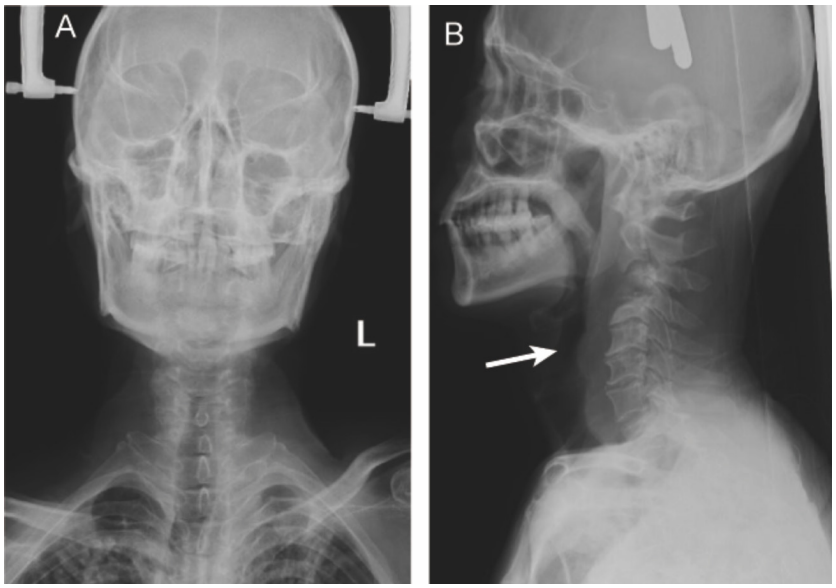

Figure 3. Positive and lateral X-ray images of the cervical spine after traction. **A**, Orthogonal view of the cervical spine after 6 Kg of cranial traction. **B**, Lateral image with arrows indicating bone destruction and C3-C4 vertebral collapse.

groove was prepared by grinding and drilling the articular eminence joint. A sterile dressing was applied to cover the operative site, and the bone was slightly displaced and rotated. After percussion with a percussion device, the bone graft was examined for stability and the deep fascia, subcutaneous tissue, and skin of the broad cervical muscle were sutured anteriorly. For images of this surgical procedure see Figure 4.

Results

The selected surgical approach achieved satisfactory efficacy when used to treat this patient. X-ray and CT imaging at 1 month post-surgery revealed clear improvements in the physiological curvature of the cervical spine, with good positioning of the internal fixation, bone implantation between the C3/C4 vertebrae, and an appropriately positioned bone graft with no evidence of significant movement. A further review of cervical spine CT images collected at 3 months postoperatively revealed good structural implant fusion with the autologous iliac bone graft, good bone graft fusion between the vertebral plates in the posterior column, internal fixation in position, and improved cervical kyphosis. The patient's VAS score declined from a preoperative value of 6 to a postoperative value of 2, with a similar decrease in ODI score from 65 to 17. The patient

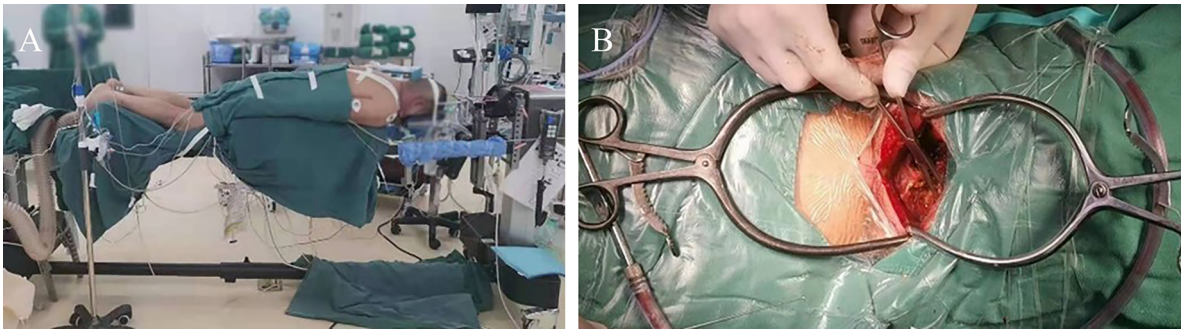

Figure 4. Surgical procedure. **A**, An image obtained with the patient in the prone position. **B**, Intraoperative photographs showing the removal of the pedicle and the beginning of the osteotomy, which was followed by the use of an osteotome to remove more bone and create smooth walls for bony apposition.

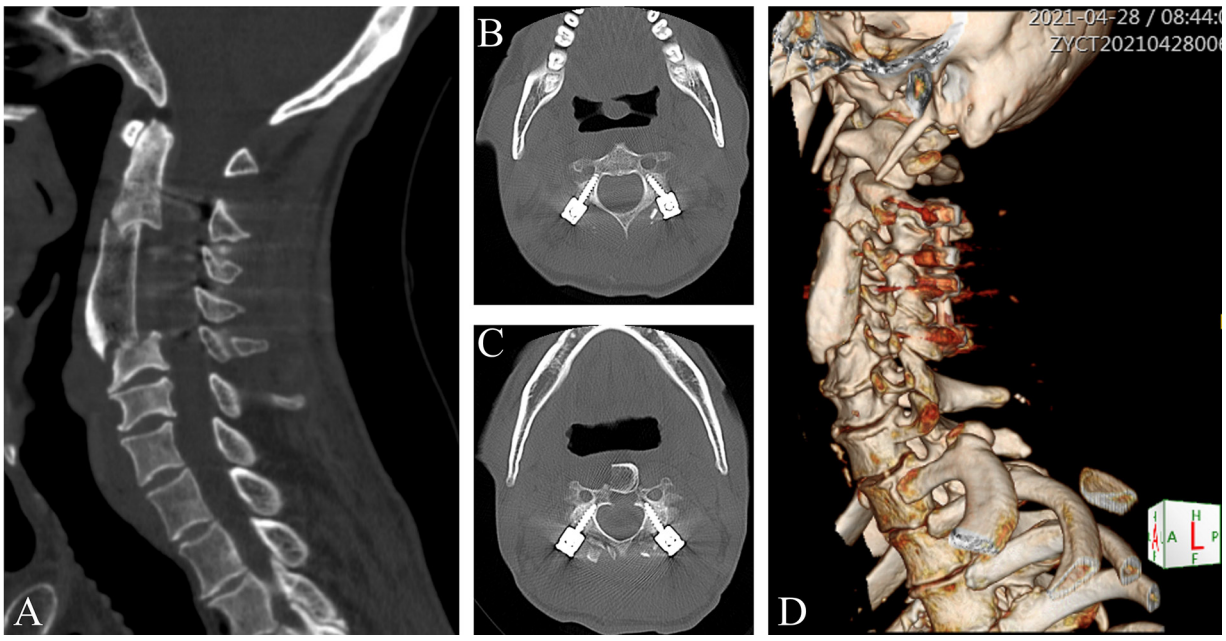

Figure 5. CT image of the spine 1-month post-surgery. **A**, Cervical CT sagittal view of the C3/C4 intervertebral body with the bone graft in place. **B-C**, Axial view with internal fixation in the pedicle. **D**, 3D CT reconstruction.

exhibited a good prognosis and no longer experienced any significant discomfort (Figures 5-6).

Discussion

Advantages of the Jackson Table-Assisted Anterior-Posterior Approach

While a combined anterior-posterior approach can be advantageous when performing spinal surgery, it necessitates manual intraoperative turning that entails a high level of risk. The development of the Jackson table has improved the safety and efficacy of this operative approach, providing improved stability when adjusting patients from the supine to the prone position in individuals with thoracolumbar spine instability relative to the traditional log roll method[15]. Smith[16] found that patients operated in the prone position faced surgical risks, leading to their development of devices capable of reducing these operative complications[17,18]. The Jackson table is particularly popular among spinal surgeons as it allows for easy intraoperative positioning of the patient, is X-ray permeable, and exhibits pad adjustability. The Jackson table can also support patients of varying shapes and sizes without any substantial impact on circulatory or respiratory function before or after turning[19].

At present, the optimal surgical approach used to treat spinal tuberculosis remains controversial and has yet to be standardized. Combining anterior and posterior approaches enables surgeons to perform debridement, decompression, and grafting anteriorly, followed by posterior internal fixation to restore the biomechanical stability of the spine in an effort to minimize the need for postoperative revision or the potential for recurrence[20]. The combined anterior-posterior approach achieved posterior internal fixation with a nail bar following anterior lesion debridement and bone grafting-mediated fusion[21]. This procedure is well-established, and allows for lesion removal through a process separate from that used to achieve internal fixation, reducing the odds of bacterial spread. The anterior approach is also more intuitive, allowing for relatively complete lesion removal. In cases of early atlantoaxial tuberculosis, atlantoaxial dislocation is generally entirely or partially reversible, and posterior atlantoaxial segmental fixation can be combined with anterior lesion removal. In cases of irreversible atlantoaxial dislocation, severe atlantoaxial destruction, atlantoaxial instability with nerve injury, or critical nerve injury are often observed, and patients generally need to undergo posterior cervical-occipital fusion with anterior decompression. When mild vertebral body destruction or mild kyphosis are evident, patients can undergo anterior fusion with bone grafting[22]. In cases of severe vertebral body destruction or kyphosis coinciding with significant cervical instability, a

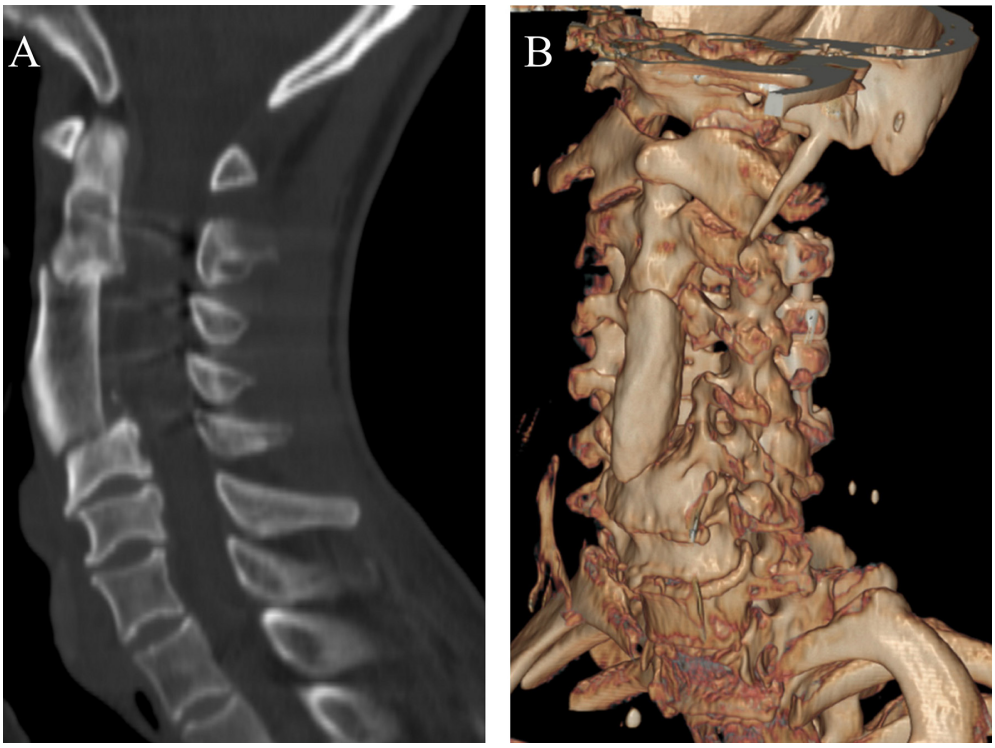

Figure 6. CT image of the spine at 3 months postoperatively. **A**, Blurred structural bone graft with autologous iliac bone graft, good fusion, good fusion of the interlaminar bone graft in the posterior column, internal fixation in place, and improvement of cervical kyphosis. **B**, 3D CT reconstruction.

combined anterior and posterior approach may instead be employed[23]. Both the anterior and posterior approaches to internal fixation seek to establish a stable internal environment postoperatively, allowing for the local control of the tubercular lesion while allowing for bony fusion such that the lesion and associated tissue damage can be satisfactorily repaired. However, both of these approaches are subject to certain limitations. The anterior approach is associated with complex anatomical considerations that contribute to higher rates of surgical trauma and associated complications, increasing the odds of surgical site infection and prolonging the surgical procedure. This procedure also exhibits limited orthopedic efficacy for patients with a posterior convexity deformity, and associated bone graft weakness can impair bone graft fusion. Incomplete wound drainage may also contribute to surgical site infection and surgical failure.

In a retrospective analysis[24] of 60 spinal tuberculosis patients, a combined approach was found to require more operative time than the anterior approach, with the latter being well-suited to cases of severe vertebral collapse necessitating the reconstruction of vertebral body height. One meta-analysis[25] assessing 2,345 adults with spinal tuberculosis treated using a range of surgical strategies, showed that the posterior approach exhibited advantages over the anterior approach with respect to bleeding, operative duration, orthopedic angle, and complication rates; whereas the combined approach outperformed the anterior approach with respect to the length of stay and complication rate. In cases where patients exhibit extensive anterior disruption such that treatment *via* the posterior approach alone may result in poor correction, unsatisfactory decompression, or secondary damage resulting from insufficient anterior support, the combined approach should thus be considered. For the present case, a Jackson table was used to aid the execution of surgery performed *via* a combined anterior-posterior approach, thus avoiding damage resulting from cervical spine instability owing to a long operative duration or intraoperative turning. Jackson table use can significantly lower pre- and postoperative differences in hemoglobin levels by decreasing intraoperative blood loss and reducing the overall operative duration.

This may be because when the patient is in the prone position, their abdomen is fully suspended and their lower limbs are positioned below the cardiac level, thereby lowering intra-abdominal and vena cava pressure and mitigating the risk of venous obstruction or excessive paravertebral venous reflux[19,26,27]. These factors contribute to the decrease in intraoperative blood loss observed for such treatment.

Management of Cervical Tuberculosis

Cervical tuberculosis is much less common than cases affecting the thoracolumbar spine, comprising just 3-5% of all spinal tuberculosis cases[6]. Recent increases in spinal tuberculosis incidence, however, have driven a rising number of cases of cervical tuberculosis seen in the clinic. Affected patients generally exhibit nodular lesions involving the anterior and middle columns of the cervical spine, resulting in damage to and destruction of the vertebrae and adjacent discs, contributing to anterior and middle column instability while leaving the posterior column largely intact. Disease progression leads to the gradual collapse of the affected vertebrae and the narrowing or loss of the intervertebral space. As the cervical spine is subject to high levels of mobility and loading forces, symptoms in affected patients often develop rapidly. Abscesses, vertebral destruction, and granulation tissue can all contribute to spinal deformities and the compression of the spinal cord such that patients may have trouble breathing or swallowing[1,28,29]. While standardized anti-tuberculosis treatment can cure many patients[30], residual kyphosis can nonetheless cause secondary spinal cord compression such that the height of the diseased vertebrae should be restored, kyphosis should be corrected, and cervical spine stability should be re-established in treated patients. When tuberculosis-related abscesses enter the spinal canal, they can compress the cervical spine and cause spinal cord injury, potentially leading to paralysis. Surgical treatment for patients with cervical tuberculosis primarily aims to remove the associated lesion, alleviate nerve compression, correct kyphosis, and restore cervical stability[1]. Surgery is essential for individuals with vertebral lesions, refractory disease, severe kyphosis, neurological deficits, and deterioration or failure to improve[1]. Moorthy et al[31] determined that spinal tuberculosis with spinal cord or root compression could be safely treated through central vertebral body resection with bone grafting without internal fixation, and with bed rest for 4-6 weeks. Raja et al[32] employed ACDF with iliac bone grafting and titanium plate internal fixation to successfully achieve anterior cervical decompression, treating tuberculous spondylolisthesis successfully without any deaths or complications. In cases with kyphosis greater than 30 degrees or the involvement of multiple adjacent segments, a combined anterior-posterior approach is recommended for peri-annular fusion[33-36]. A systematic review[37] of 456 cases demonstrated the importance of anti-tuberculosis treatment for all cervical tuberculosis patients, even if they undergo surgery. Decompression and internal fixation can provide better cervical stability to individuals affected by neurological deficits. Anterior surgical internal fixation can also be effectively employed to protect bone grafts and improve anterior fusion[38]. Anterior internal fixation achieved using titanium cages, plates, and screws can improve associated stability and thereby better repair deformities. However, this approach can cause complications including the displacement of the internal fixation or damage to anterior vertebral vessels or internal organs[39]. In this case, the patient's spine was damaged by internal fixation. Given the severe infection and invasion of the posterior column structures in this patient, the application of anterior internal fixation was considered to be a possible cause of osteoarthritis contributing to a higher risk of implant non-union, though posterior pedicle screw protection was sufficient to protect against postoperative spinal instability.

Postoperative anti-tuberculosis drug treatment can more effectively access the target lesion while promoting effective recovery[40]. The currently available antitubercular drugs on the market can access bone, caseous tissue, pus, and granulation tissue at concentrations exceeding the minimum inhibitory concentration values such that they can reliably promote lesion healing[11]. In this patient, cervical spine CT imaging performed at 3 months after surgery did not exhibit any evidence of bone graft displacement together with good bone graft fusion.

Conclusions

As demonstrated through this case, the removal of the target lesion and the reconstruction of the vertebral body in patients with cervical tu-

berculosis and kyphosis can effectively improve neurological function, alleviate neck pain, and correct associated kyphosis. However, there are some limitations to the utilized anterior-posterior approach. The use of two positions and two incisions in this case prolonged the operative duration, increased intraoperative bleeding, and contributed to higher levels of trauma and associated risk for the treated patients. Patients in poor general health may also be unable to tolerate this combined treatment approach. Focal debridement serves as an adjunct to the treatment of spinal tuberculosis, with surgery as just one component of the treatment of this condition. The surgical treatment of spinal tuberculosis should be based on systemic antituberculosis chemotherapy, and the optimal surgical strategy should be optimized in accordance with individual patient-specific characteristics.

Conflict of Interest
The Authors declare that they have no conflict of interests.

Ethics Approval
The Ethics Committee of China-Japan Union Hospital approved this study (20221020031).

Informed Consent
The patient provided written informed consent for the publication of this case report.

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Each author participated sufficiently in the work to take public responsibility for the content.

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Authors' Contributions
JC and PL conceived the review; JHM, DS and ZLW acquired data; JC, FHT and LZG participated in the process of writing the manuscript; PL reviewing the manuscript. All authors contributed to the conception and revision of the manuscript and approved its submission.

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Availability of Data and Materials
The data used to support the findings of this study are available from the corresponding author upon request.

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