

Single-stage transverse process resection, debridement, interbody fusion, and internal fixation for the treatment of lumbar spinal tuberculosis via posterior-only approach

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Abstract

Background: Spinal tuberculosis (TB) is a less frequently reported infectious spinal pathology. There are controversies on the surgical intervention of lumbar spinal TB with neurological damage and paraspinal abscess. This retrospective study was conducted to determine the effectiveness of single-stage transverse process resection, debridement, interbody fusion, and internal fixation for the treatment of lumbar spinal TB via posterior-only approach.

Methods: From January 2015 to June 2018, 32 consecutive patients (19 males and 13 females) with lumbar spinal TB complicated with neurological damage and paraspinal abscess treated by single-stage transverse process resection, debridement, interbody fusion, and internal fixation were enrolled. Medical records, imaging studies, laboratory data were collected and summarized. Anti-TB drugs with HREZ chemotherapy regimen was administered to all patients. Surgical outcomes were evaluated based on visual analogue scale (VAS), American Spinal injury Association (ASIA) classification. The changes in C-reactive protein (CRP) levels, erythrocyte sedimentation rate (ESR), clinical symptoms and complications were investigated. Graft fusion was evaluated using Bridwell grading criteria.

Results: The mean follow-up period was 20.41 ± 5.19 months. No implant failures were observed in any patients. Wound infection was observed in one patient. Solid bony fusion was achieved in 9 cases at 6 months and 23 cases at 12 months after operation. Kyphosis angle was $11.28 \pm 4.01^\circ$ at final follow-up. The levels of ESR and CRP were returned to normal at the final follow-up. VAS scores were significantly improved ($P < 0.05$). According to ASIA classification, 6 cases were classified as with grade D and 26 cases were classified as grade E at the last follow-up.

Conclusion: Single-stage transverse process resection, debridement, interbody fusion, and internal fixation via posterior-only approach is a feasible and effective surgical therapy for lumbar spinal TB with neurological damage and paraspinal abscess.

Background

Tuberculosis (TB), a potentially serious infectious disease, remains a severe impact on human health, particularly in developing countries [1, 2]. Skeletal TB is 10% of the extrapulmonary TB, of which spinal TB accounts for approximately 50% [3, 4]. Spinal TB, the most common pattern of extrapulmonary TB, is a severe spinal disease characterized by spinal cord compression, abscess formation, and kyphotic deformity, frequently causes neurologic deficit and even paraplegia [5–7]. Spinal TB often have evident collapse of vertebra because of TB destruction, and it occurs most commonly in the lumbar region [8, 9].

Although there has been a significant evolution in spinal TB treatment during the past several decades, anti-TB therapy and external immobilization remain the irreplaceable treatment options in most patients of spinal TB [10, 11]. However, cases with neurological dysfunction, spinal instability, abscess formation, kyphotic deformity and failed response to conservative treatment may require surgical intervention [12]. Diverse surgical approaches have been performed for the treatment of spinal TB patients, including an anterior-only, posterior-only or combined anterior-posterior approaches [13]. The posterior-only approach with the instrumentation

system has been proven to be effective for treating various thoracic and lumbar spinal disorders with the strategy of more conservative and less invasive in recent years [14, 15].

Despite the fact that posterior-only approach has been widely used in spinal TB treatment, there is no report on the feasibility and safety of single-stage transverse process resection, debridement, interbody fusion, and internal fixation for the treatment of lumbar spinal TB. The objectives of our study are: 1) to present the indications of single-stage transverse process resection, debridement, interbody fusion and pedicle screw fixation in the treatment of lumbar spinal TB via posterior-only approach; 2) to evaluate the outcomes of single-stage transverse process resection, debridement, interbody fusion and pedicle screw fixation in the treatment of lumbar spinal TB via posterior-only approach.

Methods

Inclusion and exclusion and general information

Written informed consent was obtained from all patients, and this study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University. From January 2015 to June 2018, 32 patients with lumbar spinal TB complicated with neurological damage and paraspinal abscess received surgery by the same surgical team. Among these patients, 19 of them were males and the other 13 were females, aging from 16 to 65 years old with an average of 41.21 years old. Surgery was considered in the presence of the following indications: (1) patients with lumbar TB were clearly diagnosed, and the lesions were located in L1-5; (2) progressive neurological deficit and paraspinal abscess that were unresponsive to chemotherapy for 2 months; (3) patients with paraspinal abscess without infusing into the presacral and iliac fossa; (4) with moderate and severe kyphosis (kyphosis angle $< 60^\circ$); (5) multilevel vertebrae were involved (less than 3 levels) with significant vertebra destruction or collapse (\leq the intact vertebral height). Patients that presented with the following conditions were excluded: (1) complicated with open pulmonary TB and acute miliary TB; (2) cervicothoracic, thoracic and lumbosacral spinal TB; (3) multilevel lesions that require anterior long-segment bone fusion; (4) patients with severe cardiopulmonary diseases and could not tolerate surgery. Preoperative X-ray, CT and MRI showed different degrees of bone destruction, and the lesions were located in L1-3 (6 cases), L2-3 (12 cases), L3-4 (10 cases), and L4-5 (4 cases). All the patients had different degrees of low back pain as the first symptoms, of which 18 cases were accompanied with TB poisoning symptoms such as low fever, night sweats and fatigue, and 10 cases had difficulty walking due to pain. Of the 32 patients, 22 cases were complicated with paraspinal abscess, 22 cases had symptoms of spinal cord injury. According to the American Spinal Injury Association (ASIA) classification, 4 cases were classified as with grade C and 18 cases were classified as grade D. Twenty-one cases had different degrees of kyphosis with a preoperative Cobb angle of $28.97^\circ \pm 8.28^\circ$, (range, $12^\circ - 46^\circ$). The preoperative Visual analogue scale (VAS) score was 5.81 ± 1.03 , (range, 4–8). The erythrocyte sedimentation rate (ESR) was 44.44 ± 10.24 mm/h, and the C-reactive protein (CRP) was 35.75 ± 22.19 mg/L.

Preoperative procedure

A chemotherapy regimen was administered to all patients. Anti-TB drugs with HREZ chemotherapy regimen that consisted of isoniazid (300 mg/day), rifampicin (300 mg/day), ethambutol (500 mg/day), and

pyrazinamide (750 mg/day) was administered 2–4 weeks before operation. The ESR, CRP, and temperature needed to decrease significantly before the surgical intervention was performed.

Operative technique

After administration of general anesthesia with endotracheal intubation, all the patients were placed in a prone position on the spinal surgeon table. The paraspinal muscles were stripped from the spinous process to the outer margin of the articular processes after a standard dorsal midline incision was performed. In general, the pedicle screws were inserted into the two superior and two inferior healthy vertebrae. The correct position of screws was evaluated with the assistance of intraoperative C-arm fluoroscopy. The internal fixation can also be adjusted according to the vertebral lesions. A pre-bent long rod was installed and tightened on the side with less abscess and mild lesions to ensure the spinal stability and avoid spinal cord injury during decompression and debridement. Debridement and bone grafting were performed on the side where the paraspinal abscess, lesions, and vertebral collapse were relatively severe. The transverse process of vertebral body on the lesion space was exposed and removed (Fig. 1). Furthermore, the articular processes above intervertebral foramen were removed to expose the nerve roots. The psoas major muscle was exposed carefully, and the abscesses were debrided. After routine exposure, the caseous necrosis and granulation tissues, necrotic discs and infected endplates, sequestered bone within the vertebral body and collapsed vertebrae were debrided with curettes as thoroughly as possible via paravertebral space. A large amount of normal saline was utilized for surgical area irrigation to clear the residual tuberculous tissue following completed hemostasis. Afterwards, a pre-bent rod was temporarily installed on the other side and the rod installed previously was removed. The same operation was performed on the opposite side of the lesions if necessary. The suitable autologous iliac bone was mixed with 0.2 g streptomycin and the posterolateral fusion using autograft was performed. The compression and stretch of the internal fixation instruments were used to rectify the kyphosis deformity cautiously and slowly. Sequentially, the rods were tightened under pressure and checked the nerve root. Thereafter, 1.0 g streptomycin was administered accurately into the operative area. The drainage tube with negative pressure was routinely placed in the operative region before the incision sutures performed finally. All the resected specimens were sent for histopathologic examination.

Postoperative care

Vital signs, motor, and sensory functions of both lower limbs were observed after the operation. When the drainage volume was less than 100 ml in 24 hours, the drainage tube could be pulled out. One day after the drainage tube was removed, the X-ray of the anterior and lateral position of the lumbar vertebrae were reexamined. Ambulation was allowed gradually with the protection of custom-made thoracolumbar brace. The anti-TB therapy was continued for 12 months after operation according to the liver function.

Follow-up index and statistical analysis

For all cases, the following indexes were recorded preoperatively, postoperatively, six months of post operation, and during follow-up: (1) Cobb angle; (2) AISA; (3) VAS; (4) ESR; (5) CRP; and (6) liver function. Cobb angle, VAS, ESR and CRP were statistically analyzed by paired *t*-test preoperatively, postoperatively, and during follow-up; while ASIA was statistically analyzed by Wilcoxon signed tank test preoperatively, postoperatively, and during follow-up. Statistical analyses were performed using SPSS 20.0 software (SPSS, Inc., Chicago, IL, USA). $P < 0.05$ were considered significant for all analyses.

Results

All the 32 patients completed the operation successfully. No nerve and macrovascular injury were observed during the operation. There was no cerebrospinal fluid leakage and aggravation of neurological function after operation. The operation time was 191.91 ± 28.85 min (range 150–260 min), blood loss was 527.93 ± 156.53 ml (range 260–950 ml) (Table 1). Follow-up duration of all the 32 patients was 20.41 ± 5.19 months (range 12–33 months).

Table.1 Basic information of all patients

| Male/Female | Age (years) | Follow-up time (months) | Operation time (minutes) | Blood loss (ml) | Bone fusion time (months) |
|-------------|-------------------|-------------------------|--------------------------|---------------------|---------------------------|
| 19/13 | 41.21 ± 12.93 | 20.41 ± 5.19 | 191.91 ± 28.85 | 527.93 ± 156.53 | 9.00 ± 2.29 |

VAS of pain was 5.81 ± 1.03 preoperatively, which dropped to 3.62 ± 1.13 postoperatively and 1.53 ± 0.59 during the final follow-up. All patients had no recurrence of TB, and all patients had pain relief. Kyphosis angle was $28.97^\circ \pm 8.28^\circ$, preoperatively; which significantly decreased to $11.03^\circ \pm 3.76^\circ$, 3 days after operation ($P < 0.05$). Kyphosis angle was $11.28 \pm 4.01^\circ$ at final follow-up with a loss of correction of only $0.25 \pm 0.12^\circ$. This continued to significantly improve compared to preoperative measurements ($P < 0.05$).

Neurologic deficits in all patients improved at the final follow-up examination. Results were evaluated by ASIA classification during the final follow-up, 6 cases were classified as with grade D and 26 cases were classified as grade E (Table 2). Statistical analysis revealed that there was a significant difference between pre-operation and the final follow-up ($P < 0.05$). Six patients revealed incomplete neurological function attributed to delayed diagnosis. Intervertebral bone graft and intertransverse fusions were performed in all patients. Lateral X-ray or CT was used to assess the fusion and formation of the bone bridge according to the criteria of Lee et al [16]. All patients achieved bone fusion within 5.3 ± 2.8 months after surgery (Fig. 2). The bone fusion was performed in 9 cases at 6 months and 23 cases at 12 months after operation. Average pre-treatment for ESR and CRP was 44.44 ± 10.24 mm/h and 35.75 ± 22.19 mg/L, respectively; which returned to 24.09 ± 6.03 mm/h and 10.59 ± 4.13 mg/L postoperatively, and 9.47 ± 3.16 mm/h and 5.13 ± 2.83 mg/L at the time of the final follow-up. The difference in ESR and CRP between the preoperative period, postoperative period, and during final follow-up was significant ($P < 0.05$).

Table.2 Clinical details of surgery

| Schedule | Classification of neurological function by ASIA | | | VAS | Kyphosis angle (°) | ESR mm/h | CRP mg/L |
|-----------------|---|----|----|-------------|--------------------|---------------|---------------|
| | C | D | E | | | | |
| Preoperative | 4 | 18 | 10 | 5.81 ± 1.03 | 28.97° ± 8.28° | 44.44 ± 10.24 | 35.75 ± 22.19 |
| Postoperative | 2 | 15 | 15 | 3.62 ± 1.13 | 11.03° ± 3.76° | 24.09 ± 6.03 | 10.59 ± 4.13 |
| Final follow up | 0 | 6 | 26 | 1.53 ± 0.59 | 11.28° ± 4.01° | 9.47 ± 3.16 | 5.13 ± 2.83 |

Scores were demonstrated as Mean ± Standard deviation

ASIA the American spinal injury association score system, VAS visual analogue scale, ESR erythrocyte sedimentation rate, CRP C-reactive protein

In 31 patients, the incision healed in one stage, and the bone graft in the lesion space achieved bony fusion. One patient recurred on the 40th day after the operation, the incision had chronic sinus formation, and the cause of recurrence was anti-TB drug resistance. Complete recovery was achieved after adjusting the anti-TB therapy and the reoperation of debridement. No failure of internal fixation was found in 32 patients during the follow-up period.

Discussion

Our study shows that single-stage transverse process resection, debridement, interbody fusion and pedicle screw fixation via posterior-only approach is an effective and feasible approach for the treatment of lumbar spinal TB with kyphosis deformity and neurological deficits. However, standard anti-TB therapy, strict bed rest, and supportive therapy remain the fundamental approaches for treating spinal TB. Surgical intervention is only recommended for lumbar spinal TB patients with abscess formation, spinal cord compression, significant kyphosis deformity, and neurological dysfunction.

Spinal TB accounts for almost half of the bone and joint TB, mainly affecting the anterior and middle column of the spine and leading to vertebral bone defects, collapse, compression, and kyphosis deformity [17]. The anterior-only approach is preferred for decompression and debridement in spinal TB as it allows direct access to the lesion site, complete debridement, sufficient decompression, and reduces muscle trauma [18]. However, the high frequency of complications such as pseudarthrosis, ineffective correction of kyphosis and maintenance of the correction, unsatisfactory neurological function, and vascular injuries overwhelm its advantages [19]. Many researchers reported that patients treated by the anterior-only approach experience more significant blood loss, longer duration of the operation, and the hospitalization period than that of the posterior-only approach [20]. Combined anterior and posterior surgery has become popular due to its beneficial clinical outcomes [21]. However, when poor conditions complicate the aged, it would be difficult to tide over the serious trauma such as more significant loss of blood, longer operation time, and approach-related complications [22].

Furthermore, no literature reports in the surgical management of lumbar spinal TB by single-stage transverse process resection, debridement, interbody fusion, and internal fixation via a posterior-only approach.

Controversies on the strategy of a posterior-only approach in treating lumbar spinal TB mainly concentrated in whether surgeons can thoroughly perform debridement and anterior decompression in such a limited visual field, whether it would achieve the anterior bony fusion, and whether it would maintain the spinal stability [23, 24]. A number of advantages to the posterior-only approach were highlighted: reduced bleeding, shorter operation and hospitalization durations, released the nerve compression, corrected kyphosis deformity, regained spinal stability, and improved the quality of life of these patients [25]. These results reflect those of Abulizi *et al.* who also found that single-stage transforaminal decompression, debridement, interbody fusion, and posterior instrumentation is an effective and safe surgical for the treatment of spinal infection [14]. Additionally, as far as the patients with less involved spinal TB for the anterior column that is mainly affected by TB achieving spontaneous fusion are concerned, the posterior-only approach may be a better strategy [26, 27].

Although previous studies have demonstrated that the translaminar debridement and transforaminal bone graft are feasible with minimal damage to the posterior column, the operation still results in a certain degree of damage to the lamina or the superior and inferior articular processes [28]. Therefore, some investigators have several concerns: (1) if the lesion of spinal TB involves the anterior and middle column, surgery via posterior approach may cause the metastasis of lesion into the posterior column, even retrograde infection caused by spinal dura rupture; (2) the structure destruction of the lamina and articular processes by the posterior surgery results in the disruption of the three-column spine may aggravate the instability of the diseased vertebrae. In this study, the authors began to explore whether the debridement, intervertebral bone grafting, internal fixation, and reconstruction of spinal stability can be achieved without destroying the lamina and the superior and inferior articular processes.

The single-stage posterior approach proposed by the authors is based on posterior en-bloc resection of spinal tumor and oblique lumbar interbody fusion (OLIF) technique. The feasibility of this approach need to be highlighted: (1) the surgery access is constructed by posterior en-bloc block resection to remove the transverse processes of the superior vertebral body and a small part of the lamina above the intervertebral foramen to expose the nerve root of the involved segment. This strategy not only meets the requirement of not destroying the lamina structure and superior and inferior articular processes but also achieve the debridement; (2) the operation area is mainly in the posterolateral lumbar spine. The long-segment bone graft from posterior to anterior with intervertebral foramen decompression and transforaminal lumbar interbody fusion (TLIF) cannot be achieved [29]. Additionally, this method of long-segment bone graft with interlaminar decompression and posterior lumbar interbody fusion (PLIF) approach is infeasible [30]. Therefore, OLIF fusion technique can only be used for interbody fusion. According to these two ideas, the problems of lesion debridement, bone grafting in the anterior and middle column can be treated poster laterally. Combine the absolute advantages of posterior internal fixation and correction of the deformity, we believe that this surgical approach can be used as a surgical choice for lumbar spinal TB.

This study holds several limitations. The potential risk of TB spreading to the healthy posterior regions is concerned in this surgical therapy, as posterior debridement can result in diffusion of infection and fistulas. Fortunately, this complication was not found in our research. Our study included 32 patients, future study

should include multicentre studies and larger sample size to confirm our results. Furthermore, some patients with missing data or lost to follow-up were excluded from the analysis. The future management of these patients should be enhanced with further long-term follow-up data to closely monitor the effect of this surgical option.

Conclusion

The present study demonstrated that single-stage transverse process resection, debridement, interbody fusion, and internal fixation via posterior-only approach could be a feasible and effective treatment therapy for most patients with lumbar spinal TB and associated with great neurologic recovery, correction of kyphosis deformity.

Abbreviations

TB: Tuberculosis; ASIA: The American Spinal Injury Association score system; VAS: Visual analogue scale; ESR: Erythrocyte sedimentation rate; CRP: C-reactive protein; OLIF: oblique lumbar interbody fusion; TLIF: transforaminal lumbar interbody fusion; PLIF: posterior lumbar interbody fusion.

Declarations

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Authors' contributions

ZWL, SWZ: conception and design, analysis and interpretation, drafting. MH: design, analysis and interpretation. DMZ: analysis and interpretation. XMY, HH: design and critical revision. HC: conception and design, analysis and operation. All authors revised and approved the final submitted manuscript.

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Availability of data and materials

The datasets supporting the conclusions of this article are included within the article.

Ethics approval and consent to participate

The study was approved by the ethical committee of the First Affiliated Hospital of Xinjiang Medical University, China. Patients provided written informed consent for the publication of their individual clinical details. The procedures followed were in accordance with the ethical standards of Helsinki Declaration.

Consent for publication

Written informed consent for publication of their clinical images, laboratory data, and some personal details, including gender, age were obtained from the patients.

Competing interests

The authors declare that they have no competing interests.

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Figures

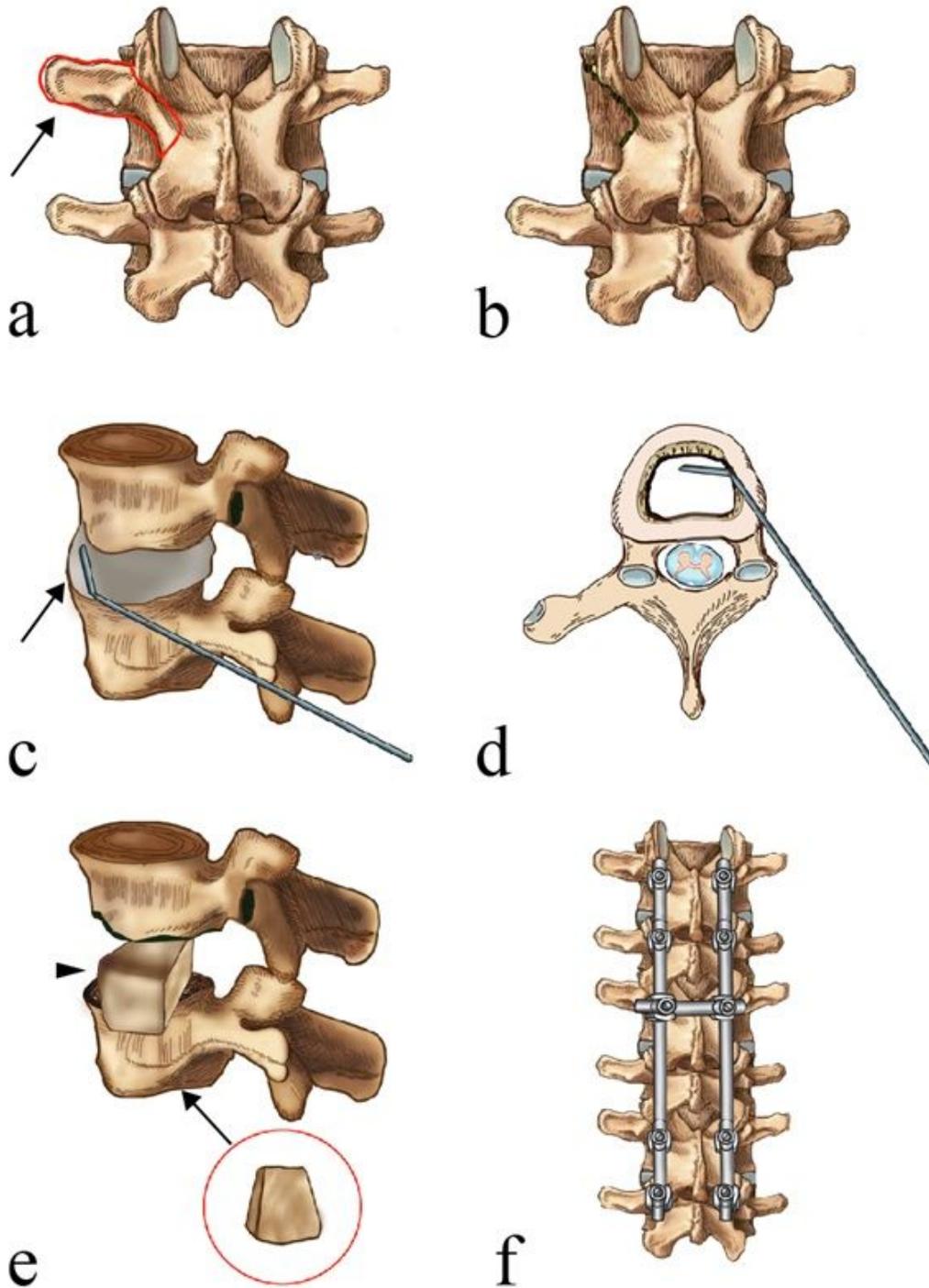


Figure 1

Detailed schematic diagram of surgical operation of lumbar tuberculosis (L1/2). (a) Expose bilateral lamina, articular processes and, left transverse process of L1; (b) Resect the left transverse process of L2 and part of the lamina above the intervertebral foramen of L1/2; (c) Debride the lesions with a long curette (abscess, tuberculosis granulation tissue, caseous necrotic tissue, dead bone, necrotic intervertebral disc); (d) The cross-sectional view of L1/2 intervertebral disc space after debridement; (e) Harvest autogenous iliac bone and make

it into a wedge-shaped bone, implant the wedge-shaped bone into the defected area. (f) Fix the pedicle screws on both sides to precontoured rods under compression.

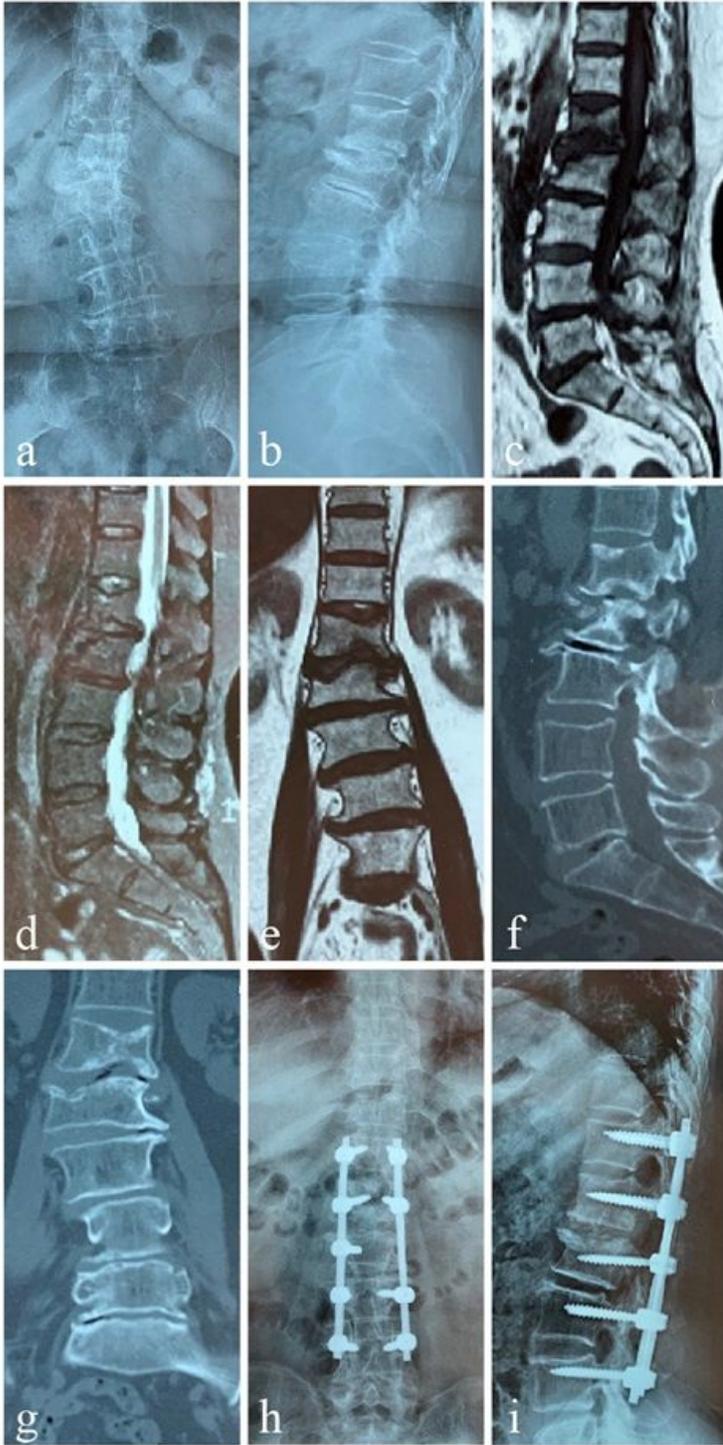


Figure 2

Single-stage posterior transverse process resection, debridement, interbody fusion, and internal fixation of a 60-year-old female with L1/2 lesions. (a, b) Preoperative showed L1/2 presented with bone destruction, vertebral collapse, and disc space narrowing; (c-e) Preoperative T1WI and T2WI MRI images in sagittal, and T1WI MRI image in coronal indicated L1/2 vertebral bodies' destruction and spinal cord severely compressed; (f, g) Preoperative coronal and sagittal CT-scan showed bone destruction, vertebral collapse, and disc space

narrowing; (h, i) Postoperative anteroposterior and lateral X-ray indicated the satisfactory bone fusion without presence of complications related to instrumentation at the final follow-up.