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SURGERY

Therapeutic Efficacy of Transpedicular Impaction Bone Grafting with Long Segmental Posterior Instrumentation in Stage III Kümmell Disease

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Study Design. A retrospective review of clinical and radiological parameters.

Objective. To evaluate the therapeutic efficacy of transpedicular impaction bone grafting (TIBG) with long segmental posterior instrumentation for the treatment of stage III Kümmell disease.

Summary of Background Data. The optimal treatment for stage III Kümmell disease remains controversial and unclear. Theoretically, transpedicular bone grafting can reconstruct anterior column support and reduce the failure of internal fixation, which is an intuitive method for the treatment of Kümmell disease. However, the use of this technique has rarely been reported for the treatment of this disease. This study reported the clinical and radiological results of TIBG with long segmental posterior instrumentation for the treatment of stage III Kümmell disease.

Methods. Between August 2011 and December 2017, we retrospectively analyzed 24 patients with stage III Kümmell disease who underwent TIBG with long segmental posterior instrumentation. Anterior vertebral heights, kyphotic Cobb angle, visual analog scale (VAS), Oswestry disability index (ODI), and American Spinal Injury Association (ASIA) impairment scale were used to evaluate the effects of surgery.

Results. The mean time to follow-up was 38.1 ± 10.2 months. The average operative duration was 136 ± 16.5 minutes, and the average intraoperative blood loss was 293 ± 41.3 mL. The VAS, ODI, anterior vertebral heights, and kyphotic Cobb angles were improved significantly at 1 week after surgery compared the preoperative examinations, and were well maintained at the final follow-up evaluation. Fourteen patients (58%) had mild neurological impairments before surgery, with neurological function returning to normal at the final follow-up evaluation. There was no instance of instrumentation failure.

Conclusion. TIBG combined with long segmental posterior instrumentation is a safe and effective surgical option for stage III Kümmell disease.

Key words: Kümmell disease, long segmental posterior instrumentation, posterior approach, transpedicular impaction bone grafting.

Level of Evidence: 4

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Kümmell disease, which is also known as delayed posttraumatic vertebral collapse, was first described by German surgeon Hermann Kümmell in 1895,[1] and primarily occurs in middle-aged and elderly patients with osteoporosis.[2] Patients develop delayed vertebral collapse and thoracolumbar kyphosis months to years after minor spinal trauma. The clinical symptoms of Kümmell disease include intractable back pain, limited daily activity, and even neurological dysfunction, which severely reduces the patient's independence and quality of life.[2,3] The disease is different from common osteoporotic vertebral compression fractures. Due to the presence of necrotic bone in the injured vertebrae of Kümmell disease patients, conservative treatment is usually ineffective and requires surgical intervention.[3,4]

Percutaneous vertebroplasty (VP) or kyphoplasty (KP) has been widely used to treat Kümmell disease and provides good results in patients with persistent pain and an intact posterior wall (stage I or II disease).[4–6] However, for patients with posterior cortex breakage or complications with neurologic deficits (*i.e.*, stage III disease), VP and KP are inappropriate and open surgery is required.[7–9] In previous reports, various surgical techniques have been proposed for the management of stage III Kümmell disease, including anterior decompression and instrumentation,[8] posterior

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decompression with pedicle subtraction osteotomy (PSO),[9] and combined approaches (anterior and posterior decompression).[10] However, there are several distinct disadvantages with those methods, including relatively large surgical trauma, long surgery times, and they are technically demanding.[3,11–13] At present, there is no consensus regarding optimal disease treatment.[3,4]

As vertebral ischemic osteonecrosis has been widely accepted as the pathophysiological mechanism of Kümmell disease, and intravertebral bone grafting is considered to be an intuitive therapeutic approach.[14] However, there are few studies on the treatment of Kümmell disease using this technology, and the results were inconsistent.[14,15]

In this study, transpedicular impaction bone grafting (TIBG) was performed to restore the height of the vertebral body and correct kyphotic deformities, with long segmental posterior instrumentation (LSPI) to stabilize the spinal column. The purpose of this study was to investigate the efficacy of TIBG with LSPI in treating stage III Kümmell disease.

MATERIALS AND METHODS

Patient Population

This study was approved by our Institutional Review Board. Between August 2011 and December 2017, 24 Kümmell disease patients with posterior wall collapse, with or without neurological impairment (stage III) underwent TIBG with LSPI. All patients fulfilled the diagnostic criteria for Stage III Kümmell disease: (1) computed tomography (CT) scan showed the vacuum cleft with posterior cortical breakage in the vertebral body; (2) magnetic resonance imaging (MRI) showed a low signal in T1-weighted images and a high signal with a fluid signal in T2-weighted images in the cleft region; and (3) dynamic mobility in the vertebral body was noted on radiographs.[4] The inclusion criteria included the following: single-level Kümmell disease; no relief in pain after conservative treatment for 1 month; less than 1/3 spinal canal occupation due to retropulsed bony fragments; and the diameter of the pedicle of the injured vertebra was more than 5 mm. The exclusion criteria included pathological fracture and suspected underlying malignant disease.

Patient characteristics are depicted in Table 1. There were five males and 19 females included in the study, with an average age of 69.5 ± 7.0 years. The disease course ranged from 2 to 19 months, with an average of 4.9 ± 3.5 months. All patients had a history of minor back trauma, and the affected level was T11 in two cases, T12 in 10 cases, L1 in nine cases, and L2 in three cases. The mean T score of the bone mineral density was -3.3 ± 0.6. The transplantation materials used in the surgery included a mixture of allogeneic bone particles and bone marrow concentrate.

TABLE 1. Summary of Clinical Characteristics Obtained From 24 Patients With Kümmell Disease

Case	Age/Sex	BMD	Delay in Presentation (mo)	Hospitalization time (d)	FU (mo)	Vertebral Level	Instrumented Level	Cement-Augmented Screws
1	72/M	−3.2	5	14	64	T12	T10–L2	None
2	64/F	−4.2	2	10	38	T11	T8–L1	Y
3	62/F	−2.9	4	12	26	T12	T10–L2	None
4	66/F	−3.4	3	10	33	T11	T9–L1	None
5	66/F	−2.7	2	11	24	T12	T10–L2	None
6	73/F	−3.2	4	13	34	L1	T11–L3	None
7	70/F	−2.3	3	12	29	T12	T10–L2	None
8	74/F	−3.6	7	11	38	L1	T11–L3	None
9	70/F	−2.6	19	9	27	L2	T12–L4	None
10	74/F	−4.4	3	16	45	T12	T10–L2	Y
11	59/F	−3.3	6	13	29	L1	T11–L3	None
12	62/F	−2.8	2	9	30	L1	T11–L3	None
13	77/F	−4.3	5	10	39	T12	T10–L2	Y
14	66/F	−1.9	3	7	55	L1	T11–L3	None
15	78/M	−3.5	6	13	38	L1	T11–L3	None
16	61/F	−2.6	4	8	27	L2	T12–L4	None
17	71/M	−3.1	9	12	36	T12	T10–L2	None
18	84/M	−4.0	6	16	31	L1	T11–L3	Y
19	64/F	−3.0	3	10	36	L2	T12–L4	None
20	58/F	−3.5	7	12	51	T12	T10–L2	None
21	75/F	−4.0	4	9	42	L1	T11–L3	Y
22	67/F	−2.7	2	7	48	L1	T11–L3	None
23	82/M	−3.7	6	11	44	T12	T10–L2	Y
24	72/F	−3.3	3	13	50	T12	T10–L2	None

BMD indicates bone mineral density (DEXA); FU, follow-up time.

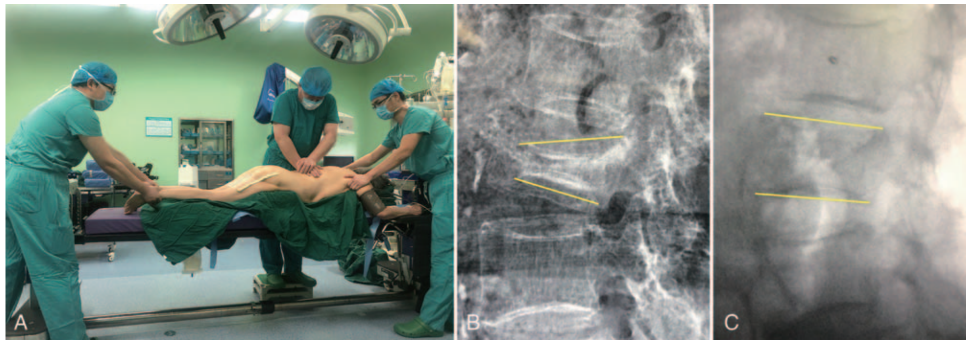

Figure 1. **A**, The picture shows manual reduction before surgery. **B**, The preoperative radiographs show the collapsed vertebral body with reductions in the height of the anterior vertebral body. **C**, C-arm fluoroscopy showing the restoration of the vertebral body after manual reduction.

Surgical Procedures

Surgery was performed under general anesthesia. All patients were placed in a prone position on an open Jackson table. The manual reduction was applied first, and the process was performed under intraoperative neurophysiologic monitoring to prevent the occurrence of neurological injury. During manual reduction, one assistant held the patient's shoulder, one assistant held the patient's leg and gave proper traction, and the surgeon gently compressed the fractured vertebra (Figure 1A). Due to the presence of pseudarthrosis in the injured vertebrae, manual reduction can usually significantly restore the height of the injured vertebral body (Figure 1B, C). A standard posterior midline approach was used to expose the posterior elements of the spine at the predetermined level. The spinous process, and interspinous and supraspinous ligaments were preserved. Pedicle screws were inserted into the vertebrae two levels above and below the injured vertebra. In patients with severe osteoporosis, before the insertion of each screw, approximately 1.5 mL of polymethyl methacrylate (PMMA) was injected under fluoroscopic guidance into the vertebral bodies through a tapping hole, which was then screwed.

Under C-arm fluoroscopy, bilateral pedicle tunnels to the fractured vertebral body were made by an awl. The pedicle tunnels were then expanded using a pedicle screw (5.0 mm in diameter) (Figures 2A and 3A). After the establishment of the bone grafting channel, curettes were inserted into the vertebral body to remove the necrotic cancellous bone and fibrous tissue until only healthy bone tissue remained. The curette was then used to pry in the direction of the upper and lower endplates of the injured vertebrae to increase the distance between the upper and lower endplates (Figure 2B, C). A surgical assistant trimmed the allogeneic bone particles to a size of 3×3 mm and mixed them with the bone marrow concentrate. The mixture was placed in the bone graft funnel and pushed into the fractured vertebral defect. The bone particles were then compacted continuously with

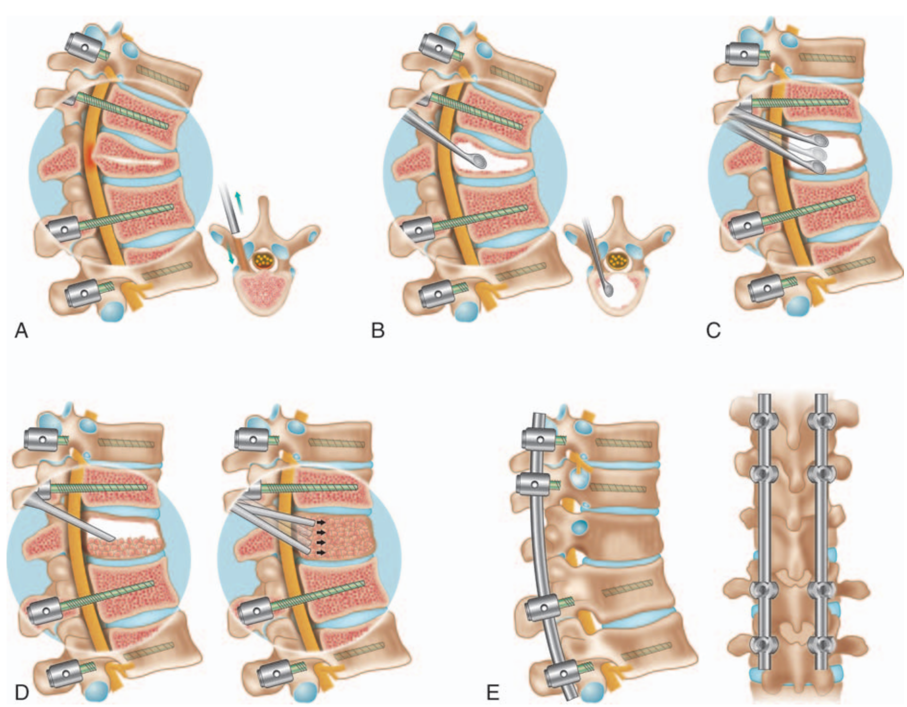

Figure 2. The flow chart shows the procedures of TIBG and LSPI. **A**, Establishment of a bone graft channel via the bilateral pedicles of the affected vertebral. **B**, Removal of necrotic cancellous bone and fibrocartilaginous tissues using a curette. **C**, Further reduction of the injured vertebral endplate. **D**, Transpedicular impacted bone graft. **E**, Posterior fixation using long segmental instruments. LSPI indicates long segmental posterior instrumentation; TIBG, transpedicular impaction bone grafting.

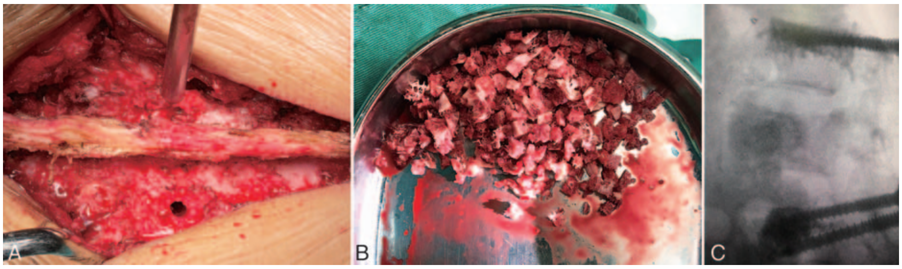

Figure 3. A, Image of the bone graft channel established during surgery. **B**, Bone graft materials used in surgery, including a mixture of allogeneic bone particles and a bone marrow concentrate. **C**, Intraoperative fluoroscopy indicating that the shape of the vertebral body returned to normal following bone grafting.

a mallet and the height of the injured vertebral body gradually returned to the normal level (Figures 2D, E and 3B, C). After attaching the rods to the screws, the wound was closed in layers.

Postoperative Management

All patients were asked to get out of bed 1 to 2 days after surgery and received more than 1 week of rehabilitation exercise in the hospital. All patients received a pharmacological antiosteoporotic treatment after hospital discharge, including a standard daily dose of calcium (800 mg daily, by mouth), alfacalcidol vitamin D supplement (0.25 μg/bid, by mouth), and zoledronic acid (intravenous drip of 5 mg, once per year). Patients were followed up with at regular intervals.

Radiological and Clinical Evaluation

Clinical and radiological data were reviewed before surgery, 1 week after surgery, and at the final follow-up evaluation. Positive and lateral x-ray films were obtained at each follow-up evaluation, and CT scans were used to evaluate the healing of injured vertebrae at the final follow-up evaluation. Bone union of the injured vertebra was defined as obvious bridging trabeculae and bone formation on CT images and lateral films, and there were no signs of vacuum or cleft in the vertebral body.

Using lateral radiographs, the Cobb angle was used to assess kyphosis and was measured as the subtended angle between the upper end plate of the uppermost vertebra and the lower end plate of the lowest vertebra, at the instrumented fusion levels. Anterior vertebral height was measured along the borders of the anterior vertebral body. The VAS score and the ODI score were used to evaluate the patient's improvement in pain and functional outcomes. The American Spinal Injury Association (ASIA) impairment scale was used to assess the neurologic status, preoperatively, and at the final follow-up evaluation. Surgical data, including surgery time, intraoperative blood loss, and complications were documented.

Statistical Analysis

Categorical variables were expressed as counts and percentages. Continuous variables were presented as the mean and standard deviation (SD) for normally-distributed data, or median (25th–75th percentiles) for skewed data, as evaluated by the Kolmogorov–Smirnov test. Repetitive measures of visual analog scale (VAS), Oswestry disability index (ODI), anterior vertebral height, and Cobb angle (the measure of kyphosis) at different time points were evaluated using one-way repeated measures analysis of variance with P-values <0.05. The Linear-by-Linear Association test was performed to evaluate the differences between the pre- and postoperative neurological status of ASIA. Analyses were performed using IBM SPSS Statistics software, v24.0 (IBM SPSS, Chicago, IL), and all tests were two-tailed.

RESULTS

All patients were followed up for at least 2 years, and the average follow-up period was 38.1 ± 10.2 months. The average hospital stay was 11.2 ± 2.4 days, the average operative duration was 136 ± 16.5 minutes, and the average intraoperative blood loss was 293 ± 41.3 mL. Among pedicle instrumentation surgery, bone cement-augmented screws were used in six patients with severe osteoporosis. The fusion levels were T8–L1 in one case, T9–L1 in one case, T10–L2 in 10 cases, T11–L3 in nine cases, and T12–L4 in three cases (Table 1).

Detailed clinical data for the patients in this report are provided in Table 2. The average VAS and ODI scores 1 week after surgery were significantly lower than those before surgery ($P < 0.001$; Table 3). Lasting pain relief and functional improvement were achieved in all cases. At the final follow-up evaluation, the VAS and ODI scores were 2.0 ± 0.8 and 20.5 ± 4.8, respectively, which were significantly lower than those before surgery and 1 week after surgery ($P < 0.001$).

The anterior vertebral height and the Cobb angle were corrected after surgery and maintained during the follow-up period (Table 3; Figure 4A–L). One week after surgery, the anterior vertebral height and the Cobb angle corrections were 9.3 ± 3.6 mm and $18.9 \pm 7.4°$, respectively. During the follow-up period, the loss of vertebral height and kyphosis correction were 2.6 ± 1.3 mm ($P < 0.001$) and $3.1 \pm 1.5°$ ($P < 0.001$), respectively. The affected vertebrae of all patients exhibited substantial bone union, which was confirmed by CT scans at the final follow-up evaluation (Figure 4K and L).

According to the ASIA neurological grading system, 14 patients were preoperatively classified as grade D, and 10

TABLE 2. Summary of Clinical and Radiological Outcomes of 24 Patients

Case	VAS			ODI (%)			Kyphotic Angle (°)			Height (mm)			ASIA	
	Pre	Post	Final	Pre	Post	Final	Pre	Post	Final	Pre	Post	Fin	Pre	Final
1	8	3	2	74.0	46.7	26.7	23	13	19	16	21	17	E	E
2	9	5	3	76.0	53.3	22.2	30	8	10	10	23	21	D	E
3	8	3	2	68.0	44.4	22.0	17	5	8	19	24	22	E	E
4	9	4	2	84.0	48.9	20.0	42	16	20	8	19	19	D	E
5	8	3	2	76.0	40.0	17.8	28	9	11	10	25	25	D	E
6	6	3	1	70.0	37.8	15.6	18	−5	−3	15	22	19	E	E
7	8	4	2	75.6	35.6	20.0	35	13	16	5	16	14	D	E
8	8	3	2	80.0	44.4	20.0	21	7	9	14	21	18	E	E
9	7	3	2	75.6	37.8	22.2	8	−5	−3	18	23	20	E	E
10	8	5	3	74.0	40.0	26.7	44	19	23	7	19	18	D	E
11	7	3	1	68.0	33.3	14.0	13	4	6	16	20	18	E	E
12	7	3	2	72.0	42.2	26.0	34	12	15	13	22	19	D	E
13	7	4	2	77.8	46.7	26.7	23	4	7	10	19	16	D	E
14	9	5	4	82.2	48.9	30.0	51	9	16	5	23	17	D	E
15	6	3	1	66.7	35.6	15.6	30	11	14	9	22	20	D	E
16	8	4	2	76.0	40.0	18.0	−9	−20	−20	19	25	23	E	E
17	7	3	2	80.0	42.2	18.0	38	14	17	8	19	16	D	E
18	5	2	1	60.0	37.8	17.8	16	−1	3	9	18	15	E	E
19	7	3	1	74.0	33.3	14.0	−12	−21	−18	19	26	24	E	E
20	9	3	2	78.0	44.4	16.0	34	15	18	10	20	16	D	E
21	8	5	3	74.0	51.1	28.0	28	5	10	13	22	18	D	E
22	8	4	2	77.8	46.7	22.2	10	0	3	13	19	18	E	E
23	6	3	1	64.4	37.8	15.6	32	10	12	15	23	19	D	E
24	8	4	2	78.0	42.2	16.0	27	6	10	9	23	20	D	E

ASIA indicates American Spinal Injury Association; Final, final follow-up; Height, anterior vertebral height; ODI, Oswestry disability index; Pre, preoperative; Post, postoperative; VAS, visual analog scale.

were classified as grade E. None of whom suffered from new permanent neurological deficits postoperatively. At the final follow-up evaluation, all patients that were preoperative grade D were found to have improved to grade E (*P* for trend <0.001) (Table 4). Two patients experienced delayed wound healing due to superficial infections after surgery, and were successfully treated by antibiotic therapy and frequent dressing changes until hospital discharge. No other obvious surgery-related complications occurred. There were no cases of posterior instrumentation failure, including pedicle screw loosening or breakage during the follow-up period.

DISCUSSION

The optimum surgical procedure for the treatment of stage III Kümmell disease remains controversial.[2–4] Although various fixation methods and body reconstruction techniques have been reported in the literature and have shown a trend conducive to symptom improvement and nerve recovery, most of those procedures were accompanied by large operative traumas or a high incidence of complications.[8,9,11,12,16,17]

In recent years, multiple researchers have attempted one-stage posterior decompression and stabilization combined with VP for the treatment of Kümmell disease. Such researchers believe that the most significant advantage of

TABLE 3. Analysis Prior to and Following Surgery

	VAS	ODI (%)	Kyphotic Angle (°)	Anterior Vertebral Height (mm)
Preoperative	7.5 ± 1.1	74.3 ± 5.7	24.2 ± 15.1	12.1 ± 4.4
1 week post-up	3.5 ± 0.8*	42.1 ± 5.5*	5.3 ± 10.1*	21.4 ± 2.5*
Last follow-up	2.0 ± 0.8*,†	20.5 ± 4.8*,†	8.5 ± 10.8*,†	18.8 ± 2.7*,†
P-value	<0.001	<0.001	<0.001	<0.001

**$P < 0.05$, versus preoperative value.*

†$P < 0.05$, versus 1 week postoperative value.

ODI indicates Oswestry disability index; VAS, visual analogue scale.

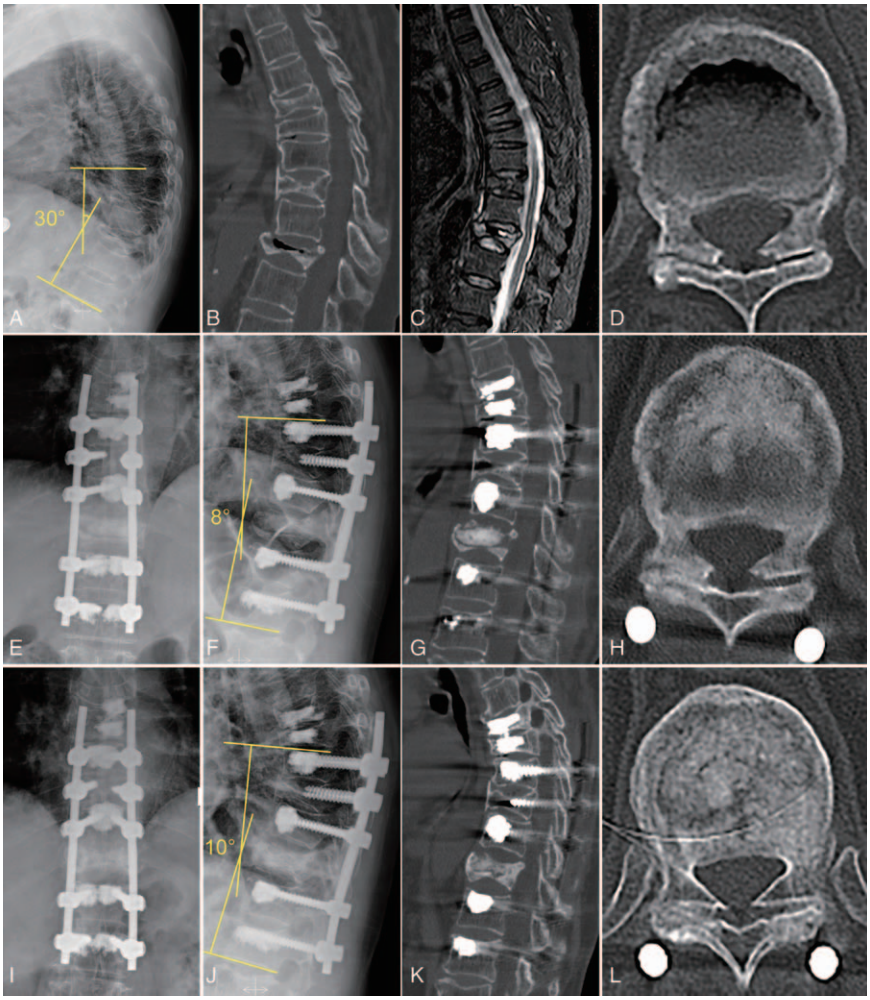

Figure 4. A 64-year-old female patient who underwent TIBG with LSPI for T11 Kümmell disease. **A**, Preoperative imaging showed multiple vertebral compression fractures and kyphotic deformity, with a 30° Cobb angle. **B**, **D**, Preoperative CT scan demonstrating the intervertebral cleft and breakage of the posterior cortex in the T11 vertebra. **C**, Preoperative MRI showing a mixed signal of fluid and gas in the injured vertebrae and spinal cord compression. **E**, **F**, One week after operation, radiographs demonstrated restoration of the vertebral height and the kyphosis was corrected to 8°. **G**, **H**, Postoperative CT scan revealed that the bone graft in the vertebral body was sufficient and uniform, and the condition of internal fixation was good. **I**, **J**, At the last follow-up, radiographs demonstrated that no decrease was present in the vertebral height and kyphosis did not recur. The Cobb angle of kyphosis was 10°. **K**, **L**, At the last follow-up, the CT scan showed that the injured vertebra healed well and no loosening or breakage of internal fixation was observed. CT indicates computed tomography; LSPI, long segmental posterior instrumentation; MRI, magnetic resonance imaging; TIBG, transpedicular impaction bone grafting.

this technique is that it allows the reconstruction of the anterior and middle column to support the vertebral body with less surgical trauma.[6,7] However, there are also studies indicating that the long term results of this technique were unsatisfactory, and the incidence of postoperative vertebral re-collapse and injured vertebral nonunion was high.[18] VP-enhanced anterior column was not chosen in this study as there are some limitations to the method. First, injecting bone cement into the vertebrae with a fractured posterior wall increases the potential risk of cement leakage into the spinal canal.[3,4,6] Second, bone cement has no osteoconductive or inductive properties, and it cannot replace autogenous or allogeneic bone grafts in terms of providing the best bone healing. Thus, it is difficult to achieve permanent anterior column reconstruction.[18] In addition, several recent studies indicated that pre-existing osteonecrosis is the greatest risk factor for re-collapse of vertebrae previously treated with VP.[19,20]

Based on the pathophysiology of Kümmell disease, TIBG was used in this study as another method to reconstruct the anterior column. Compared with bone cement, bone grafting has the advantages of causing only mild tissue rejection, and it easily induces bone formation and facilitates bone healing.[14] More importantly, TIBG is safer than injecting

TABLE 4. The Neurological Status of Patients Preoperative and at Last Follow-up Based on ASIA Classification

Time Point	ASIA Classification					χ^2	*P* for Trend
	A	B	C	D	E		
Preoperative				14	10	19.353	<0.001
Last follow-up				0	24		

ASIA indicates American Spinal Injury Association.

liquid bone cement into the injured vertebral body because the bone particles are solid and are pushed into the vertebral vacuum cleft through the bilateral pedicle. Because the inner and inferior walls of the pedicle were not damaged when surgery was performed carefully, the procedure prevented spinal cord and nerve-root damage.

It has been shown that autologous bone marrow concentrate combined with allograft cancellous bone is equivalent to autologous iliac bone in bony fusion.[21] Considering the low quality of iliac bone in osteoporotic patients and the possible donor-site complications (primarily chronic pain at the harvest site), we did not perform an iliac graft and used only a mixture of allogeneic bone particles and bone marrow aspiration concentrate during surgery (Figure 3B). Mesenchymal stem cells and endothelial progenitor cells contained in bone marrow concentrate promote osteogenesis and microangiogenesis.[22,23] In this study, after cleaning the necrotic bone tissue, the bone marrow concentrate and bone particles were mixed and implanted into the injured vertebral body, which may be beneficial to bony healing.

In the present study, the vertebral body height was restored and kyphosis was corrected. One week after surgery, the average vertebral height increased from 12.1 ± 4.4 to 21.4 ± 2.5 mm, and kyphosis was corrected from $24.2 \pm 15.1^\circ$ to $5.3 \pm 10.1^\circ$. More importantly, even though all patients had osteoporosis, the vertebral height and kyphosis that were corrected immediately after surgery remained at the last follow-up evaluation (Table 3; Figure 4). The restoration of vertebral height and the correction of kyphosis were achieved through three steps. (1) Preoperative manual reduction was initially performed; (2) during the surgery, the curette was used to reposition the endplate; and (3) a large number of allogeneic bone particles were implanted through the pedicle and were fully suppressed. In all cases, instead of using contouring rods, distraction, or the compression of screws to restore vertebral height and correct kyphosis, we pre-bent the titanium rod according to the degree of correction observed by intraoperative fluoroscopy, such that no stress was exerted between the titanium rod and the pedicle screw. Thus, this may explain why we did not observe cases of instrument failure. At the final follow-up evaluation, no recurrence of pain was observed, and only a slight loss of vertebral height and increases in kyphosis angle was observed. All bone-grafted vertebrae healed well and no instrumentation failure was observed during the follow-up period. Thus, those data showed the reliable long-term effects of our surgical approach.

We believe that the use of LSPI to stabilize the spine is another important reason for the satisfactory results of our surgeries. Although the short segmental posterior instrumentation has been widely applied and allows more motion segments to be saved, implant failure and the progression of kyphosis have been noted in long-term follow-up studies.[14,24–27] In 2013, Lee *et al*[14] described the use of a transpedicular intracorporeal bone graft with short-segmental posterior instrumentation in 36 patients with Kümmell disease. However, although the symptoms improved in a short period of time, 14% of patients experienced screw loosening during the follow-up period, and more than 70% of patients developed progressive kyphosis and back pain 1 year after surgery. Even if the axial bearing capacity of the anterior column was partially restored by transpedicular bone grafting to the fractured body, the bone graft could not provide sufficient structural support immediately before fracture healing.[14] In addition, the low bone mass of the spine of the patients with Kümmell disease also necessitates higher strength requirements for the fixation strength of instruments.[11,15] Taking these factors into account, we used LSPI to stabilize the spinal column after TIBG. Previous studies showed that LSPI may largely reinforce fixation and is superior to short segment fixation in preventing the progression of postoperative kyphosis and vertebral re-collapse.[27,28] In addition, considering the unsatisfactory performance of traditional pedicle screws in poor quality spines, we used bone cement-augmented screws in six patients with severely low bone mass, as this approach can facilitate firm integration of screws to the vertebral bodies; thus, preventing screw loosening and implant failure.[16,29,30]

We did not perform laminectomy or laminotomy, even in patients with mild neurological deficits, because the main factor causing the delayed neurological deficits was the instability of the spinal column at the fracture site, rather than mechanical compression of the spinal cord by the bone fragments or kyphosis.[11,13,31] In this study, the neurological function of each patient returned to normal at the time of last follow-up. Our surgical approach preserved the posterior column, which is beneficial to improving the stability of the spine, reducing stress in the injured anterior and middle columns, and reducing surgical trauma.[13,32] In this study, the average surgery time was 136 ± 16.5 minutes and the average blood loss was 293 ± 41.3 mL; thus, indicating that our procedure was less invasive than other extensive procedures described in the literature.[8,9,11,16]

There were some limitations to our study. First, this was a retrospective study with a limited sample size, which may limit the generalizability of our findings. Second, selection bias may have occurred as we did not include a control group in this study. Although direct comparisons with other surgical techniques were not available, our results demonstrated the effectiveness and safety of our technique. A larger population and longer follow-up periods are required to verify the efficacy of our surgical approach for treating stage III Kümmell disease.

CONCLUSIONS

Based on the outcomes of this study, TIBG combined with LSPI was a safe and effective surgery for patients with stage III Kümmell disease. This procedure facilitated the reconstruction of the anterior column of the vertebral body, and provided pain relief, neurological improvement, and prevented the loss of correction during long-term follow-up.

➢ Key Points

- ❑ Transpedicular impaction bone grafting with long segmental posterior instrumentation can effectively correct kyphosis and improve vertebral body height.
- ❑ This technique prevented the loss of correction during the follow-up period.
- ❑ This technique can provide satisfactory neurological recovery in patients with Kümmell disease with mild neurological impairment.

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