CLINICAL ARTICLE

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# Titanium Mesh Cage for Anterior Stabilization in Tuberculous Spondylitis : Is It Safe?

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**Objective :** The safety of titanium metal cages in tuberculous spondylitis has not been investigated. We evaluated the outcome and complications of titanium mesh cages for reconstruction after thoracolumbar vertebrectomy in the tuberculous spondylitis.
**Methods :** There were 17 patients with 18 operations on the tuberculous spondylitis in this study. Sixteen patients were operated with anterior corpectomy and reconstruction with titanium mesh cage followed by posterior transpedicular screw fixations on same day, two pateints were operated by either anterior or posterior approach only. After the affected vertebral body resection and pus drainage from the psoas muscle, titanium mesh cage, filled with morselized autogenous bone, was inserted. All the patients had antituberculosis medication for 18 months. The degree of kyphosis correction and the subsidence of cage were measured in the 15 patients available at a minimum of 2 years. Outcome was assessed with various cross-sectional outcome measures. Recurrent infection was identified by serial ESR(Erythrocyte Sedimentation Rate) and CRP(Cross Reactive Protein).
**Results :** There was no complication from the use of a titanium mesh cage. Recurrent infection was not detected in any case. Average preoperative of 9.2° was reduced to -2° at immediate postoperative period, and on final follow up period kyphotic angle was measured to be 4.5°. Postoperatively, subsidence was detected in most patients especially at ambulation period, however further subsidence was prevented by the titanium mesh cage. Osseous union was identified in all cases at the final follow-up.
**Conclusion :** The cylindrical mesh cage is a successful instrument in restoring and maintaining sagittal plane alignment without infection recurrence after vertebrectomy for tuberculous spondylitis.

**KEY WORDS :** Spondylitis · Tuberculosis · Surgical mesh · Vertebrectomy · Reconstruction.

## Introduction

Spinal tuberculosis(TB) was first described by Percival Pott in 1779. Spinal TB usually involves the anterior column of the spine and is more common in patients with elderly patients[11,18]. Spinal TB is the most common form of osteoarticular tuberculosis and an endemic disease in many underdeveloped countries. Neurologic deficits are reported in 10% to 60% (mean 20%) of cases with spinal TB, and changes of bowel and bladder functions. Patients with severe kyphosis and paraplegia are rarely seen today, particularly in developed or developing countries with early detection, anti-TB medication, and improved surgical techniques.

Although early start of the proper anti-tuberculosis medication leads to a favorable outcome in most patients, surgical debridement and stabilization is indicated in the presence of an epidural abscess, neurologic deficit due to neural structure compression, structural destruction resulting in instability, and failure of anti-tuberculosis chemotherapy[7,16]. Surgical treatment for spinal TB warrants extensive resection of infected vertebra and reconstruction of anterior column with or without metal implants.

The safety of implants in infectious spinal diseases is not known. There have been many reports that metal implants should not be used in spinal infections because bacteria colonized on the metal rod and form biofilms on the metal su-

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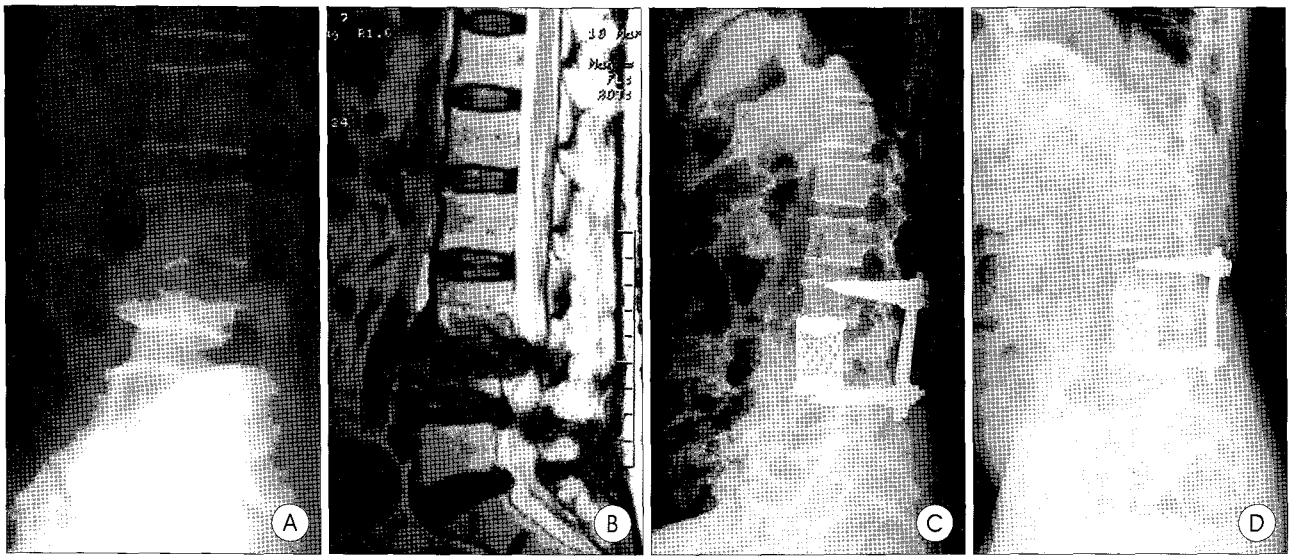


**Fig. 1.** Illustration of a case. A 71-year-old female patient with severe back pain and paraparesis. She had pulmonary tuberculosis history when she was young and had diabetes for more than 20 years. Preoperative lumbar spine lateral view (A) shows 4.5 degree kyphosis in the lumbar spine. Preopertive magnetic resonance image (B) shows kyphosis and neural compression. She underwent radical debridement including resection of L4 vertebra, the psoas absess drainage and anterior reconstruction using a titanium mesh with retroperitoneal approach. Transpedicular screw fixation was performed on same day. Preoperative kyphosis in the lumbar spine was converted to 6 degree lordosis after surgery (C) that was maintained at last follow up after 2 years after operation (D).

rface[6,12,13]. These biofims increases infection recurrence and prolong infection control. Various autogenous bone grafts, such as rib, iliac crest, and fibula for anterior column reconstruction and posterior surgical implant have been used and found safe[1-4,14]. However, the safety of implants, such as titanium mesh cages in the anterior column reconstruction after thoracolumbar vertebrectomy in spinal TB is still unknown. Recently, titanium mesh cages have been used for reconstruction of anterior column in selected cases[1,8]. We report our experiences with titanium mesh cages to reconstruct the spine after thoracolumbar vertebrectomy in spinal TB.

## Materials and Methods

Seventeen patients with spinal TB have been operated with a titanium mesh cage between 1995 and 2002. There were 18 operations with titanium mesh cage because one patient had concomitant spinal TB in both lumbar and thoracic spine. All patients except 1 case had active form of spinal TB at the time of surgery with symptoms, signs and laboratory findings of infection. Indications of operation were epidural abscess, neurologic deficit due to neural compression, structural destruction resulting in instability. Preoperative MRI showed bony destruction with various degrees of kyphosis and neural compression in all cases. Sometimes it was difficult to differentiate tuberculous spondylitis from pyogenic spondylitis because of false negative finding in AFB stain or microbiological culture for Tuberculosis. We defined tuberculous spondylitis by not only microbiological, histopathological evidence of spinal TB but also those with highly probable diagnosis, supported by radiographic features, response to the antituberculosis medication were included, even they are not confirmed microbiologically or histopathologically. There were 9 male patients and 8 female patients and their average age was 52.0 years (32~71). Upper to mid lumbar spine was most commonly affected area (Table 1).

### Surgical procedure

Anterior corpectomy and reconstruction with titanium mesh cage followed by posterior transpedicular screw fixations on the same day was carried in 16 cases (Fig. 1). Transpleural thoracotomy for the thoracic lesions, retroperitoneal approach to the lumbar lesions were performed for anterior corpectomy and reconstruction operation. Infected bone and sequestered disc compressing neural structure were removed extensively until the normal bone is exposed. Paravertebral pus pocket was drained and irrigated with copious saline as much as possible. After the affected vertebral body resection and pus drainage, a titanium mesh cage, filled with morselized autogenous bone from the iliac crest, was inserted.

One patient with chronic lumbar tuberculous spondyltis without psoas abscess was operated posteriorly only (Fig. 2). Despite of the anti-tuberculosis medication for several years, this patient showed progressive kyphosis and neural compression in the lumbar spine. To prevent the progressive kyphosis, pedicle subtraction osteotomy, interbody fusion, and transpedicular screw fixation were performed. One patient with concomitant lumbar and thoracic spine involvement

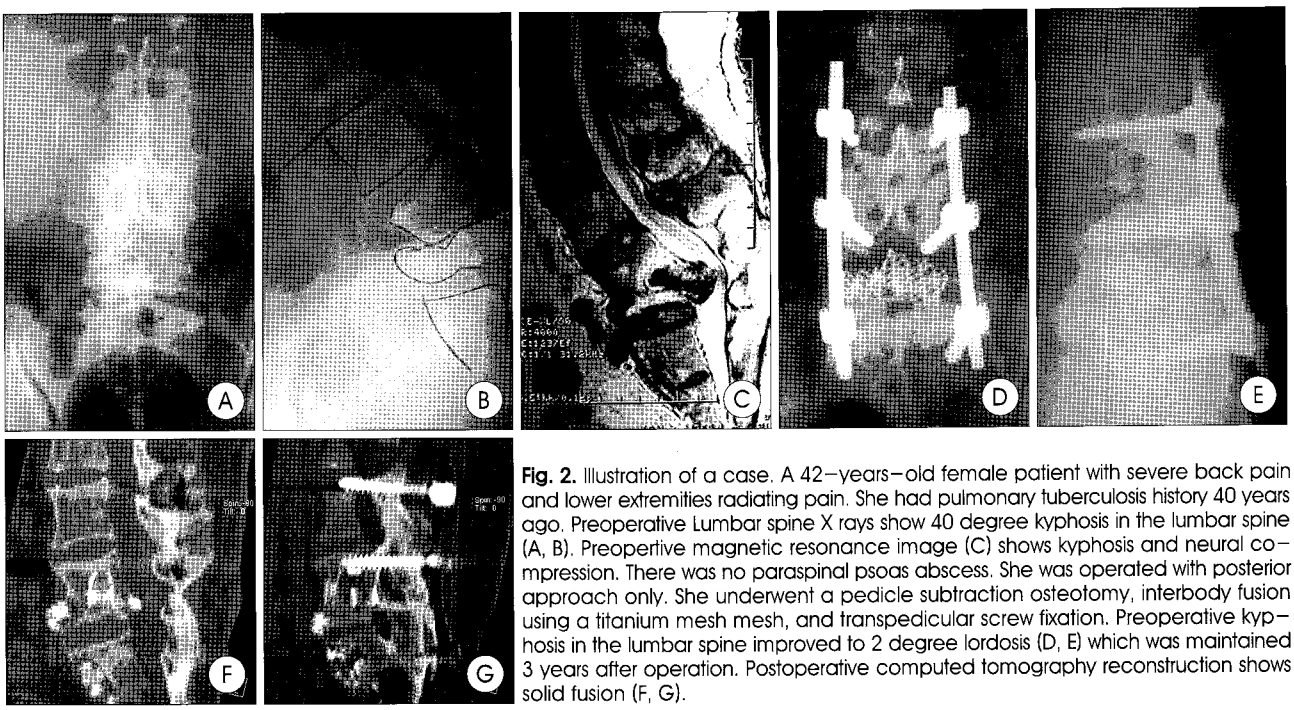


**Fig. 2.** Illustration of a case. A 42-years-old female patient with severe back pain and lower extremities radiating pain. She had pulmonary tuberculosis history 40 years ago. Preoperative Lumbar spine X rays show 40 degree kyphosis in the lumbar spine (A, B). Preopertive magnetic resonance image (C) shows kyphosis and neural compression. There was no paraspinal psoas abscess. She was operated with posterior approach only. She underwent a pedicle subtraction osteotomy, interbody fusion using a titanium mesh mesh, and transpedicular screw fixation. Preoperative kyphosis in the lumbar spine improved to 2 degree lordosis (D, E) which was maintained 3 years after operation. Postoperative computed tomography reconstruction shows solid fusion (F, G).

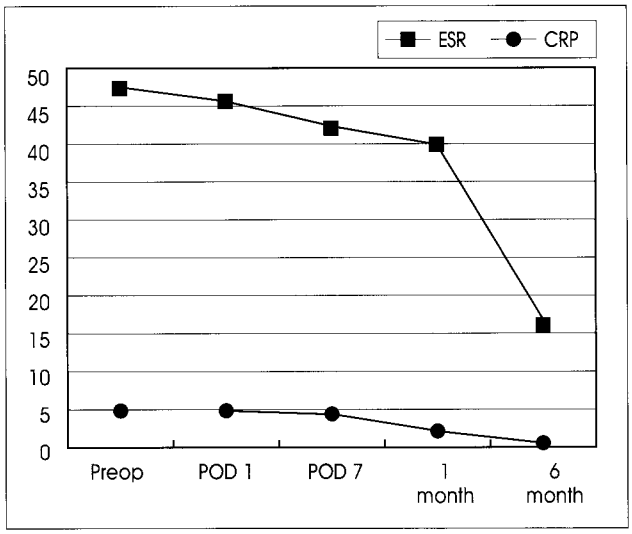


**Fig. 3.** Average ESR(Erythrocyte sedimentation rate) and CRP(C-reactive protein) level.

was operated with anterior approach (corpectomy and reconstruction with a titanium mesh cage) only for the thoracic lesion and anterior corpectomy and reconstruction with titanium mesh cage followed by posterior transpedicular screw fixations on the same day for the lumbar lesion.

Preoperative kyphotic angle was estimated to be 9.2° (range, -5-40) using Cobb method. Anti-tuberculosis medication was administered for 18 months in 17 cases. Anti-tuberculosis regimen was Isoniazid (5mg/kg/d; max 300mg/d), Rifampin (10mg/kg/d; max 600mg/d), Ethambutol (25mg/kg/d; max 2.5g/d), and Pyrazinamide (25mg/kg /d; max 2g/d). The degree of kyphosis correction and the subsidence of cage were measured. Outcome was assessed with Huskisson's visual analog scale (VAS : 0mm=no pain; 100mm=highest possible degree of pain) and Oswestry disability index(ODI) in Korean version[10]. Kyphotic angle and VAS were checked before and immediately after procedure, and followed up 1 month, 3 month and 6 months, 12 months after surgery. Recurrent infection was identified by checking Erythrocyte Sedimentation Rate (ESR : 0~10mm/hr) and C-Reactive Protein (CRP : 0.1~0.8mg/dl) serially. All the patients were followed up at least 24 months( range 28~126 months, mean : 45.7 months). Fusion success was determined by bony bridge between fused vertebral segments on 3 dimensional CT scan, no implant loosening, no movement in flexion and extension view.

## Results

There was no complication from the use of a titanium mesh cage. One patient who underwent transpleural approach had pleural effusion which was treat by chest tuber insertion for 13 days. Recurrent infection or late sepsis was not observed in all cases. Postoperatively, most patients showed unsettling amount of subsidence especially after ambulation but titanium mesh cage prevented further subsidence. The average preoperative kyphosis of 9.2° was reduced to -2° after surgery, and at final follow up was measured to be 4.5°. Osseous union on a clinical, laboratory, and imaging basis was achieved in all cases at the final follow up. All patients showed definite improvement in their symptoms and became amb-

**Table 1.** Demographic data and case summary data of the patients in this study

| Patient No | Gender | Age (yr) | Level | Pathology | Wound Culture | Radiological finding | Complication | Operation | Chest X ray | Associated disease |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F | 34 | L3-4 | Tuberculosis, consistent with | no growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | Pulmonary TB (active lesion) | Pulmonary TB |
| | | | T6 | Tuberculosis, consistent with | no growth | | Prolonged chest tube | Transpleural corpectomy and strut graft with titanium mesh insertion | cage | (-) |
| 2 | M | 51 | L2-3 | Acute and chronic inflammation with caseous necrosis | no growth | Consistent with TB | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | no active lesion | (-) |
| 3 | M | 39 | L2-3 | Tuberculosis | no growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | early Pulmonary TB. | (-) |
| 4 | F | 66 | L4-5 | Granulomatous inflammation -Consistent with Tuberculosis | no growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | Pulmonary TB(indeterminated Activity) | Pulmonary TB |
| 5 | M | 69 | L2 | Tuberculosis, consistent with | no growth | Consistent with TB | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | no active lesion | (-) |
| 6 | F | 65 | L2-3-4 | Acute and chronic inflammation | no growth | Consistent with TB | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | Pulmonary TB(indeterminated Activity) | DM |
| 7 | M | 32 | L2-3 | Tuberculosis, consistent with | no growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | Milliary TB | DM |
| 8 | M | 45 | T11-T12 | Tuberculosis, (AFB present) | no growth | | | Transpleural corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | no active lesion | (-) |
| 9 | F | 71 | L3-4 | Tuberculosis, (AFB present) | no growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | no active lesion | DM |
| 10 | F | 57 | L3-4 | Tuberculosis, consistent with | no growth | Consistent with TB | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | Pulmonary TB(indeterminated Activity) | (-) |

| Patient No | Gender | Age (yr) | Level | Pathology | Wound Culture | Radiological finding | Complication | Operation | Chest X ray | Associated disease |
|---|---|---|---|---|---|---|---|---|---|---|
| 11 | M | 61 | L2-3 | Tuberculosis, consistent with | TB growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | Pulmonary TB with tuberculoma(inactive) | (-) |
| 12 | F | 64 | L1-2 | Tuberculosis, (AFB present) | TB growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | no active lesion | (-) |
| 13 | F | 42 | L4-5 | Chronic granulomatous inflammation | no growth | | | Posterior discectomy/ corpectomy and interbody fusion with titanium mesh cage and Posterior transpedicular screw fixation | Pulmonary TB with tuberculoma (inactive) | Pulmonary TB |
| 14 | M | 48 | T10-11 | Tuberculosis, consistent with | no growth | Consistent with TB | | Transpleural corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | Pulmonary TB (indeterminated Activity) | (-) |
| 15 | M | 41 | L1-2 | Tuberculosis, consistent with | TB growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | Pulmonary TB with tuberculoma (inactive) | DM |
| 16 | F | 64 | L2-3 | Tuberculosis, consistent with | TB growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | no active lesion | (-) |
| 17 | M | 43 | L1-2 | Granulomatous inflammation- Consistent with Tuberculosis | no growth | | | Retroperitoneal corpectomy and reconstruction with titanium mesh cage and Posterior transpedicular screw fixation | Pulmonary TB with tuberculoma (inactive) | Pulmonary TB |

Tb. : Tuberculosis, DM : Diabetes Mellitus

ulatory. One patient had transient sepsis after surgery but improved after intensive care unit treatment. The ODI was improved from 89.1(SD=17.8) to 21.6(SD=14.3). Average VAS score showed marked improvement also (83 to 11).

Average CRP level remained low throughout the follow-up period. Average ESR level remained high until 4 weeks after surgery, then dropped slowly over long time (Fig. 3). Average CRP level dropped drastically right after operation and became normal in few weeks.

## Discussion

There are still many spinal TB patients need surgical treatment in spite of the medical and socioeconomic development. Sufficient debridement of pus, as well as necrotic bone and soft tissue, deformity correction and stabilization of the affected spinal segments are prerequisite for spinal TB operation. Although instrumentations are needed in spinal TB for deformity correction, deformity prevention by sufficient reconstruction, many arguments have been disputed regarding the use of instrumentation. In patients requiring surgical instrumentations, the use of instrumentation offers the theoretical advantage of deformity correction and stability but has also been closely related with an increased risk of infection, although this notion has been challenged by some results[2,3,15]. The insertion of implants, in other words, provide structural stability, however, the presence of foreign material in the infected area may diminish the effects of infection eradication[15].

Oga et al.[13] studied the risk of persistence and recurrence of infection in posterior spinal instrumentation surgery for

spinal tuberculosis in eleven patients. They operated the patients with debridement, anterior fusion, and combined posterior instrumentation. There were no cases of persistence or recurrence of infection after surgery, and they found that instrumentation provided immediate stability and protected against development of kyphotic deformity. The adherence property of *Mycobacterium tuberculosis* to stainless steel was evaluated experimentally also. They found that few *Mycobacterium tuberculosis* adhered to stainless steel while *Staphylolcoccus* heavily colonized on stainless steel. They concluded that posterior instrumentation surgery was not a hazard to spinal TB when it is combined with radical debridement and intensive anti-tuberculosis chemotherapy. Ha et al.[6] evaluated the differences in adherence and biofilm formation between *Staphylococcus epidermidis* and *Mycobacterium tuberculosis* on various spinal implant surfaces. They found that *Staphylococcus epidermidis* heavily colonized on the metal rod and form thick biofilm, while *Mycobacterium tuberculosis* rarely adhered to metal surfaces and showed scanty biofilm formation. Many experimental studies suggest *Mycobacterium tuberculosis,* unlike bacteria, has low adherence to stainless steel and forms less polysaccharide biofilm[13]. Therefore, the use of implants in the presence of spinal TB is theoretically safe.

The goal of using the titanium mesh cage with bone grafts instead of a structural bone graft alone is that cage with bone may provide more secure, accurate, and dependable deformity correction than bone graft alone. The cage provides a more rigid fixation construct and minimizes the risk of graft subsidence or dislodgement, that are well-documented complications when structural bone graft alone is used[3,15,19]. Cages with bone also provide stability to enable earlier and safer mobilization[3]. In our study, all the patients showed definite improvement in their symptoms and became ambulatory with osseous union and improvement of kyphosis without infection recurrence.

There were few studies about titanium alloys and *Mycobacterium tuberculosis.* Soultanis et al.[17] reported that titanium alloys, in general, showed relatively friendly toward the host bone and had lower infection risk. On the other hand, Mycobacterium tuberculosis has low adherence properties to the stainless steel, but its behavior towards titanium has not been studied yet[13]. Our study suggested *Mycobacterium tuberculosis* may behave toward titanium implants in a similar fashion as toward stainless steel implants. Christodoulou et al. reported similar results to our series, that titanium implants may play a good role in the lowering infection risk of *Mycobacterium tuberculosis.*

Patients in this series showed subsidence especially after ambulation. Subsidence occurred at metal-bone interface which is weakened by osteomyelitis even if we removed necrotic bone extensively. This justifies the use of posterior screw fixation. Yilmaz et al.[19] recently reported the good short-term results in patients with implants and strut grafts for anterior stabilization in patients with spinal TB. On the other hand, Christodoulou et al.[1] used a more uniform approach with a titanium mesh cage with nonstructural bone grafts. They found that additional posterior stabilization leading to 360° of fusion was not necessary because the posterior elements were intact. In their series, the postoperative deformity correction compares favorably with that reported of only structural bone grafts or a combination of grafts and posterior instrumentation[2,3,7,15]. They also found that there were no implant subsidence, graft dislodgement, or resorption on their series. Further study of comparing 360° fusion with titanium mesh cage alone according to the postoperative subsidence may be needed.

In regard to the correction of kyphotic angle, our study of mean preoperative kyphotic angle of 9.2° was reduced to -2° after surgery and 4.5° at final follow up study. Guzey et al.[5] also had similar result. They reported that 19 patients with thoracic and lumbar spinal TB underwent single-stage posterior decompression and debridement as well as the placement of posterior interbody grafts with instrumentation. They found that the mean kyphotic deformity in 13 patients was 18.2 degrees (range 5~42 degrees) preoperatively which was reduced to 17.3 degrees (range 0~42 degrees) after surgery. There was a 2.8 degrees loss of correction (range 2~5 degrees) after 44.3 months (16~64 months). These results show that our two-stage operation achieved more correction in kyphotic angle than single-stage posterior operation. We assumed that 360° fusion (titanium mesh cage with posterior transpedicular screw fixations) apparently increased stability and lead to favorable environment for infection control, and solid fusion.

## Conclusion

The cylindrical mesh cage is a safe and effective device in restoring and maintaining sagittal plane alignment without infection recurrence after vertebrectomy for tuberculous spondylitis.

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## Commentary

Vertebroplasty already has become a popular minimally invasive procedure for fractures of the spine resulting from osteoporotic or tumorous lesions. I enjoyed this interesting article by SY Kim and SW Kim on the treatment of the remnant pain after vertebroplasty. This paper classified the pain of vertebral compression fracture into pain from vertebral body itself and facet joint associated with muscles. The authors rationalized their radiofrequency neurotomy procedure to treat the pain from facet and surrounding muscles.

Though the author's concept is new, I suggest thinking about the other cause of pain originated from neural compression at the neural foramen. Bone cement can be leaked into neural foramen, which can result in radicular pain. The leakage of bone cement can be associated with the preexisting cortical destruction, rich posterior internal venous plexus, and inadequate needle puncture hole with inadvertent cortical perforation[2]. The heat and chemical irritation of bone cement can be another cause of pain[1]. Authors should have to study the status of neural foramen to check the compression of nerve root by bone cement, which should be sometimes managed by surgery[3]. In this study, 6 out of 19 patients did not satisfied with the neurotomy.

Nevertheless, this study showed very fresh concept of the remnant pain after vertebroplasty, which can be managed by radiofrequency neurotomy. As far as I am aware, there are no published studies on the effects of radiofrequency neurotomy on remnant pain after vertebroplasty. Especially, authors limited the patients with compression ratio more than 50%, which means more possibility of facet and muscular injury. I think this procedure can be one of options to treat the remnant pain after vertebroplasty in severely compressed osteoporotic spine.

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