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## The Effect of Intervertebral Fusion using the Titanium Mesh Cage in Tuberculous Spondylitis

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—— Abstract

**Background**: The problems of tuberculous spondylitis are recurrence and loss of the correction of kyphotic deformity after surgical treatments. The maintenance of correction of kyphotic deformity is one of the difficult problem in tuberculous spondylitis. We here report that titanium mesh cage impacted with autogenous bone chip is an effective intervertebral fusion in surgical treatment for tuberculous spondylitis to maintain correction of kyphotic deformity without recurrence.

**Methods**: Twenty nine patients treated with titanium mesh cage for tuberculous spondylitis were reviewed from January 1996 to June 2002. Fourteen patients were female, and 15 were male. Mean age was 52.2 years old. Mean follow-up period was 37.8 months. We analized the change of the correction of kyphotic deformity, change of ESR and CRP, fusion state and recurrence after intervertebral fusion with titanium mesh cage.

**Results**: The infected vertebral bodies were 2.3 in average. Clinical symptoms were improved in all patients without any neurologic complications. The mean kyphotic angle corrected was 11.8 degrees immediately after operation, but the loss of correction of kyphotic angle was 3.6 degrees after 3 months, 4.4 degrees after 6 months, 4.8 degrees after 12 months and 4.9 degrees after more than 18 months. We found that the loss of correction of kyphotic deformity occurred mainly within the first 3 months after surgery.

**Conclusion**: The surgical procedure of tuberculous spondylitis using titanium mesh cage with bone chip seems to be an effective procedure to minimize loss of the correction of kyphotic deformity without any aggravation inflammatory change and recurrence, when sufficient debridement and anti-tuberculous chemotherapy are achieved.

Key words : tuberculous spondylitis, titanium mesh cage, intervertebral fusion

## Introduction

A revolutionary advancement was seen in the treatment of tuberculous spondylitis since anti-tuberculous medications were developed during the 1950's. However, tuberculous spondylitis still is common in underdeveloped and developing countries.<sup>1,2)</sup> More attention should be paid to this disease with the recent rise in its incidence. Gradual kyphotic deformity, which must be corrected with surgery, may arise during the course of treating tuberculous spondylitis using only drugs.<sup>3)</sup> Tuberculous spondylitis is surgically treated through intervertebral fusion using instruments and autogenous iliac bone graft. Treatment effect could be increased with the anterior approach

교신저자 : Dae-Yong Kim Add : 34 Amnam-dong, Suh-gu, Busan 602-702, Korea Department of Neurosurgery, Kosin University College of Medicine, Busan, Korea Tel : +82-51-990-6705 Fax : +82-51-990-3042 E-mail : ykimdy@hanmail.net through sufficient debridement of the lesion by directly assessing the lesion site and grafting a piece of autogenous bone.

However, most cases of tuberculous spondylitis needing surgical treatment involve more than 2 vertebral bodies, requiring a large piece of bone graft (ex: iliac bone or fibular bone) but grafting a large piece of bone is not easy in many cases. Furthermore, stability immediately after surgery is difficult to expect and many problems including postoperative complications such as inadequate and slipped bone graft, fracture of grafted bone, pain in the donor site due to an extensive resection of grafted bone, postoperative loss of corrected kyphotic angle and recurrence of tuberculous spondylitis have been the concerns with the surgical treatment of tuberculous spondylitis.<sup>3-7)</sup> The maintenance of corrected kyphotic angle is one of the difficult problem in tuberculous spondylitis. Thus, tuberculous spondylitis was surgically treated through intervertebral fusion and screw fixation using a titanium mesh cage as a support after the invaded lesion sites were thoroughly resected in order to treat the lesions and to induce sufficient bony fusion. We here report that titanium mesh cage impacted with autogenous bone chip is an effective intervertebral fusion in surgical treatment for tuberculous spondylitis to maintain corrected kyphotic angle without recurrence.

## Materials and Methods

## Patient population

Twenty nine patients treated with titanium mesh cage for tuberculous spondylitis were reviewed from January 1996 to June 2002. Fourteen patients were female, and 15 were male. The patients ranged in age from 20 to 72 years. There were 3 patients in their 20's, 2 in their 30's, 4 in 40's, 9 in 50's, 8 in 60's, and 3 in 70's, showing most of these patients in their 50's to 60's. The mean age of the patients was 52.2 years.

Mean follow-up period was 37.8 months. CT, MRI, and bone scan were performed before surgery in all patients. We analyzed the change of the correction of kyphotic deformity, change of ESR and CRP, fusion state and recurrence after intervertebral fusion with titanium mesh cage.

## Lesion sites and the number of invaded vertebral bodies

The thoracic vertebrae were affected in 10 patients, thoracolumbar junction vertebrae involved T11, T12, L1 in 7, and lumber in 12. Two vertebral bodies were invaded in a majority of the patients in 19 cases, followed by 3 in 8 cases, and 4 in 4 cases.

## Surgical approach

All patients were operated under general anesthesia with endotracheal intubation. Anterior intervertebral fusion and fixation using screw and mesh cages through the anterior approach was performed in 22 cases. Screw fixation and intervertebral fusion using mesh cages through the posterior approach was performed in 5 cases. Anterior and posterior approach was performed in 2 cases. The grafted bones inserted into the titanium mesh cage were rib bone, iliac bone or allograft bone chips.

## Corrected kyphotic angle and recurrence; Postoperative follow-up

Changes in the kyphotic angle were evaluated using simple radiographs taken regularly, i.e., before surgery, immediately after surgery, by postoperative 3 months, 6 months, 12 months, and after more than 12 months. The degree of kyphotic angle corrected was measured according to the method by Konstam(Fig. 1).<sup>8)</sup>



Fig. 1. Measurement of the kyphotic angle.

The levels of ESR and CRP were also checked regularly to evaluate their changes. Changes in ESR and CRP and clinical symptoms were compared by postoperative 3 months, 6 months, 12 months and more than 12 months to determine whether tuberculous spondylitis had been treated and recurred. The sufficient bony fusion state was defined by taking CT after more than 12 months to evaluate the degree of bony fusion and changes in clinical symptoms.

## Administration of anti-tuberculous medications after surgery

After allowing one week of postoperative stabilization period, the patient was started on early ambulation and rehabilitation treatment, wearing a spinal brace. Each patient wore a brace for an average of 3 months. Anti-tuberculous medications were given for 12~18 months after surgery.

## Statistical analysis

Statistical analyses were conducted using SPSS for Windows (version 10.0; SPSS, Inc., Chicago, IL). A correlation analysis was performed between the radiological findings, age, sex, involed level and involved site. A value of p<0.05 was considered to be significant.

## Results

## Changes in corrected kyphotic angle

The mean kyphotic angle corrected was 11.8 degrees immediately after operation, but the loss of corrected kyphotic angle was 3.6 degrees after 3 months, 4.4 degrees after 6 months, 4.8 degrees after 12 months and 4.9 degrees after more than 18 months. We found that the loss of corrected kyphotic angle occurred mainly within the first 3 months after surgery (p<0.05)(Fig. 2).



Fig. 2. Changes of corrected kyphotic angle.

## Degree of the loss of corrected kyphotic angle according to Gender

The corrected kyphotic angle was  $11.8 \pm 5.3^{\circ}$  immediately after surgery, and the loss of corrected kyphotic angle was  $4.0 \pm 3.0^{\circ}$  by 18 months of follow-up in male patient group. In female patient group, the corrected kyphotic angle was  $11.7 \pm 5.9^{\circ}$  and the loss of corrected kyphotic angle was  $5.7 \pm 2.9^{\circ}$ . Although the loss of corrected kyphotic angle was greater in female patient group, no statistical significance could be placed in the data (p>0.05)(Table 1).

Table 1. Statistical summary of gender, lesion site, and operative approach with changes of corrected kyphotic angle

		Corrected kyphtic angle	Loss of Corrected kyphotic angle
		immediate postoperation(°)	long term follow-up(°)
Gender	Male	11.8±5.3	4.0±3.0
	Female	11.7±5.9	5.7±2.9
Lesion site	Thoracic	10.4±4.0	6.6±2.5
	Thoracolumbar	11.1±5.8	5.6±3.9
	Lumbar	13.3±6.5	$3.3 \pm 1.2^{*}$
Approach	Anterior	10.9±5.4	5.2±3.3
	Posterior	13.8±5.3	3.2±1.3
	Combine	16.0±8.5	5.5±3.5

Values are mean ± SD

<sup>6</sup> P<0.05 Compared with thoracic and thoracolumbar lesion.

Table 2. Changes of patients with normal ESR and CRP level

	Pre-Op.	3 months	6 months	12 months	>18 months
ESR	6	10	18	25	27
CRP	9	14	24	27	29

ESR : erythrocyte sedimentation rate CRP : C-reactive protein

Values are numbers of patients.

## Degree of the loss of corrected kyphotic angle according to the lesion site

The corrected angle was  $10.4 \pm 4.0^{\circ}$  immediately after surgery, and the loss of corrected kyphotic angle was 6.6  $\pm$  2.5° by 18 months of follow-up in thoracic lesion group. In thoracolumbar lesion group, the corrected kyphotic angle was  $11.1 \pm 5.8^{\circ}$  and the loss of corrected kyphotic angle was  $5.6 \pm 3.9^{\circ}$ . In lumbar lesion group, the corrected kyphotic angle was  $13.3 \pm 6.5^{\circ}$  and the loss of corrected kyphotic angle was  $3.3 \pm 1.2^{\circ}$ .

The loss of corrected kyphotic angle was lesser in lumbar lesion site group compared with thoracic and thoracolumbar lesion, statistical significance could be placed in the data (p<0.05)(Table 1).

# Degree of the loss of corrected kyphotic angle according to operative approach

No statistical significance was present with the loss of corrected kyphotic angle of  $5.2 \pm 3.3^{\circ}$  for the anterior approach group,  $3.2 \pm 1.3^{\circ}$  in the posterior approach group and  $5.5 \pm 3.5^{\circ}$  in the combine approach. Although the loss of corrected kyphotic angle was lesser in posterior approach group, no statistical significance could be placed in the data due to variable sample size (p>0.05)(Table 1).

## Changes in ESR and CRP

The levels of ESR and CRP were normal in 6 cases and 9 cases respectively before surgery, in 10 cases and 14 cases respectively by postoperative 3 months, in 18 cases and 24 cases respectively by postoperative 6 months, in 25 cases and 27 cases respectively after 12 months, and in 27 cases and 29 cases respectively after 18 months. However, even with increased levels of ESR and CRP, CT showed bony bridging within the titanium mesh cage after more than postoperative 12 months, which could suggest a bony fusion without recurrence of tuberculous spondylitis. In the case that was treated with second surgery through the posterior approach due to evidence of recurrence after postoperative 6 months, the level of ESR was 23 and that of CRP was normal. Thus, ESR or CRP level could not be a sensitive factor indicative of diagnosis and recurrence of tuberculous spondylitis.

## Postoperative complications

Slight screw loosening was seen as a postoperative complication in 2 cases shown within postoperative 3 months but did not worsen in the degree of loosening or worsening of symptom, requiring no secondary surgery. Recurrence was seen by postoperative 6 months according to specific tests and clinical symptoms in 1 case not treated with anti-tuberculous medication due to acute hepatic failure immediately after surgery. The patient improved after undergoing second surgery through the posterior approach.

#### Postoperative fusion state of mesh cage

CT was taken again by postoperative  $12 \cdot 18$  months since there is no specific test that could evaluate the presence of fusion within the cage. Postoperative CT showed a bony bridging. Thus, sufficient bone fusion was achieved with no worsening of inflammation even in the case of inflammatory spinal disease such as tuberculous spondylitis with anterior fusion using titanium mesh cage.

## Postoperative prognosis

All patients improved neurologically after surgery. Even those with paraparesis improved after surgery, making independent ambulation possible.

## Discussion

Since Pott reported surgical draining for tuberculous spondylitis in 1779, various effective therapeutic methods have been introduced. Menard reported costo-transversectomy in 1892, and Hibbs<sup>9)</sup> introduced posterior interbody fusion in 1912 as for the methods of surgically treating tuberculous spondylitis. Ito<sup>10)</sup> in 1934 first reported anterior approach operation, and Hodgson, Kirkaldy-Wills, and Roaf et al emphasized the importance of anterior interbody fusion.<sup>11-14)</sup>

Compared with anterior interbody fusion, posterior interbody fusion is relatively easier to perform, takes less time, and results in less injury to surrounding soft tissues. However, with this method, the lesion site of tuberculous spondylitis is difficult to be removed thoroughly. Instability is also induced due to instable bony fusion of the vertebral bodies. Thus, anterior interbody fusion has secured its place as the method of choice in surgically treating tuberculous spondylitis.<sup>3)</sup> Anterior interbody fusion could reduce the incidence of recurrence by the surgeon directly confirming the lesion site of tuberculous spondylitis, making sufficient removal of the lesion possible. It could also prevent kyphotic deformity and maintain spinal stability by achieving bony fusion of the spine with the grafted autogenous bone.<sup>15)</sup> Nonetheless, complications such as loss of corrected kyphotic angle could occur after anterior interbody fusion.<sup>3,5,8,16)</sup>

Baily<sup>3)</sup> stated the causes of kyphotic angle loss to be the displacement of bone graft, collapse of the bone graft into the vertebral body, grafted bone fracture, grafted bone absorption, continuous infection of tuberculous spondylitis, insufficient bone graft, and hypertrophy of the posterior side. It was also reported that the possibility of kyphotic angle loss would increase when the lesion site is in the thoracic vertebrae.<sup>7)</sup> The possibility of kyphotic angle loss could also increase due to growth difficulty in the anterior and posterior portions in pediatric tuberulous spondylitis.<sup>5,6)</sup> Other causes include insufficient support due to an

insufficient amount of grafted bone and lack of external fixative device after surgery.  $^{4,7,17)}$ 

Upon the report by Kim,<sup>17)</sup> the average degree of loss in postoperative kyphotic angle correction was 9.1 degrees in the thoracic vertebrae, 5 degrees in the thoracolumbar vertebrae and 1.9 degrees in the lumbar vertebrae, showing a less degree of kyphotic angle loss in the lumbar vertebrae. Similar results were observed in our study even without statistical significance and could be explained because the grafted bone would receive fewer loads, the insertion of bone graft is easy, and a large piece of bone graft could be used to keep the lordotic curvature in the lumbar vertebrae.

Several vertebral bodies are invaded in most cases of tuberculous spondylitis. Consequently, extensive resection of the lesion site becomes crucial when surgery is indicated. In order to cover an extensive area, the length of bone graft should be sufficiently long but there are not many bones that could provide a sufficiently large enough bone graft. When the bone graft could not provide enough support, the corrected kyphotic angle is difficult to be maintained and severe spinal deformity could be brought about. Rajasekaran<sup>7)</sup> reported that the degree of preoperative kyphotic angle, the location of lesion site, and patient age are the factors affecting postoperative spinal deformity. They stated that the level of lesion site and the lengh of bone graft are important prognostic factors after surgery, and proposed second surgery within 6-12 weeks after initial surgery when the length of bone graft is long. They also reported that kyphosis would progress when the bone graft is not large enough or bone graft is absorbed after fractured or slipped.

Govender<sup>18)</sup> reported that sufficient bony fusion could be achieved when the titanium cage was packed with cancellous bone and fresh allograft chips and the cage would give excellent support. It was also reported by Masciopinto<sup>19)</sup> that titanium mesh cages could give sufficient structural support after vertebral body reconstruction. In general, a piece of rib bone or iliac bone is used usually as an autograft after the sufficient resection of the infected lesion site. The drawbacks related with the use of these bones are pain at the donor site, meralgia

paresthetica, lack of sufficient amount of bone at the donor site, and possible fracture with increased length of the grafted bone. However, it was reported that prognosis would not be good for infection control with the insertion of instruments into the infection site in the presence of infectious spinal disease. Gristina and Costerton<sup>20)</sup> stated that the mesh cage inserted for infectious spinal disease could prolong infection with the instrument functioning as a foreign object and site of bacterial habitat. But on the other hand, Oga<sup>21)</sup> reported that there is no risk of recurrence or persisting tuberculous spondylitis with a thorough removal of the lesion and the use of strong anti-tuberculous medications since tuberculous bacteria have less resistance to host defense mechanism and antibiotics. compared with other bacteria in their biological study on mesh cages for tuberculous spondylitis.22)

Thus, with the use of titanium mesh cages, a piece of rib bone or iliac bone could sufficiently provide support. Furthermore, the cage size could be controlled to fit the lesion site, making the insertion of a sufficiently cage possible. Harms<sup>23)</sup> reported no cage displacement or infection after interbody fusion using titanium mesh cages in patients with metastatic tumors in the spine. Jang<sup>24)</sup> also reported no complications such as infection after long term follow-up of 2 cases of tuberculous spondylitis treated using cages.

In this study, bony fusion was seen in all cases when the titanium cage and bone graft were used. The one case, in which recurrence was seen and treated with second surgery through posterior interbody fusion, was the patient who could not underwent appropriate anti-tuberculous medications immediately after surgery due to acute liver function failure. Thus, sufficient removal of the lesion and the use of appropriate anti-tuberculous medications immediately after surgery are important after surgical treatment of tuberculous spondylitis.

The level of ESR can be increased due to infection, collagen disease, malignant tumors, pregnancy, lead poisoning, liver cirrhosis, and hemolytic anemia. Since it increases sensitively in the presence of infection in the body, it is used effectively as an index for evaluating the presence of infection, degree of infection progression and treatment of infection.<sup>5,25,26)</sup> In fact, an increased level of ESR or CRP is significantly seen with infectious spondylitis and with tuberculous spondylitis during its acute stage. However, an increased level of ESR does not necessarily mean worsening of tuberculous spondylitis.<sup>27)</sup> Thus, an increased ESR or CRP level during surgical treatment of tuberculous spondylitis would not be a major factor indicative worsening of tuberculous spondylitis. A low level of ESR or CRP does not necessarily mean improved tuberculous spondylitis and symptomatic improvement.

## Conclusion

The surgical procedure of tuberculous spondylitis using titanium mesh cage with autogenous bones such as rib bone and iliac bone seems to be an effective procedure to minimize loss of the correction of kyphotic deformity aggravation inflammatory change without any and recurrence, when sufficient debridement and anti-tuberculous chemotherapy are achieved. Infection due to metal instruments was not an issue by sufficiently removing the lesion and using anti-tuberculous medications. Nonetheless, further studies are needed by comparing this method with simple autogenous bone graft.

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