Healing of Autologous Bone in a Titanium Mesh Cage Used in Anterior Column Reconstruction After Total Spondylectomy

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Study Design. Autologous bone inside a titanium mesh cage, used as an anterior strut in a reconstruction after total spondylectomy, was histologically examined in a postmortem specimen.

Objectives. To determine whether the autologous bone inside the titanium mesh cage attained fusion and remodeling in a combined reconstruction, consisting of an anterior titanium mesh cage with posterior multilevel instrumentation, after total spondylectomy.

Summary of Background Data. There are few previous reports on the histologic analysis of the bone inside a titanium mesh cage when it is used clinically as an anterior column support in a spinal fusion. Attaining biologic bony fusion is desirable for long-term stability after total spondylectomy.

Methods. A postmortem specimen from a 16-year-old boy with Ewing’s sarcoma at T6, who died of lung metastasis 16 months after total spondylectomy and combined reconstruction, was analyzed.

Results. Histologic examination revealed many viable cells and normal lamella of trabecular bone formation in the grafted bone inside the mesh. Consecutive trabecular cancellous bony fusion between the grafted bone and the adjacent vertebral bodies was achieved.

Conclusion. Remodeling and fusion of the grafted bone inside the titanium mesh cage was observed. Combined reconstruction using an anterior titanium mesh cage with posterior multilevel instrumentation after total spondylectomy makes it possible to achieve biologic fusion of the bone inside the mesh cage with the adjacent vertebral bodies.

Case Report

After acute onset in November 1996, a 16-year-old boy came to another hospital with back pain and paresis of his lower extremities. Magnetic resonance imaging showed that a tumor lesion at T6 had compressed the spinal cord. He underwent piecemeal resection of the tumor, which was located in the lamina from T5 to T7, and decompression of the spinal cord.

The histologic analysis of specimen material collected during the operation revealed an Ewing’s sarcoma. After this operation, his paralysis improved and he was able to walk without canes. After surgery, the patient received three courses of adjuvant chemotherapy consisting of cyclophosphamide (5400 mg), Adriamycin (120 mg), bleomycin (120 mg), methotrexate (180 mg), vincristine (3 mg), and actinomycin D (3 mg).

He came to our hospital in March 1997. At that time, the tumor lesion was located only at the T6 vertebral body (Figure E329–E333).
Magnetic resonance imaging of the spine detected no other tumor lesions. No metastatic tumors were detected by a technetium-99m scan or by whole-body computed tomography (CT). To reduce local recurrence as far as possible and to increase survival, in April 1997, en bloc corpectomy of the remaining portion of T6 was performed via a posterior midline approach. The vertebral body and the anterior and posterior longitudinal ligaments were completely resected by use of a T-saw. The spinal column was completely interrupted at this level because the posterior elements had already been resected during the previous operation in 1996. The reconstruction included a Harms titanium mesh cage (Depuy AcroMed, Raynham, MA) filled with morcellated autologous iliac cancellous bone. The cage was positioned as an anterior strut. Before en bloc resection of the anterior column of the vertebra, the pedicle screws and rods were inserted in the two levels above and the two levels below the spondylectomy (Figure 2). The posterior instrumentation was adjusted to slightly compress the inserted titanium mesh cage. A few pieces of iliac corticocancellous bone were put around the titanium mesh cage. The surgical time was approximately 13 hours, and blood loss was approximately 1200 g.

After surgery, the patient received three courses of chemotherapy consisting of cisplatin (630 mg), adriamycin (150 mg), and caffeine (7776 mg), and three courses of local radiation therapy at T5–T7 consisting of 30 Gy in total. The Harms titanium mesh cage and the bone inside the cage were included in the area of radiation therapy. The patient was able to walk, and neither local recurrence nor metastasis could be identified for 7 months after the total spondylectomy.

However, 7 months later, in November 1997, paresis of the patient’s lower extremities occurred again. Magnetic resonance imaging showed that the recurrent tumor in the thoracic spine was compressing the spinal cord.

Although palliative surgery (curettage of recurrent tumor) was carried out seven times, and four courses of chemotherapy consisting of ifomide (44.7 g), etoposide (VP-16, 900 mg), methotrexate (300 mg), caffeine (30.132 mg), bleomycin (48 mg), cyclophosphamide (1948 mg), and actinomycin D (2 mg)
were given, the tumor invaded the dura mater. Complete paresis of the lower extremities occurred in April 1998.

An additional three courses of radiation therapy were given to the thoracic spine (T1–T7) and the spinal cord (4900 Gy in total). However, the radiation therapy was unable to halt the progression of tumor. Lung and brain metastases that had first appeared on CT in July 1998 worsened. The patient died of lung metastasis in August 1998, 16 months after the total spondylectomy had been performed in April 1997. During these 16 months, neither instrumentation failure nor loosening of the titanium mesh cage was observed by radiography.

**Histology.** The grafted bone inside the Harms titanium mesh cage was analyzed histologically. Solid fusion with the adjacent vertebral bodies was observed by manual palpation (Figure 3). Histologic examination disclosed many viable cells and normal lamella of trabecular bone formation in the bone inside the mesh cage (Figure 4). Consecutive trabecular cancellous bony fusion between the grafted bone and the adjacent vertebral bodies was observed. Remodeling of the bone inside the mesh was apparent.

### Discussion

To our knowledge, this is the first report to confirm remodeling of the grafted bone inside a titanium mesh cage when the procedure is used clinically. The development of total en bloc spondylectomy has given patients with spinal malignant tumor some long-term local control. However, from the biomechanical point of view, total en bloc spondylectomy results in complete loss of spinal stability. Thus, postoperative reconstruction and bone fusion constitute an important part of this surgery.

Structural autografts, for example iliac crest, fibula, or multiple ribs, have traditionally been used for anterior column support in spinal fusions. In recent years, many
kinds of titanium mesh cages have become popular as anterior struts. There are advantages to using titanium mesh cages: varying diameters and heights are available, they can provide great resistance to subsidence, and they can maintain spinal alignment without collapse. Further, titanium mesh cages can be filled with morcellated autograft before insertion in the expectation of attaining fusion. However, it is impossible to confirm clearly whether the grafted bone inside the mesh cage is attaining fusion by using plain radiography or sagittally reconstructed CT, because the bone inside the mesh cage is obstructed by the metal. Only a few reports have documented fusion status in structural titanium mesh cages used clinically. Eck et al assessed the intracage fusion in 66 patients by examining plain radiographs and CT scans. They concluded that although it was very difficult to assess, 78% of the anterior levels were judged to be fused. Titanium cages were used as a spacer after corpectomy or an interbody fusion in their cases. Togawa et al described the histologic appearance of biopsy specimens from the grafted bone in four Harms titanium mesh cages and five Brantigan carbon fiber cages that were used as interbody fusions. Those authors showed that the bone graft incorporation was still incomplete because of the presence of fibrous tissue and necrotic bone in most biopsy specimens, although the clinical and radiographic findings were favorable. The previous studies did not include a case of total spondylectomy. The present report is the first to confirm bony fusion histologically in a reconstruction using a mesh cage after total spondylectomy. It is well documented that local irradiation and chemotherapeutic agents prevent bone remodeling and fusion. Although high doses of local radiation therapy and anticancer chemotherapy were given in this case, good bone remodeling was achieved.

There are only a few biomechanical studies related to the reconstruction method after total spondylectomy. Ikekuchi investigated the stiffness of multilevel posterior reconstructed spine after total spondylectomy by a finite element method. It was concluded that multilevel posterior segmental fixation had enough stability for primary fixation, but the reconstruction section might fail because of fatigue fracture; therefore, biologic bony fusion was required for long-term maintenance of stability. Oda et al concluded that the addition of the Kaneda SR systems as an anterior instrumentation to posterior pedicle screw instrumentation increased the rigidity of fixation and provided a superior biomechanical construct in biomechanical tests using human cadaver spines. However, we do not believe that it is necessary to achieve high fusion stiffness because the aim of applying instrumentation is to produce biologic bony fusion. In this case, a reconstruction that combined an anterior titanium mesh cage with autologous bone graft and posterior multilevel instrumentation after total spondylectomy achieved fusion of the morcellated bone inside the mesh cage with the adjacent vertebral bodies.

**Key Points**

- This is the first report to confirm histologic remodeling of the grafted bone inside the titanium mesh cage when used clinically.
- Reconstruction using an anterior titanium mesh cage with posterior multilevel instrumentation after total spondylectomy achieved biologic fusion of the bone inside the mesh cage with the adjacent vertebral bodies.

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**References**


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