New material for reconstruction of the anterior chest wall, including the sternum

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The effectiveness of surgical resection for locally recurrent breast cancer invading the chest wall remains poorly defined.¹⁻³ If structural stability is required, however, either autogenous tissue or prosthetic material can be used. Various materials for reconstruction of the anterior chest wall have been reported.⁴⁻⁶ We report the case of a 38-year-old woman who underwent resection and reconstruction of the anterior chest wall because of metastasis of carcinoma from the left breast to the sternum. We used a new material made from a ceramic prosthesis composed of a combination of hydroxyapatite and tricalcium phosphate. This is a review of a new material and method of reconstruction.

Clinical Summary

A 38-year-old woman successfully treated with a left mastectomy for breast cancer in October 1990 had a local recurrence in the sternal manubrium in May 1995. Radiotherapy was performed with a total of 54 Gy delivered in 30 daily fractions of 1.8 Gy by using 6-MV photons. The NCC-ST 439 (Nippon Kayaku Co, Ltd, Tokyo, Japan) serum level recovered to a normal value, and magnetic resonance imaging showed that the abnormal mass in the sternum was eliminated. Thereafter, the patient returned to an active social life. Unfortunately, the NCC-ST 439 serum level increased, and magnetic resonance imaging revealed an abnormal mass in the sternal manubrium and upper sternal body in January 2000 (Figure 1). No other remote metastases were found during further examination, and therefore surgical treatment was scheduled.

A longitudinal 10-cm skin incision was made above the sternum. The tumor did not seem to have invaded the surrounding tissue beyond the periosteum wrapping the sternum. The bilateral sternoclavicular joints were released, and the bilateral first to third rib cartilages were transected 20 mm or more from each sternocostal joint. Finally, the sternal body was divided at the upper edge of the fourth sternocostal joint, and the tumor was removed with

the sternal manubrium, upper sternal body, and part of the bilateral first to third rib cartilages. Negative margins were obtained in the operating room.

The new prosthetic bone (Ceratile; NGK Spark Plug Co, Aichi, Japan) was prepared in advance by cutting slots and holes in the Ceratile prosthesis for use as fasteners (Figure 2). The prosthesis was placed in the anterior chest wall. Nonabsorbable polyethylene tape (Nesplon; AZWELL Ins, Osaka, Japan) was used for connecting the prosthesis to each clavicle, and sternal wires and 0-0 silk sutures were used to attach the rib cartilage and the sternal body to the prosthesis. Two drainage tubes were placed below and above the prosthesis. Extubation of an endotracheal tube was performed in the operating room immediately after the operation without any respiratory trouble.

The postoperative course was uneventful, and the patient was discharged on the 14th postoperative day without any symptoms, such as paradoxical movement of the chest or regional effusion. She returned to regular activity 2 months after the operation. A chest radiograph showed neither dislocation nor abnormality of the prosthesis (Figure 3). She was doing well without any recurring signs of a tumor 2 years after the operation.

Discussion

The role of surgical intervention for recurrence and metastasis of breast cancer involving the chest wall and sternum remains controversial. Operations are considered for simple palliation and local control of the disease.^{1,2} In the reconstruction of the anterior chest wall, it is important to minimize chest deformity, prevent paradoxical movement of the anterior chest wall, and reduce the probability of thoracic organ injury caused by external impact.

Some autogenous or prosthetic materials are frequently required to reconstruct the anterior chest wall after a wide resection including the sternum. Muscle and myocutaneous flaps^{5,7} are used for reconstruction of a small anterior chest defect, and autogenous ribs are used as fresh nonvascularized autogenous rib graft or vascularized autogenous rib graft⁸ with muscle flaps. Although these materials are strong enough to prevent paradoxical movement of the chest wall, they are not always sufficient to protect thoracic organs from an external impact, and harvesting these flaps is slightly complicated. Furthermore, harvesting these grafts leads to some amount of deformity of the site harvested.

Prosthetic woven meshes⁹ (Prolene mesh [Ethicon, Inc, Somerville, NJ], Vicryl mesh [Ethicon, Inc], and Marlex [polypropylene] mesh¹⁰ [C. R. Bard, Inc, Billerica, Mass]), which are doubled over and sutured to adjacent ribs and fascia to cover the immediate surface of the skeletal defect, are also used. Although these meshes are easy to handle and have long-term tolerability without remarkable foreign body reactions, the strength is not always sufficient to protect underlying endothoracic organs from

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Received for publication April 21, 2003; accepted for publication May 28, 2003.

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J Thorac Cardiovasc Surg 2003;126:1212-4

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0022-5223/2003 \$30.00 + 0

doi:10.1016/S0022-5223(03)00933-4

Figure 1. Preoperative magnetic resonance image showing a 55 × 55-mm mass in the manubrium and upper sternal body.

Figure 2. A new prosthetic bone prepared in advance by cutting slots and holes in the Ceratite prosthesis for use as fasteners to reconstruct the anterior chest wall: *A*, frontal view; *B*, lateral view.

an external impact. Rigid prosthesis (methylmethacrylate) or moldable titanium plates are not used alone usually and are sandwiched between 2 layers of prosthetic mesh.^{5,11} The mesh-methacrylate composite has been frequently used on large anterior chest wall defects and provides chest wall stability, which minimizes ventilatory impairment. The size and shape of the prosthesis can be

determined easily in the operation. Although these various materials have some advantages and disadvantages, no materials, except autogenous ribs have osteoconductivity (ie, the ability to provide the appropriate scaffold or template for bone formation or capability of functioning as a cellular scaffold with a degradation profile suitable for bone regeneration). We decided to use this

Figure 3. Postoperative chest radiograph showing no dislocation of the Ceratite block.

prosthetic material, which has long-term tolerability and strength, to reconstruct the patient's anterior chest wall because she is very active and hesitated to have more deformity of the chest wall than that caused in the first operation. The new material, which was selected and used to reconstruct the anterior chest wall in this operation, is a ceramic prosthesis composed of hydroxyapatite and tricalcium phosphate (Ceratite).¹² Although the economic cost is a little bit high (10,000 yen per gram in Japan), the material has many advantages, such as osteoconductivity,¹³ strength, biocompatibility, and lack of risk of disease transmission associated with

these materials, and it is easy to shape. Ceratite is very useful, reliable, and safe for reconstructing anterior chest wall defects.

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