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Pectoralis major and serratus anterior muscle flap for diaphragmatic reconstruction

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Pectoralis major and serratus anterior muscle flap for diaphragmatic reconstruction

Muscle-flap diaphragmatic reconstruction

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Abstract

We have reported a new reconstruction method using a pectoralis major and serratus anterior muscle flap for diaphragmatic defects after chondrosarcoma resection. The reconstruction of diaphragmatic defects is challenging. In diaphragmatic reconstruction with chest wall defects, strong chest wall reconstruction and diaphragmatic flexibility are important to avoid interference with respiration. The artificial material Gore-Tex is used as the first choice, but it has infection-, exposure-, and durability-related drawbacks. As an alternative method using artificial material, we have reported our new technique—diaphragmatic reconstruction using a reversed-combined pectoralis major and serratus anterior muscle flap.

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Introduction

Chondrosarcoma is a rare sarcoma. Importantly, reconstruction for diaphragmatic defects associated with tumor resection must be strong and flexible to circumvent respiratory problems or diaphragmatic hernia. Reconstruction using artificial materials or the fascia lata without blood circulation has been reported.[1,2] However, diaphragmatic reconstruction with non-blood flow autologous tissue, such as artificial material or the fascia, may cause postoperative infections. Therefore, diaphragmatic reconstruction using muscle flaps has been reported.[3-7] Particularly, diaphragmatic reconstruction using reversed latissimus dorsi muscle flaps remains the first choice among muscle flaps, and its safety and efficacy have been reported in many cases.[5-7]

Muscle flaps used for diaphragmatic reconstruction are selected from the remaining surrounding tissue after sarcoma resection. Therefore, it is ideal to have various muscle flap options that may be used for diaphragmatic reconstruction. We have reported an alternative method for diaphragmatic reconstruction that combines reversed-combined pectoralis major muscle and serratus anterior (PM/SA) muscle flaps for diaphragmatic reconstruction after chondrosarcoma resection together with the diaphragm, rectus abdominis, external oblique, and latissimus dorsi muscles.

Technique

The patient was a 51-year-old man who noticed a soft-tissue mass measuring 25 × 20 cm^2

centered on the right chest toward the abdomen (Figure 1A). He had a history of hypertension and hereditary multiple exostoses. The soft-tissue mass was diagnosed as low-grade chondrosarcoma based on needle biopsy of the tumor, and the chondrosarcoma was secondary to hereditary multiple exostoses. Contrast-enhanced computed tomography (CT) showed infiltration of the right 8th to 12th ribs; right diaphragm; right liver lobe; and right latissimus dorsi, right rectus abdominis, and right external oblique muscles. No pelvic cavity metastases were noted (Figure 1B, C).

Chondrosarcoma resection was planned to include the right 7th to 12th ribs; right diaphragm; right liver lobe; and right latissimus dorsi, right rectus abdominis, and right external oblique muscles (Figure 2A).

Considering the possibility of infection at the time of tumor recurrence, we planned diaphragmatic reconstruction using an infection-resistant muscle flap and thoracoabdominal wall reconstruction using an anterolateral thigh (ALT) flap.

When selecting muscle flaps for diaphragmatic reconstruction, the rectus abdominis, latissimus dorsi, and external oblique muscles were not used because they were resected with the tumor. Therefore, diaphragmatic reconstruction was performed with a combination of right pectoralis major and serratus anterior (PM/SA) muscle flaps with the 6th intercostal artery as the muscle flap pedicle.

The pectoralis major muscle was detached from the 2nd to 6th ribs, which was nourished by

the anterior intercostal perforator vessels from the 6th intercostal space, and the PM/SA muscle flaps were harvested as a combined muscle flap (Figure 2B). Doppler ultrasonography revealed multiple perforating branches from the internal thoracic artery and perforator vessels of the 6th anterior intercostal artery; the entire muscle flap exhibited contrast enhancement from the perforator vessels on indocyanine green (ICG) angiography (Figure 2C).

The reversed-combined PM/SA muscle flap was inverted to the diaphragmatic defect at 270° centering at the 6th intercostal space and sutured to the diaphragmatic defect stump (Figure 2D). To reconstruct the thoracoabdominal wall skin defect, the fascia lata (3 × 25 cm^2) was attached to the ALT flap (3 × 20 cm^2), and the thoracoabdominal wall was reinforced by the fascia lata of the ALT flap. The ALT flap survived without complications.

Eight months postoperatively, contrast-enhanced CT was performed, confirming contrast enhancement in the reversed-combined PM/SA muscle flap used for diaphragmatic reconstruction (Figure 3A, B). Chest radiography confirmed diaphragmatic mobility during respiration (Figure 3C, D). The respiratory function test showed the following (preoperative vs. postoperative): vital capacity (L), 2.84 vs. 2.46; forced expiratory volume (FEV)1 (L), 2.35 vs. 2.40; and FEV 1%, 82.5 vs. 90.2. No hindrances in daily living were reported.

Comment

The first choice for diaphragmatic reconstruction involves using artificial materials because of the procedural ease.[6] However, reconstruction with artificial materials requires careful

usage indications considering infection if postoperative radiotherapy is planned or there is a high tumor recurrence possibility.[1-5,7] In contrast, autologous tissue reconstruction with blood flow is less likely to cause postoperative infection because it involves autologous tissue.[1-5] Reversed latissimus dorsi muscle flaps are often reported as the first choice for diaphragmatic reconstruction, but there are various muscle-flap choices, such as rectus abdominis, external oblique, and serratus anterior flaps.[1-5] Diaphragmatic reconstruction methods using these muscle flaps include the muscle tissue remaining after tumor resection, and the muscle flap to be used must be selected depending on the tumor resection site. In our patient, the 7th to 10th ribs; right diaphragm; right liver lobe; and right latissimus dorsi, right rectus abdominis, and right external oblique muscles were resected with the chondrosarcoma, limiting the usable muscle flaps. Therefore, the reversed-combined PM/SA muscle flap, which were nourished by the perforator vessels from the 6th anterior intercostal and internal thoracic arteries, was inverted 270° to reconstruct the right diaphragm.

The perforator vessels from the 6th anterior intercostal artery and internal thoracic artery perforator vessels are important to maintain blood flow in the reversed-combined PM/SA muscle flap.[8] Blood circulation in the pectoralis major muscle is largely controlled by four blood vessels, with reported territories for the thoraco-acromial, lateral thoracic, internal thoracic, and intercostal arteries. Per this report, the pectoral branch of the thoraco-acromial artery supplies 50.7% of the vascular territory of the pectoralis major. The lateral thoracic artery was

present in 37 of 43 angiograms, supplying a mean territory of 6.6%. The anterior intercostal perforating branches of the internal mammary artery supplies 43% of the muscle parenchyma. However, due to individual differences, the blood flow range cannot be unequivocally defined.[8]

Intraoperative ICG imaging confirmed that the PM/SA muscles were imaged entirely from the 6th intercostal perforator vessel to the internal thoracic and anterior intercostal arteries.

Additionally, postoperative contrast-enhanced CT confirmed contrast enhancement from the intercostal artery into the pectoralis major muscle.

Eight months postoperatively, the diaphragmatic movement was confirmed during respiration, and the flexibility of the pectoralis major muscle, which did not interfere with the remaining diaphragmatic contractile function, was confirmed. Additionally, although the FEV1 decreased, there were no problems in daily living, and the clinical course was favorable. Autologous tissue used for diaphragmatic reconstruction comprises a simple method similar to using the reversed-combined latissimus dorsi and serratus anterior muscle flap. The reversed-combined PM/SA muscle flap is an alternative reconstruction option.

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Figure 1.

(A) The soft-tissue mass was on the right chest wall.

(B, C) Contrast-enhanced computed tomography.

Figure 2.

(A) The right diaphragm after chondrosarcoma resection.

(B) The PM/SA muscle flap.

(C) ICG angiography.

(D) The PM/SA muscle flap was sutured to the diaphragmatic defect.

Figure 3.

(A, B) Eight months post-operation. Contrast-enhancement in the reversed-combined PM/SA muscle flap.

(C) Exhalation.

(D) Inhalation.

Figure

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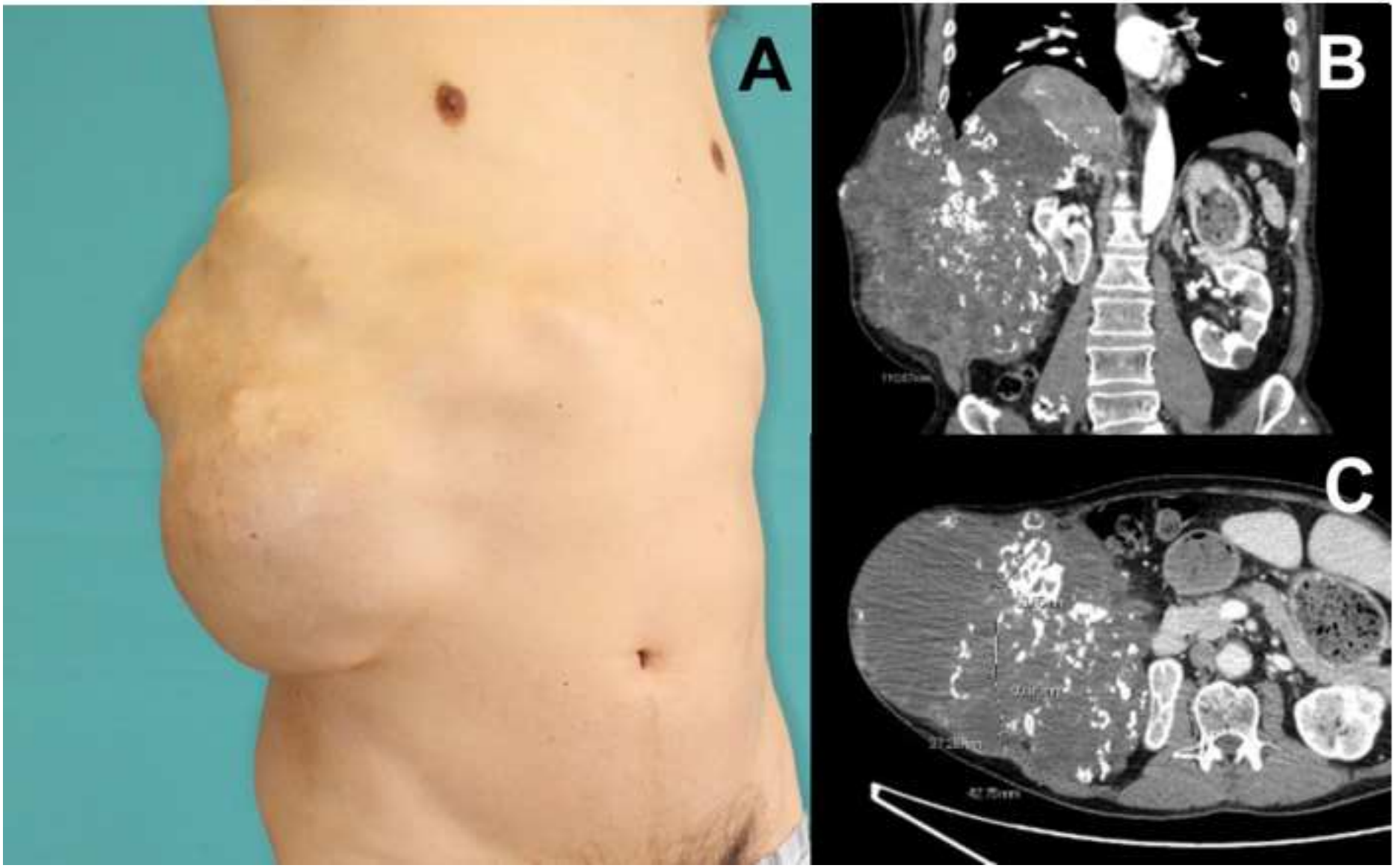

Figure

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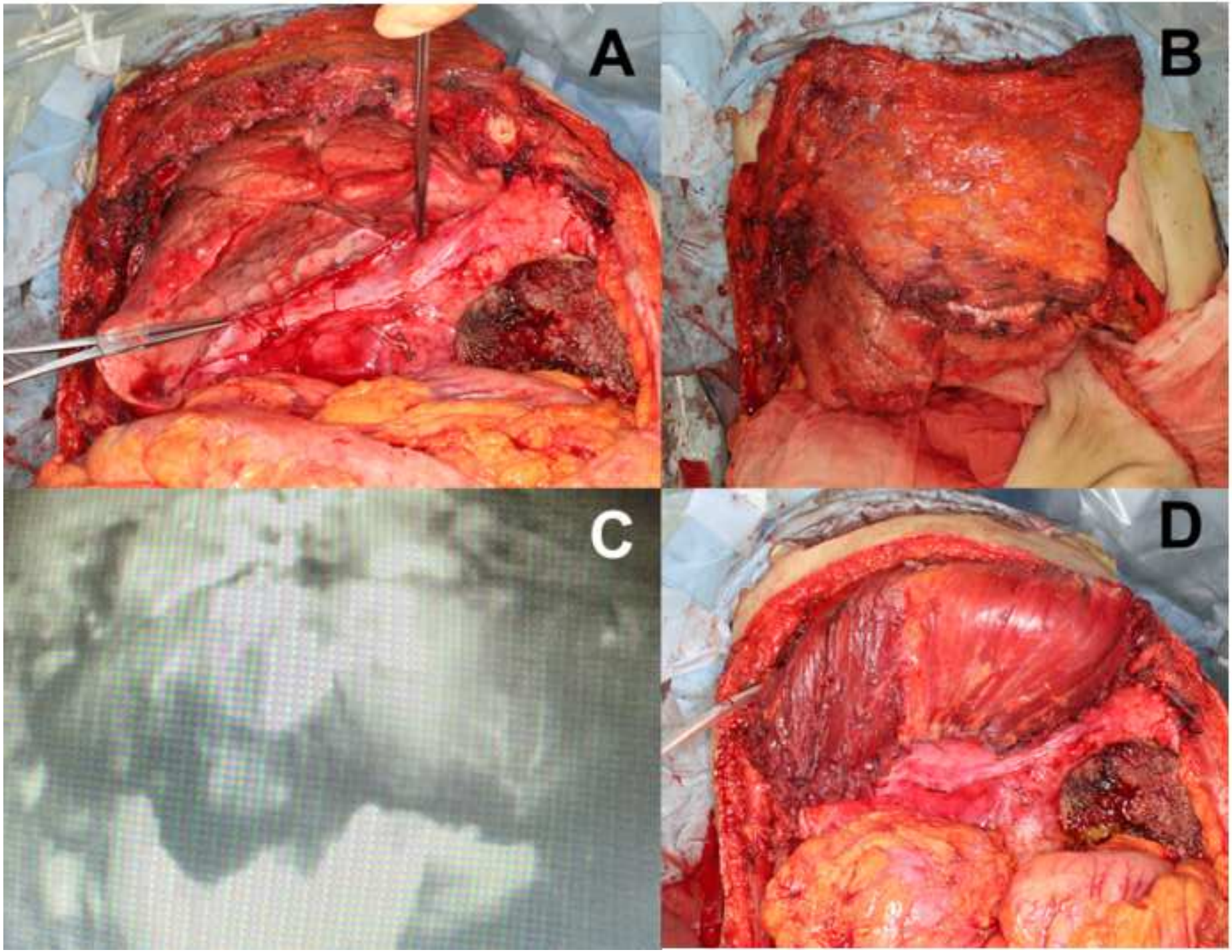

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