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흉벽 재건에서 합성 물질의 피복을 위한 부분 근피판 조합의 효용성

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Usfullness of Partial Muscle Flaps and Combination Method for Coverage of Prosthetic Material in Chest Wall Reconstruction

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Purpose: Reconstruction of chest wall has always been a challenging problem. Muscle flaps for chest wall reconstruction have been helpful in controling infection, filling dead space and covering the prosthetic material in this challenge. However, when we use muscle flaps, functional and cosmetic donor site morbidities could occur. The authors applied and revised various partial muscle flaps and combination use of them to cover the prosthetic material for the chest wall reconstruction and evaluated the usefulness of partial muscle flaps.

Methods: This study included 7 patients who underwent chest wall reconstruction using partial muscle flap to cover prosthetic material from 2004 to 2008. The pectoralis major muscle was used in anterior 2/3 parts of it leaving lateral 1/3 parts of it. The anterior 2/3 parts of the pectoralis major muscle were used while lateral 1/3 parts were left. In case of the rectus abdominis muscle flap, we used upper half of it, or we dissected it around its origin and then advanced to cover the site. The latissimus dorsi muscle flap was elevated with lateral portion of it along the descending branch of the thoracodorsal artery. If single partial muscle flap could not cover whole prosthetic material, it would be covered with combination of various partial muscle flaps adjacent to the coverage site.

Results: Flap coverage of the prosthetic material and chest wall reconstructions were successfully done. There occurred no immediate and delayed post operative complications such as surgical site infection, seroma, deformity of donor site and functional impairment.

Conclusion: When we use the muscle flaps to cover prosthetic material for chest wall reconstruction, use of the partial muscle flaps could be a good way to reduce donor site morbidity. Combination of multiple partial flaps could be a valuable and good alternative way to overcome the disadvantages of partial muscle flaps such as limitation of volume and size as well as flap mobility.

Key Words: Partial muscle flap, Chest wall reconstruction, Prosthetic material, Combination of flaps

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I. INTRODUCTION

There has been much progression since reconstruction of the chest wall using muscle flaps was first introduced by Tansini in end of the 19th century. Various muscle flaps have been used for chest wall reconstruction along with the vascular and muscle anatomy advancement. Among them, the pectoralis major muscle flaps, the latissimus dorsi muscle flaps and the rectus abdominis muscle flaps have been widely used for chest wall reconstruction due to adjacent location near chest wall. Major advantages of muscle flaps for chest wall reconstruction are to control infection, fill dead space and cover the prosthetic material. Especially if we would use skin flap only on the prosthetic material, possibility of dead space, seroma and infection could increase. So we recommend to use muscle flaps to cover the prosthetic material. However, if we use the muscle flaps, functional and cosmetic morbidities of donor site could occur. In case of the pectoralis major muscle, the cosmetic deformity due to loss of the anterior axillary line and difficulty of shoulder abduction could be a problem. In case of the rectus abdominis muscle flaps, abdominal wall weakness could occur causing hernia. In the latissimus dorsi muscle, the patients sometimes suffered from seroma and climbing motion difficulty. To minimize these complications, partial muscle flaps have been considered.

The authors applied various partial muscle flaps to cover prosthetic material for the chest wall reconstruction in the past five years in our center and revised combination method of them in some different ways to cover the large prosthetic material.

II. MATERIALS AND METHODS

7 patients were subjected to chest wall reconstruction with the prosthetic material and partial muscle flaps from 2004 to 2008 (Table I). The age ranged from 29 to 72, with the average of 48.9. Five patients were men and the other two were women. The causes of operation were thoracic involvement by tumor in 5 cases, infection after previous thoracic surgery in 2 cases, respectively. The locations of defect were the anterior including sternum in 4 cases, the lateral portion of chest in 2 cases and the posterior portion in 1 case, respectively. Numbers of rib resected were none in 1 case (sternum resection only case), three in 2 cases, four in 1 case and five in 3 cases, respectively. 3 cases had sternum resection. The average area of the defect was 184.6 cm^2. The prosthetic materials used in the operation were the Gore-Tex patches in 4 cases, the Prolene mesh in 1 case and Methylmethacrylate & prolene mesh sandwich for a stronger framework to reinforce sternal resection area in 2 cases, respectively.

Partial muscle Flaps used to cover prosthetic material were the pectoralis major muscle in 1 case, the rectus abdominis muscles in 2 cases, the latissimus dorsi muscled in 2 cases and combinations of these partial muscle flaps in 2 cases, respectively.

Muscle flap was partially used without whole dissection of muscle to minimize the complications of the donor site morbidity. We used anterior 2/3 parts of the pectoralis major muscle leaving lateral 1/3 of it in order to preserve the anterior auxiliary line. The lateral portion of the latissimus dorsi muscle flap along the descending branch of the thoracodorsal artery was elevated to avoid seroma and motion difficulties. In case of the rectus abdominis muscle flap, if internal mammary artery was saved, upper half of the rectus abdominis muscle was partially used. If it was not saved, upper part of the rectus abdominis muscle was dissected around its origin and advanced to cover site. If single partial muscle flap could not cover whole prosthetic material, it was covered with combination of these partial muscle flaps.

III. RESULTS

The average of hospital days after the surgery was 20.4 days and the mean follow-up period was 20 months. During the follow-up period, there were no complications such as surgical site infection, seroma, deformity of donor site and functional impairment related to operation. Some patients suffered from nausea and general weakness due to the planned radiotherapy and chemotherapy. 2 patients were dead due to lung and distant metastasis and 5 patients are on close observation in healthy condition.

Table I. Summary of Patients

Patient	Age/ Sex	Etiology	Location	Resected ribs	Defect size (cm)	Alloplastic material	Caverage
1	40/M	Wound infection after mesothelioma excision	Lateral	5	22 × 15	Gore-Tex	PRA
2	29/M	Recurred spindle cell sarcoma	Posterior	5	18 × 15	Gore-Tex	PLD
3	49/F	Wound infection after pneumonectomy	Anterior	3	13 × 12	Prolene mesh	PRA
4	61/M	Lung cancer	Anterior	5 (Sternectomy)	22 × 16	Prolene mesh + bone cement	PPM
5	37/M	Metastasis of hepatocellular carcinoma	Anterior	0 (Sternectomy)	9 × 5	Gore-Tex	Bilateral PPM & RAM
6	54/F	Malignant melanoma	Anterior	4 (Sternectomy)	21 × 17	Prolene mesh + bone cement	Bilateral PPM & RAM
7	72/M	Chest wall metastasis of gastrointestinal stromal tumor	Lateral	3	15 × 9	Gore-Tex	PLD

PPM, partial pectoralis muscle; PLD, patial latissimus dorsi muscle; PRA, partial rectus abdominis muscle

Case 1

A 72-year-old man underwent wide excision for chest wall metastasis of GIST (Gastro intestinal stromal tumor) (Fig. 1). Three ribs were resected and defect size was 15 × 9 cm^2. We maintained patency of the chest cavity using the Gore-tex patch and then elevated the lateral half portion of the latissimus dorsi muscle flap along the descending branch of the thoracodorsal artery without an additional incision. We covered the Gore-tex with the elevated flap and then performed skin closure (Fig. 2).

Case 2

A 54-year-old female patient underwent wide excision for recurred malignant melanoma around sternum (Fig. 3). Four ribs were resected and defect size was 21 × 17

Fig. 1. Case 1. Chest computed tomography image of 72 year old patient with GIST. There was large mass on right lateral chest wall involving some ribs.

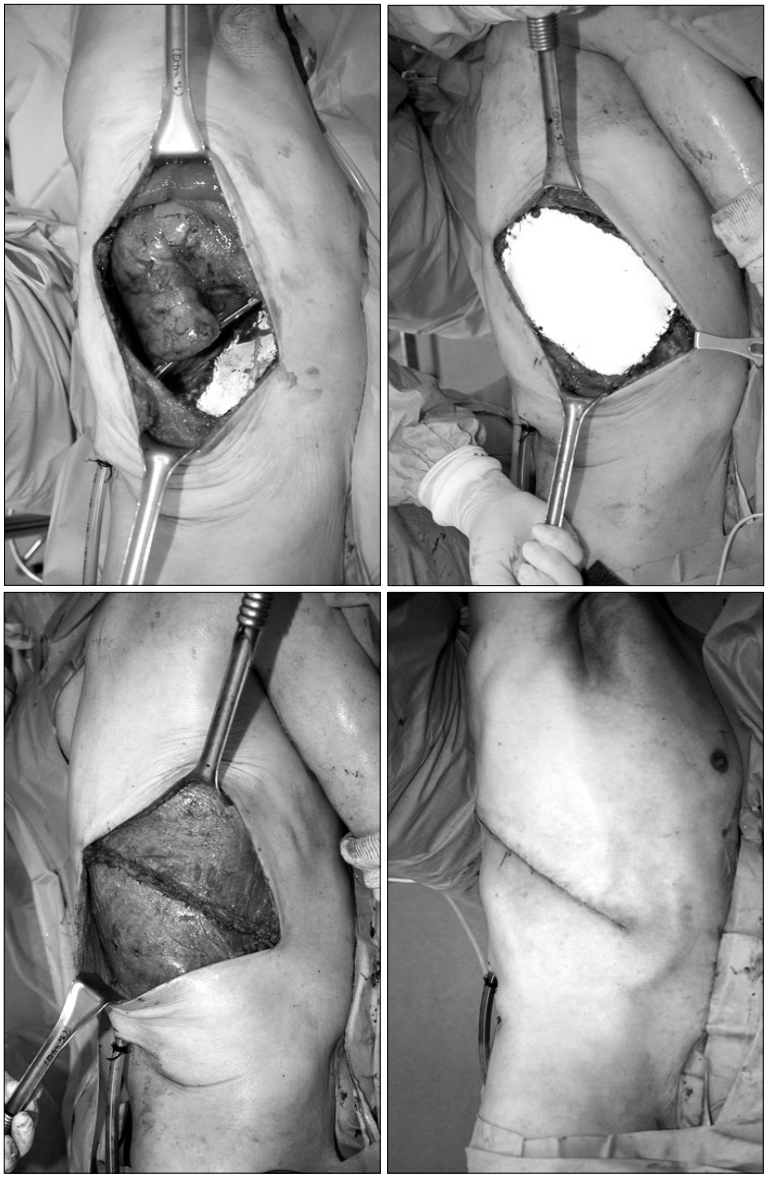

Fig. 2. Case 1. (Above, left) Large defect after chest wall resection exposing right lung cavity. (Above, right) Coverage with Gore-tex for air tightness. (Below, left) Covering Gore-tex with partial latissimus dorsi muscle flap. (Below, right) Skin closure. There was no additional incision.

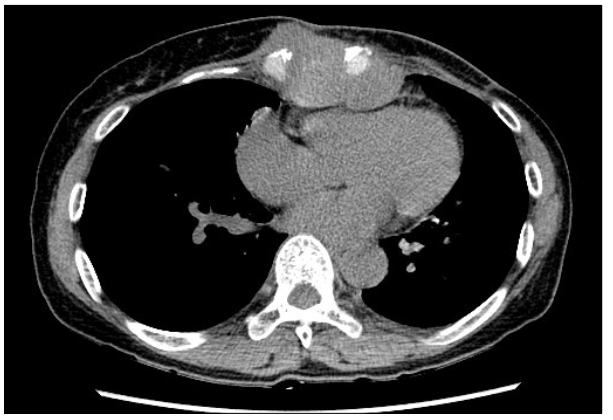

Fig. 3. Case 2. Chest computed tomography image of 54 years old female patient with malignant melanoma. We could find large mass on anterior chest with sternal involvement.

cm^2 with internal organs exposure. To create backbone like sternum, we used Methylmethacrylate & prolene mesh sandwich. Both medial half of pectoralis major muscles were separated and used to cover the upper portion of the prosthetic sternal backbone. Internal mammary arteries of both sides were sacrificed while wide excision. To cover lower portion of prosthetic sternal backbone, we dissected around origin of both side of the rectus abdominis muscles and advanced and interlocked them to elevated pectoralis major muscles used in upper portion of the prosthetics (Fig. 4).

IV. DISCUSSION

Chest wall reconstructions can be complex and chal-

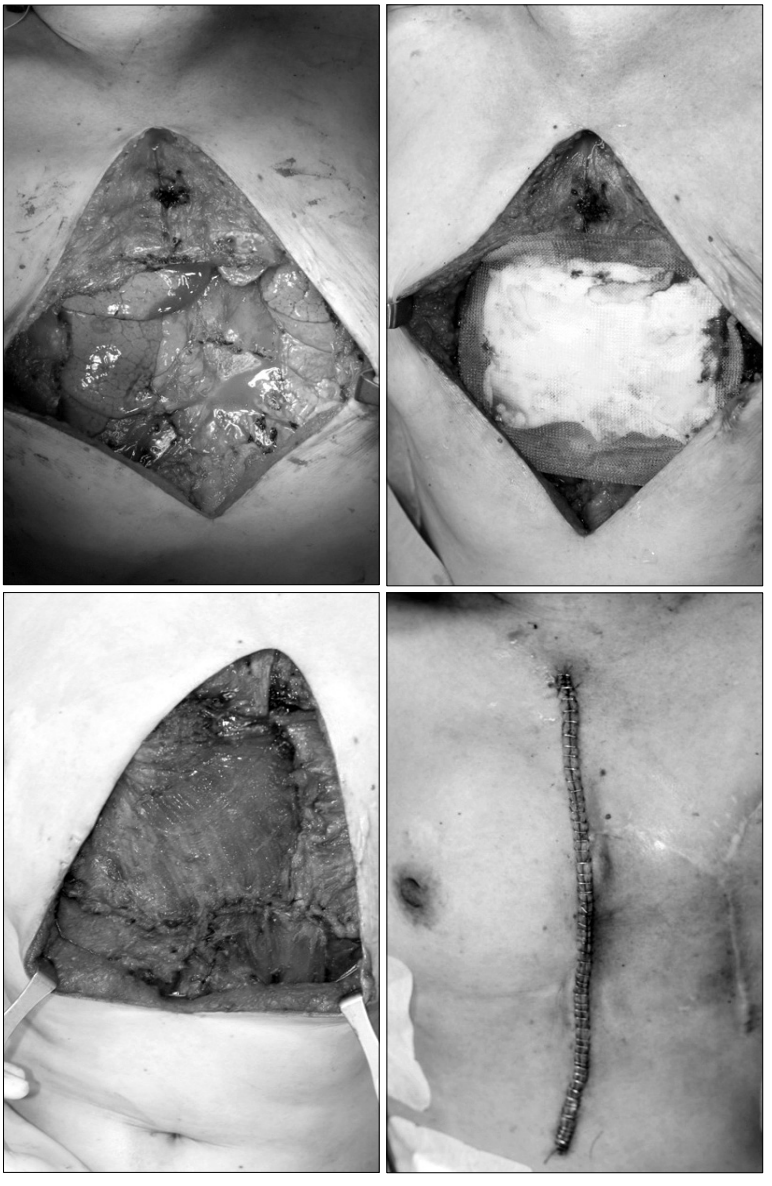

Fig. 4. Case 2. (Above, left) Large defect after chest resection with sternectomy. Four ribs were resected and defect size was $21 \times 17\ cm^2$ with internal organs exposure. (Above, right) Methylmethacrylate & prolene mesh sandwich for a stronger framework to reinforce sternectomy site. (Below, left) Combination of both the partial pectoralis major flaps and advanced both the rectus abdominis muscle flaps to cover Methylmethacrylate & prolene mesh sandwich. (Below, right) Skin closure. Also we did not need any additional incision for muscle flap elevation.

lenging procedure and may require some physiologically considerations. Restoration of skeletal stability was a very important factor among them because it should be required to protect intrathoracic contents such as heart, lungs and great vessels as well as to preserve the mechanical forces that allow respiration in chest wall reconstruction. To reach this goal, the ideal prosthesis should have following characteristics such as availability, ease of use, adaptability to any size and shape, durability, incorporation by body tissue and resistant to infection and so on.[5] The available prosthetic materials are diverse and can provide these characteristics. The Gore-Tex, Prolene, Marlex and Methylmethacrylate are used in chest wall for reinforcing the backbone now days. But post-operative wound infection was more common in the prosthetic material. But if we use skin flap only, possibility of exposure of prosthetic material, dead space, seroma and infection can be increased.[5] So the vascularised muscle flaps and omental flaps are often required to close larger defects, control infection, obliterate dead space, and provide coverage of prosthetic material. The highly vascularized omental flap has been widely used for chest wall reconstruction because it can provide relatively large size and fill large cavities. But it requires laparotomy to harvest with potential intraabdominal morbidity and it is difficult to accurately predict flap size preoperatively. Also it requires additional procedure such as skin graft.[4] Muscle flaps have been introduced in form of free tissue transfer and pedicled muscle or myocutaneous flaps. The pectoralis major, latissimus dorsi and rectus abdominis muscles remain the most common flaps for chest wall reconstruction.[4] However, if we use these muscle flaps, donor site morbidity could be a problem. The pectoralis major muscle flap is the most commonly used pedicled muscle flap for coverage of defects in the sternal, anterosuperior chest, intrathoracic and neck regions. These flaps sometimes require division of its humeral insertion and depending on the required reach, division of its clavicular origin and thoracoacromial pedicle. For these reasons, donor site deformity is significant if a portion of the overlying breast is included as a skin island. Loss of the anterior axillary fold is a result of complete muscle harvest.[1] This loss may be avoided if only the medial two thirds of the muscle is used as a turnover flap, sparing the lateral third and the thoracoacromial pedicle.[4] The authors used inner 2/3 of the pectoralis major muscle saving 1/3 outer portion to preserve the anterior axillary line (Fig. 6). It was used in 1 case. In the other 2 cases, we also use it with the partial rectus abdominis flap to cover the prosthetic material and good results were obtained without cosmetic and functional problem. The rectus abdominis flaps on the cover of the sternum area have been widely used with the pectoralis major muscle.[1] But there could be donor site morbidity of the rectus

Fig. 5. Case 2. Photograph of post-operative 35 days.

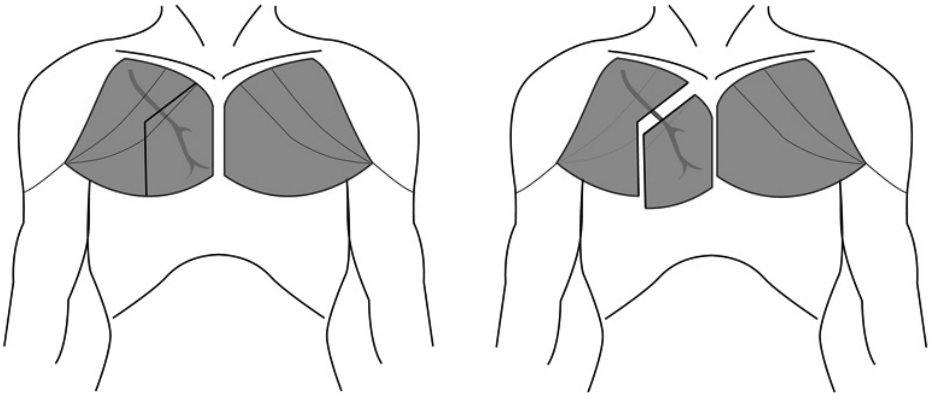

Fig. 6. How to use of the partial pectoralis major muscle for sternal coverage.

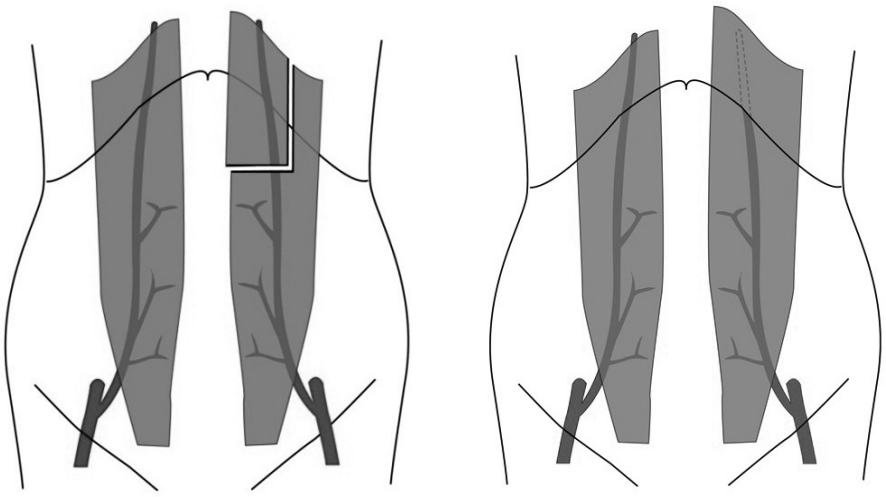

Fig. 7. How to use the partial rectus abdominis muscle flap. (Left) If the internal mammary artery was saved, upper half of the rectus abdominis muscle was partially harvested. (Right) If it was not saved, upper part of the rectus abdominis muscle was dissected around its origin and advanced to coverage site.

abdominis flap in the form of abdominal wall weakness such as abdominal bulges or hernias.[6] They remains the main criticism of the rectus abdominis flaps based on the deep epigastric system. In an effort to minimize donor site morbidity by preserving the muscular and fascial integrity of the abdominal wall, the deep inferior epigastric perforator flap and superficial inferior epigastric artery flap have been developed for the free tissue transfer.[4] But these are not muscle flaps. The authors used superior portion of the rectus abdominis flap partially if the internal mammary artery was preserved. When the internal mammary artery was damaged, we dissected it around its origin and superior portion of the rectus abdominis muscle and advanced it to prosthetic material with minimal damage of the muscle (Fig. 7). If it could not cover the whole prosthetic material, we combined it with the partial pectoralis major muscle flaps. The latissimus dorsi myocutaneous flap has been widely used in chest wall reconstruction owing to its reliability, size, and location.[4] The disadvantages of the latissimus dorsi muscle flap include a high donor site seroma, functional disability, conspicuous scar, and wound breakdown of the back incision.[2] The functional shoulder disability following the latissimus dorsi muscle harvest has generally been considered minimal but loss of strength of shoulder adduction and extension may have serious consequences for some patients. 2 Buntic F. tried to solve this problem, he dissected transverse branch to use upper part of the latissimus dorsi muscle for free tissue transfer.[2] The authors elevated lateral portion of the latissimus dorsi muscle along the descending branch of thoracodorsal artery with amount of flap we need. So we could performed the chest wall reconstruction maintaining flap mobility the same as using whole muscle flap without additional incision, seroma and any functional loss of motion of shoulder (Fig. 8).

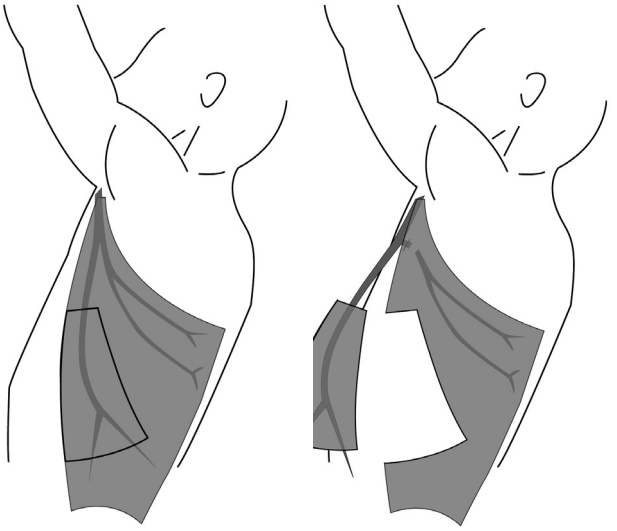

Fig. 8. How to use the partial latissimus dorsi muscle flap. The flap was elevated lateral portion of the muscle along the thoracodorsal artery with amount of flap needed. This method can help maintaining flap mobility the same as using whole muscle flap.

Thus, by using a partial muscle flap donor site shown above, problems of donor site can be overcome to some extent. In addition, operation time could be reduced

because it reduces the extent of dissection. Also scars could not be extended because additional incision for whole muscle elevation was not needed. However, there were some disadvantages of the partial muscle flap. Volume and size of flap could not be enough also it had limited flap mobility.[1] Free muscle transfer is commonly used in chest wall reconstruction because large defect can be occurred during chest wall resection. But donor vessel might be damaged in the process of chest wall resection so it is not always suitable for all occasions. Also harvesting whole one muscle flap to cover large prosthetic material could cause donor site morbidity as described. Operation time could be elongated and additional scar could be inevitable. The combination technique of these partial muscle flaps in each method as described could cover large defect without free muscle transfer and overcome limitation of flap mobility. This technique could be used in sternal coverage especially because the pectoralis major muscles and the rectus abdominis muscles were adjacent to it. Also if we could not use these muscle flaps due to previous operation or process of wide excision, we could recruit the latissimus dorsi partial muscle flap and compensate them because it has a wide mobility as enough. Though we used multiple muscle flaps in same time, partial harvest of each muscles could not increase donor site morbidity. Also we did not need additional scars and operation time could be reduced.

V. CONCLUSION

In the chest wall reconstruction, application of muscle flaps and prosthetic materials have been an effective way to maintain the physiological characteristics of the chest wall. By covering prosthetic material with muscle flaps, complications related to prosthetic material can be reduced. When we use the muscle flaps, the partial muscle flaps could be a good way to reduce donor site morbidity. Combination technique of multiple partial muscle flaps could be a valuable and good alternative way to overcome disadvantage of partial muscle flap such as limitation of volume and size and muscle mobility.

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