Complex Microsurgical Reconstruction After Tumor Resection in the Trunk and Extremities

Omar N. Hussain, MD, M. Diya Sabbagh, MD,
Brian T. Carlsen, MD*

KEYWORDS

• Microsurgery • Extremities • Sarcoma • Flap • Limb salvage surgery • Trunk

KEY POINTS

- Soft tissue tumors of the trunk and extremities represent a challenge because of the paucity of soft tissue and the relative close proximity with critical structures.
- A multidisciplinary team approach should be adopted, especially for the trunk and lower extremity.
- Every attempt should be made to preserve a limb. When amputation is inevitable, the remaining limb must be optimized to maintain function or to improve prosthesis control.
- Several flaps can be used to cover soft tissue defects in the trunk and extremity. Biological and synthetic materials can add to the wide variety of options in the armamentarium of the reconstructive surgeon.

GENERAL CONSIDERATIONS IN ONCOLOGIC RECONSTRUCTION

Thorough evaluation of the patients' health status, functional demands, location, and extent of the tumor as well as the tissue loss expected with tumor ablation procedures must be done before attempting any course of treatment. A multidisciplinary team approach also helps the reconstructive surgeon in selecting the appropriate flap for the defect and minimizing donor site defects, especially for trunk and lower extremity reconstruction.[1] Accurate assessment of the defect, meticulous dissection of the recipient site, precise microvascular anastomoses, and proper flap insets are essential factors for an optimal outcome. The timing of the reconstruction depends on the surgeon's preference and the patients' medical status, but it is preferable to do the reconstruction immediately after tumor resection. This approach decreases the number of operations and minimizes contamination of deep tissues and structures.[2–4]

Reconstruction in patients with cancer is unique, as adjuvant chemotherapy and radiation therapy can affect wound healing and flap survival; neoadjuvant radiation therapy usually creates a zone of injury that extends beyond the margins of resection. Furthermore, patients with cancer are well known to be hypercoagulable and, therefore, have a higher risk for venous thromboembolism. Chemotherapy, radiation, and immobilization further increase the risk of thromboembolic events in this special patient population. All of these factors make oncologic reconstruction more challenging and necessitates careful planning and individualization of treatment plans.[2,5–9]

GOALS OF RECONSTRUCTION IN THE TRUNK

The primary goals of chest wall reconstruction are stabilization of thoracic skeletal defects that may

The authors have no financial interests to declare in relation to the content of this article.
Division of Plastic Surgery, Mayo Clinic, 200 First Street, Rochester, MN 55905, USA
* Corresponding author.
E-mail address: Carlsen.Brian@mayo.edu

Clin Plastic Surg ■ (2016) ■–■
http://dx.doi.org/10.1016/j.cps.2016.11.008

alter respiratory mechanics, obliteration of intrathoracic dead space, protection of vital intrathoracic structures and suture lines, and soft tissue coverage of extrathoracic defects.[10] Other considerations include avoiding lung herniation, counteracting substantial shrinking of the thorax, leading to thoracoplastylike effect, preventing entrapment of the scapula in posterior resections, protecting mediastinal organs against external impact, and maintaining a good cosmetic chest contour.[11] Additional challenges exist when reconstructing the lower extremities. These challenges include restoring painless function be it ambulation in regard to the lower extremity or fine dexterity and hand function in regard to the upper extremity. The slower rate of nerve regeneration and the higher incidence of flap failure and wound complications add to the complexity of extremity reconstruction.[2,3,5,12,13]

FREE TISSUE TRANSFER FOR TRUNK RECONSTRUCTION

Chest wall tumors account for most indications for chest wall reconstruction in large retrospective series, which include primary lung cancer, primary chest wall tumors, contiguous breast cancer, and metastases.[14–18] The most common benign chest wall tumors are osteochondromas, chondromas, fibrous dysplasia, and desmoid tumors. The most common primary malignancies are soft tissue sarcoma, chondrosarcoma, and Ewing sarcoma.[18] Wide local excision is the mainstay of treatment. High-grade malignancies and desmoid tumors typically require 4-cm margins of normal tissue, whereas low-grade malignancies are typically resected with 1- to 2-cm margins. Bony involvement for many lesions necessitates resection of the entire rib or sternum with resection margin guidelines of one normal rib above and below the level of involvement.[18–20] The excision of tumors with a wide margin of normal tissue leads to large defects that routinely require complex reconstruction of the chest wall and soft tissue coverage.[14–17] Chest wall reconstruction after tumor resection should be approached in a systematic fashion. Depending on the type of tumor, extent of resection, and history of radiation, reconstructive options include primary closure, skin grafts, local flaps, pedicled muscular, musculocutaneous flaps, and free flaps.

The chest wall is divided into the anterior, lateral, and posterior regions. Prosthetic skeletal reconstruction is typically reserved for anterior chest wall defects greater than 5 cm or involving 3 or more contiguous ribs because of the increased chance of paradoxic chest wall motion.[18,21] Posterior chest wall defects can tolerate up to a 10-cm diameter resection because of support from the scapula unless the defect extends beyond the fourth rib where entrapment of the scapula can occur during movement of the arm.[15] However, the reconstructive plan must be tailored to each individual patient. Patients with borderline pulmonary function may require reconstruction for smaller defect to avoid postoperative insufficiency, and others with rigid chest walls from radiation or adhesions may tolerate larger defects without affecting pulmonary function.[22] Synthetic options for skeletal support include polytetrafluoroethylene, polypropylene, Vicryl, mesh-methyl methacrylate sandwich, methyl methacrylate neo-ribs, osteosynthesis systems, and dedicated sternal prostheses.[11,15] Biological options include autogenous tensor fascia latae, rib grafts, bovine pericardium, or acellular dermal matrix.[14,21,23]

Intrathoracic infection from ongoing airway or esophageal leak is a life-threatening condition often attributed to the presence of a persistent pleural space and continuing empyema.[24,25] Intrathoracic muscle transposition can augment the closure of the leak with well-vascularized tissue and prevent recurrence and the long-term sequelae of ongoing infection.[25] This transposition can be performed with pedicled pectoralis major, serratus anterior, latissimus dorsi, and omentum flaps.[17,26–29] In complex cases after multiple operations, local muscles are often no longer available for reconstruction because of transection or previous attempts at reconstruction. Intrathoracic free tissue transfer has been shown to provide an abundance of well-vascularized tissue with the versatility of accessing the entire intrathoracic cavity and reducing morbidity by covering the fistula repair and obliterating the pleural dead space in a single operation.[27–29]

Extrathoracic soft tissue coverage should be anticipated preoperatively and requires a combined effort between the extirpative surgeon and the reconstructive surgeon for coverage of prosthetic devices, maintenance of intrathoracic integrity, and restoration of aesthetic contours while improving survival and minimizing donor site morbidity.[10,11,14–18,20–23] Anticipation of further resections for recurrence is necessary to maximize the use of local flaps while preserving options for future reconstruction, and a variety of reconstructive algorithms have been described.[17,29–32]

Recurrence is common after resection of soft tissue sarcoma in the chest, with 23% of patients experiencing a recurrence and 38% of those presenting as a local recurrence an average of 11.6 months after resection.[33] The only factor improving survival after surgical resection of