Oncologic Resection and Reconstruction of the Chest Wall: A 19-Year Experience in a Single Center

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Background: The aim of this study was to analyze chest wall reconstruction following oncologic resection performed by a single surgeon over a 19-year period.

Methods: A retrospective review was performed for 135 patients who underwent oncologic chest wall resection from 1997 to 2015.

Results: Average patient age was 57.8 years. Indications for resection were advanced breast cancer (n = 44), soft-tissue sarcoma (n = 38), bone sarcoma or chondrosarcoma (n = 28), desmoid tumor (n = 11), metastasis from other cancers (n = 7), and other primary tumors (n = 7). There were 72 full-thickness and 63 partial-thickness resections (34 soft-tissue resections only and 29 skeletal bone resections only). Resection margins were wide (n = 29), marginal (n = 82), and intralesional (n = 24). Reconstruction was warranted in 118 cases: chest wall stabilization and flap coverage in 57, chest wall stabilization only in 36, and soft-tissue flap coverage only in 25 cases. In total, 82 flaps were performed (17 free flaps and 65 pedicled/local flaps). There were no perioperative mortalities or flap losses. Complications occurred in 29 operations (Clavien-Dindo classifications grade II, n = 12; grade IIIa, n = 4; grade IIIb, n = 10; and grade IVa, n = 3) and 19 reoperations were necessary. Median follow-up was 49 months. Survival was calculated by the Kaplan-Meier method. One-, 2-, and 5-year survival rates were 84, 82, and 70 percent, respectively.

Conclusion: With careful patient selection, appropriate perioperative and postoperative care, and accurate surgical technique, even extensive chest wall resections and reconstructions are safe. (*Plast. Reconstr. Surg.* 142: 536, 2018.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

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THERAPEUTIC

Extensive chest wall resections are nowadays feasible because of improvements in surgical technique, perioperative and intensive care, and developments in soft-tissue reconstruction methods. Chest wall resections pose a unique surgical challenge because of the complex anatomy of the chest wall and its protective function for vitally important organs.[1]

Large chest wall defects usually result from tumor resection, infection, trauma, radiation therapy, or congenital deformities.[2] Oncologic chest wall tumor resection may be attributable to a primary, locally invading, or metastatic tumor. The most common oncologic indications for chest wall resection are bone and cartilage tumors, soft-tissue sarcomas, advanced lung cancer, and breast cancer.[3,4]

Oncologic chest wall resection can be performed with a curative or palliative intention.[5] Despite modern advances in oncologic and surgical care, some patients are still treated with palliative intention, because of pain, infection, and tumor ulceration. Palliative surgery may be justified to attain better quality of life and symptom palliation.[6,7]

The goals of chest wall reconstruction are widely accepted. Reconstruction should provide

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adequate stability, allowing maximal physiologic movements, avoid paradoxical chest wall motion, and provide airtight closure.[7,8] Reconstruction should also protect the vital intrathoracic structures and restore respiratory function and obliterate dead space in the chest wall cavity.[1,5,9] Thus, coverage with well-vascularized soft tissue is essential, as is providing an acceptable cosmetic appearance.[10]

Pedicled myocutaneous flaps are usually the soft-tissue flap of choice for the coverage of chest wall defects.[2] When these flaps are inadequate in size or no longer available, microvascular reconstruction may be mandatory to achieve well-vascularized soft-tissue coverage.[11,12]

There is a paucity of literature reporting large patient series. To the best of our knowledge, there are only a few reports of series including over 100 patients.[2–4,13,14] This may be attributable to the rarity of the cases and challenges posed by this complex surgical procedure. Therefore, the aim of this current study was to retrospectively analyze chest wall reconstructions following oncologic resection during a 19-year period in the Helsinki University Hospital. Our focus was surgical outcome and patient survival.

PATIENTS AND METHODS

The hospital electronic database at the Department of Plastic Surgery, Helsinki Finland, was searched for patients who had undergone chest wall resection at the department from January 1, 1997, to December 31, 2015. These data were confirmed and completed with information from the electronic patient records. We included only patients having undergone oncologic chest wall resection. Exclusion criteria consisted of infected sternotomy or other chest wall infection, simple benign tumor excision with direct closure, congenital chest wall deformity, or bronchopleural fistula. The study plan was approved by the Ethics Committee of Helsinki University Central Hospital, and 135 patients were eventually selected for analysis.

Data were collected for age, sex, tumor type and location, extent of resection, anatomical location, and reconstructive method. Follow-up began from the date of the chest wall operation and ended at the time of death, or the end of the study period (June 30, 2016), whichever occurred first. The Charlson Comorbidity Index[15] was calculated for each patient based on the diagnosis in the computerized medical records, and postoperative complications were classified according to the Clavien-Dindo classification,[16] which consists of seven complication grades (I, II, IIIa, IIIb, IVa, IVb, and V) based on the severity and on the type of therapy needed to correct the complication. Statistical analysis was performed using NCSS 8 software (NCSS, LLC, Kaysville, Utah). Survival was calculated by the Kaplan-Meier method.

RESULTS

Of the 135 patients undergoing chest wall resection, 118 also underwent chest wall reconstruction. In short, 70 percent of patients were female, with a mean age of 60 years. Previous radiotherapy was given at the site of chest wall for 50 patients (37 percent). Detailed patient demographics are illustrated in Table 1. Resections and reconstructions in this series were all performed by the senior author (E.T.).

Resection Surgery

All patients in this study had chest wall resection because of a tissue defect resulting from tumor removal. The most common indications were breast cancer, soft-tissue sarcoma, and osteosarcoma or chondrosarcoma, comprising 81 percent of all cases. Table 2.

Our series included 72 full-thickness and 63 partial-thickness chest wall resections (of which 34 were soft-tissue resections only and 29 were skeletal bone resections only). Operative resection characteristics are listed in Table 3.

The most common anatomical site of chest wall resection was anterolateral [n = 77 (57 percent)]. Rib resection was performed in 95 operations (70 percent). A median of three ribs were resected. The median defect size was 156 cm^2 (range, 9.9 to 1400 cm^2). The histologic margins were wide (>2.5 cm or intact fascia/pleura) or marginal (1 mm to 2.5 cm) in 111 cases (82 percent).

Reconstruction/Reconstructive Surgery

All patients had one-stage surgery that included tumor removal and defect reconstruction in the same procedure. In only 17 patients (13 percent) could the chest wall defect be closed primarily, whereas the remaining 118 (87 percent) patients all required chest wall reconstruction (Table 4).

We used mesh if the resection included one or two ribs to prevent bulging or herniation of lung. Additional stabilization with the sandwich technique (methyl-methacrylate between two meshes) or earlier rib graft with mesh was used if

Table 1. Patient Characteristics

Characteristic	Value (%)
No. of patients	135
Age, yr	
Median	60
Range	17–90
Sex	
Male	41 (30)
Female	94 (70)
BMI, kg/m^2	
Median	25.2
Range	17–39
Current smoking	
Yes	19 (14)
No	116 (86)
Comorbidities	
Hypertension	33 (24)
Diabetes	11 (8)
Thyroid disease	9 (7)
COPD/pulmonary disease	7 (5)
Coronary artery disease	6 (4)
Atrial fibrillation	6 (4)
Congestive heart failure	5 (4)
Previous myocardial infarction	5 (4)
Previous chest wall surgery	5 (4)
Therapeutic anticoagulation	4 (3)
Previous pulmonary embolism history	3 (2)
Rheumatoid arthritis	3 (2)
Aortic dilatation	2 (1)
Oncologic history	
None	62 (46)
Previous chemotherapy	22 (16)
Previous radiotherapy at site	50 (37)
Previous chemoradiotherapy	1 (1)
American Society of Anesthesiologists class	
I	22 (16)
II	59 (44)
III	44 (33)
IV	10 (7)
Charlson comorbidity index	
Median	2
Range	2–8
Average	3.5
Charlson age-comorbidity index	
Median	5
Range	2–12
Average	5.1

BMI, body mass index; COPD, chronic obstructive pulmonary disease.

Table 2. Indication for Resection and Tumor Characteristics

Characteristic	Value (%)
No. of patients	135
Breast cancer	
Total	44
Primary (locally advanced)	7
Recurrent/metastatic	37
Soft-tissue sarcoma	
Total	38
Primary	34
Recurrent	3
Metastatic	1
Osteosarcoma or chondrosarcoma	
Total	28
Primary	26
Recurrent	2
Desmoid tumor	11
Metastases	
Total	7
Melanoma	2
Colorectal cancer	2
Epidermoid cancer	1
Renal cancer	1
Ovary cancer	1
Other primary tumors	
Total	7
Solitary fibrous tumor	2
Basosquamous carcinoma*	1
Neuroendocrine tumor	1
Basal cell carcinoma	1
Granulocellular tumor	1
Osteochondroma	1

*Gorlin-Goltz syndrome.

Table 3. Operative Resection Characteristics

Characteristic	Value (%)
No. of resections	135
Location	
Anterolateral	77 (57)
Thoracoabdominal	22 (16)
Anterior (sternal)	21 (16)
Posterolateral	12 (9)
Forequarter amputation	4 (3)
Resection	
Full-thickness resection	72 (53)
Partial-thickness resection	63 (47)
Only skeletal bone resections	29
Only soft-tissue resection	34
Rib resection	95 (70)
Average no. of resected ribs	2.8
Sternal resection	49 (36)
Diaphragmatic resection	20 (15)
Clavicle resection	13 (10)
Lung resection	7 (5)
Liver wedge resection	1 (1)
Defect size, cm^2	
Median	156
Range	9.9–1400
Operative margin	
Wide	29 (21)
Marginal	82 (61)
Intralesional	24 (18)

the resection comprised three or more ribs in the anterolateral or anterior area (including ribs I to VII) or extended Forequarter amputation (FQA) (sometimes including ribs I to III). However, if the resected ribs were inferior (VII to XII, usually thoracoabdominal resections) or posterolateral (covered with scapula and muscles), additional stabilization was not used. Chest wall stabilization was performed in 93 patients, whereas in 25 patients soft-tissue coverage alone with a flap was sufficient and actual chest wall stabilization was unnecessary.

Chest wall stabilization consisted of 59 cases using a mesh, 20 cases using a sandwich-technique (methyl-methacrylate between two meshes), 13 cases using free avascular rib grafts and a mesh, and one case using titanium bars Stratos (Medxpert, Eschbach, Germany). In 57 patients

Table 4. Reconstructive Procedures*

	All (%)	Full-Thickness Resection	Partial-Thickness Resection
Total	118 (87)	72	46
Reconstruction			
Chest wall stabilization and flap coverage			
Total	57	57	0
Mesh and pedicular/local flap	20	20	0
Mesh and cement sandwich plus pedicular/local flap	12	12	0
Mesh and rib graft plus pedicular/local flap	11	11	0
Mesh and free flap	7	7	0
Mesh and cement sandwich plus free flap	4	3	0
Mesh and rib graft plus free flap	2	2	0
Mesh and Stratos† plus pedicular/local flap	1	1	0
Chest wall stabilization			
Total	36	12	24
Mesh	32	9	23
Mesh and cement sandwich	4	3	1
Soft-tissue flap coverage			
Total	25	3	22
Pedicular/local flap	21	1	20
Free flap	4	2	2
Primary chest wall closure	17 (13)	0	17
All	135 (100)	72	63

*n = 135.
†Strasbourg Thoracic Osteosyntheses System (MedXpert GmbH, Eschbach, Germany).

undergoing chest wall stabilization, concurrent soft-tissue reconstruction with a flap was indicated. The remaining 36 patients undergoing chest wall stabilization did not require flap reconstruction.

Overall, soft-tissue reconstruction with a flap was performed in 82 patients (Table 5). Pedicled (Fig. 1) or local flaps were used in 65 patients (79 percent) and a free flap (Fig. 2) was necessary in 17 patients (21 percent). The most common pedicled flap used was the ipsilateral musculocutaneus latissimus dorsi flap [n = 58 (70 percent)] and the most common free flap used was the tensor fascia lata flap [n = 11 (14 percent)].

We compared the free flap patients with the patients who underwent correction with other flaps. Median defect size in free flap patients was larger, 248 cm^2 versus 168 cm^2 ($p < 0.001$). Previous chest wall surgery, previous radiation therapy, resection (partial- versus full-thickness resection), and location of resection showed no statistical difference. The recipient vessels for the free flaps are listed in Table 6.

Table 5. Flaps Used*

	No. (%)
Free flap	17 (21)
TFL	8 (10)
TFL and rectus femoris	3 (4)
TRAM	2 (2)
Upper extremity fillet flap	2 (2)
ALT	1 (1)
TFL and ALT	1 (1)
Pedicular/local flap	65 (79)
Latissimus dorsi (ipsilateral)	58 (70)
Mammary gland (used as flap)	3 (4)
Rectus abdominis (supercharged)	1 (1)
Pectoralis major	1 (1)
Propeller flap	1 (1)
Rotation flap	1 (1)

TFL, tensor fascia lata; TRAM, transverse rectus abdominis musculocutaneous; ALT, anterolateral thigh.
*n = 82.

Surgical Outcome and Complications

Operative details and surgical outcomes are listed in Table 7. Median operative time was 225 minutes in all operations and 375 minutes (range, 250 to 495 minutes) in microsurgical operations.

By role, patients were extubated within 24 hours after the operation. Extubation was performed in the operating room in 71 cases (53 percent) and in the intensive care unit in 64 cases (47 percent). Median length of stay in the intensive care unit was 1 day (range, 0 to 38 days). Seven patients stayed in the intensive care unit for more than 10 days and needed prolonged ventilation assistance (Table 8). One of these needed tracheostomy, because of severe general complications (pneumonia, heart-related complication, sepsis, and respiratory failure).

There were no perioperative mortalities or flap losses. In the majority of patients [n = 106 (79 percent)], no complications were observed.

The most common complications included partial flap loss [n = 8 (5 percent)], pneumonia [n = 7 (5 percent)], and cardiac-related complications [n = 6 (4 percent)] (Table 9). In this series, 19 reoperations were needed (Table 10).

Fig. 1. (*Above*, *left*) Chest wall recurrence of breast cancer. (*Above*, *right*) Anterolateral chest wall resection. (*Below*, *left*) Chest wall stabilization with a sandwich technique (methylmethacrylate between two meshes). (*Below*, *right*) Soft-tissue reconstruction with a pedicled musculocutaneus latissimus dorsi flap.

Surgical complications were classified with the Clavien-Dindo classification (Table 11). Grade I complications were not evaluated. Preoperative radiation therapy did not statistically significantly increase the incidence of wound complications ($p = 0.595$).

A more complex reconstruction (chest wall stabilization and flap), intralesional surgical margins, increased blood loss, and increased operative time were all associated with a significantly increased risk of complications ($p < 0.05$). Full-thickness chest wall resection, increased blood loss, and prolonged operative time were associated with a significantly increased length of intensive care unit stay ($p < 0.05$). Patient age was not significantly correlated to length of intensive care unit stay ($p = 0.077$).

Follow-Up, Survival, and Mortality

Average follow-up was 68 months (range, 2 to 232 months), with a median of 49 months. There was no 30-day mortality. By the end of the study period, 80 patients were alive and 53 had died. Two patients had moved overseas. We compared

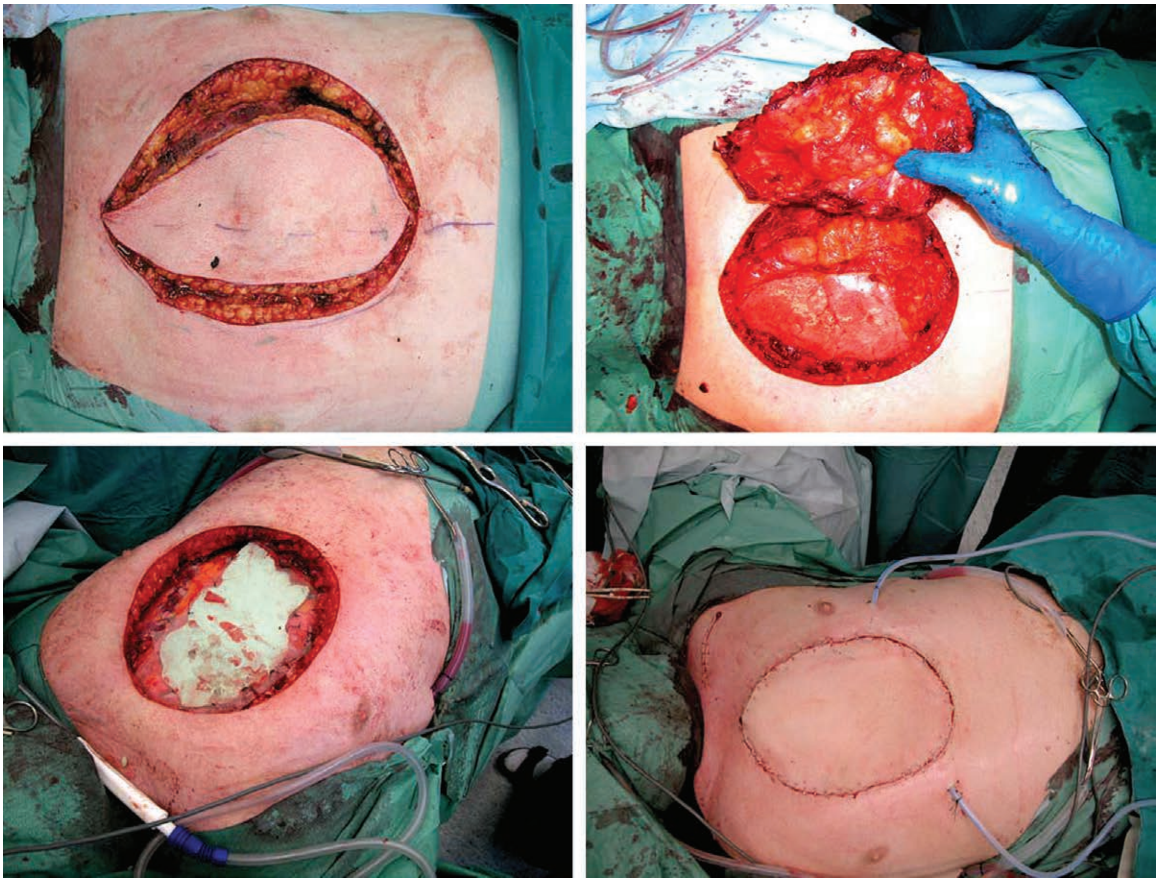

Fig. 2. (*Above*, *left*) Chest wall chondrosarcoma. (*Above*, *right*) Anterior full-thickness resection. (*Below*, *left*) Chest wall stabilization with a sandwich technique. (*Below*, *right*) Soft-tissue reconstruction with a free flap from tight area.

Table 6. Recipient Vessels for Free Flaps

	No.
Artery	17
Internal thoracic artery	4
Subclavian artery	4
Vein loop from femoral artery	3
Subscapular artery	3
Thoracodorsal artery	2
Axillary artery	1
Vein	17
Subclavian vein	5
Axillary vein	3
Vein loop to femoral vein	3
Internal thoracic vein	2
External jugular vein	2
Circumflex scapular vein	1
Thoracodorsal vein	1

Table 7. Operative Characteristics and Outcomes

Characteristic	Value (%)
Operative time, min	
Median	225
Range	35–600
Blood loss, ml	
Median	600
Range	80–7500
Extubated in the OR	71 (53)
Extubated in the ICU	64 (47)
Admission to the ICU	79 (59)
Length of stay in the ICU, days	
Median	1
Range	0–38
Length of stay in the hospital, days	
Median	9
Range	1–40
Complications	
No	106 (79)
Yes	29 (21)
No. of reoperations	19

OR, operating room; ICU, intensive care unit.

the 80 living patients with the 53 patients who died. High American Society of Anesthesiologists class ($p = 0.024$), appearance of complication ($p = 0.048$), and high Charlson Comorbidity Index ($p = 0.015$) were significantly more/higher in patients who died; there was no statistical difference between groups in smoking ($p = 0.213$), grade of complication ($p = 0.697$), or body mass index ($p = 0.813$).

Survival for all patients (Fig. 3) and subgroups (Fig. 4), and disease-free survival for all patients

Table 8. Reasons for Prolonged Ventilator Treatment/Intensive Care Unit Treatment in Seven Cases*

	No.
Pneumonia	4
Heart-related complication	4
Pleural effusion	3
Respiratory failure	1
Arterial/vein thrombosis of the flap	1
Empyema	1
Hematoma	1
Sepsis	1
Pulmonary embolism	1

*Each patient could have one or several reasons listed.

Table 9. Complications in 135 Patients Undergoing Chest Wall Surgery

Complication	No. of Patients (%)
General	
Pneumonia	7 (5)
Heart-related complication	6 (4)
Pulmonary embolism	2 (1)
Sepsis	2 (1)
Respiratory failure/problem	1 (1)
Ileus	1 (1)
Deep vein thrombosis	1 (1)
Primary operation area/chest wall	
Distal tip necrosis of the flap	8 (6)
Wound infection	6 (4)
Pleural effusion	5 (4)
Abscess	2 (1)
Skin necrosis	2 (1)
Arterial/vein thrombosis of the flap	2 (1)
Hernia	1 (1)
Titanium bars broken (latent)	1 (1)
Empyema	1 (1)
Hematoma	1 (1)
Bowel perforation	1 (1)
Donor side	
Wound infection	5 (4)
Wound dehiscence	4 (3)
Wound necrosis	3 (2)

Table 10. Reason for Reoperation

Reason	No.
Total	19
Flap tip necrosis	5
Donor-site minor wound complication	4
Anastomosis vein thrombosis	2
Surgical-site infection	2
Hematoma	1
Empyema	1
Late bowel perforation	1
Severe general complications (tracheostomy was needed)	1
Titanium bars broken (latent)	1

Table 11. Clavien-Dindo Classification of Surgical Complications

	No.
Total no. of complications	29
Grade	
II	12
IIIa	4
IIIb	10
IVa	3
IVb	0
V	0

(Fig. 5) and subgroups (Fig. 6), were calculated using the Kaplan-Meier method. Subgroups consisted of chondrosarcoma or osteosarcoma, soft-tissue sarcoma, and advanced breast cancer. One year, 2-year, and 5-year survival rates are listed in Table 12.

DISCUSSION

In this study, we reviewed our 19-year experience with chest wall resection and complex chest wall reconstruction, focusing on surgical outcome and patient survival. Chest wall resection and reconstruction can be considered a safe therapeutic modality, following careful patient selection, appropriate perioperative and postoperative care, and accurate surgical technique. To the best of our knowledge, this present series is one of the largest in the world and thus far the largest series in Europe.

Our series consisted of only oncologic chest wall resection patients. In other large series published, the patients have been more heterogeneic, and they have also included bronchopleural fistulae,[14] infections,[2,4,13,14] osteoradionecrosis,[2–4,13,14] trauma,[4] and congenital deformities,[4] none of which were included in our study.

Smaller reported series have included only oncologic resection patients.[17–20] There were no advanced lung cancer patients in our series, because they are treated by another multidisciplinary tumor board.

We calculated the Charlson Comorbidity Index for each patient and the median for all series. In general, the calculated index helps to classify prognostic comorbidity and potentially compare patients' prognostic comorbidities in different series. However, the Charlson Comorbidity Index has not been calculated in other series.

In our series, 51 of 135 patients (37 percent) had received previous radiotherapy (or chemoradiotherapy) to the resection site. In the large series by Deschamps et al.,[13] only 41 of 197 patients (21 percent) had received earlier radiotherapy. This, however, did not increase the incidence of wound complications in our study group. This could possibly be accounted for by flap selection outside of the radiation zone.

Resection

We report a higher rate of sternal area resection than in other large series: 49 of 135 (36 percent) versus 53 of 197 (27 percent),[13] 27 of 113 (24

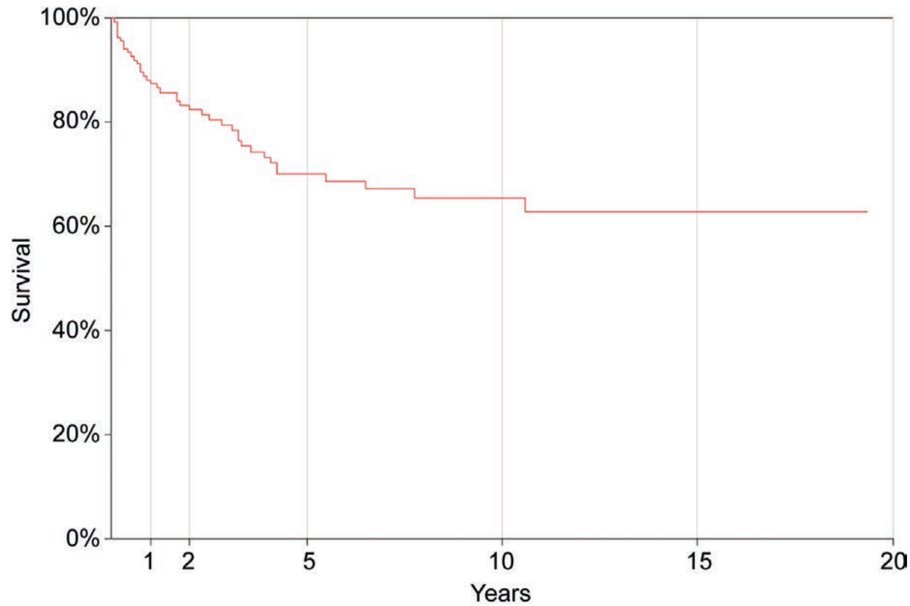

Fig. 3. Survival for all patients.

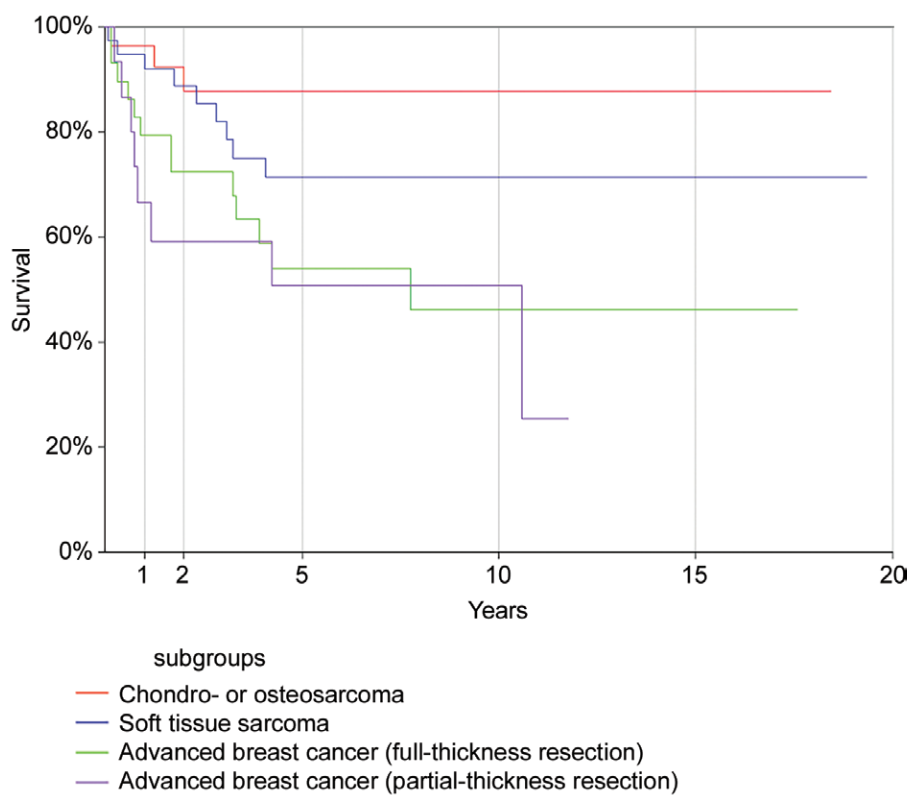

Fig. 4. Subgroup survival.

percent),[14] and 56 of 200 (28 percent).[4] Sternal resection is well tolerated and patients recover well. Success in achieving adequate surgical margins was observed, with 82 percent cases with wide or clear histologic margins. This was despite some operations being performed with palliative intention.

Reconstruction

In reconstructive procedures, we adhered to the reconstructive elevator algorithm.[21] We aim to avoid the use of skin grafts, as they are suboptimal in this type of defect reconstruction. Most cases of reconstruction were performed with

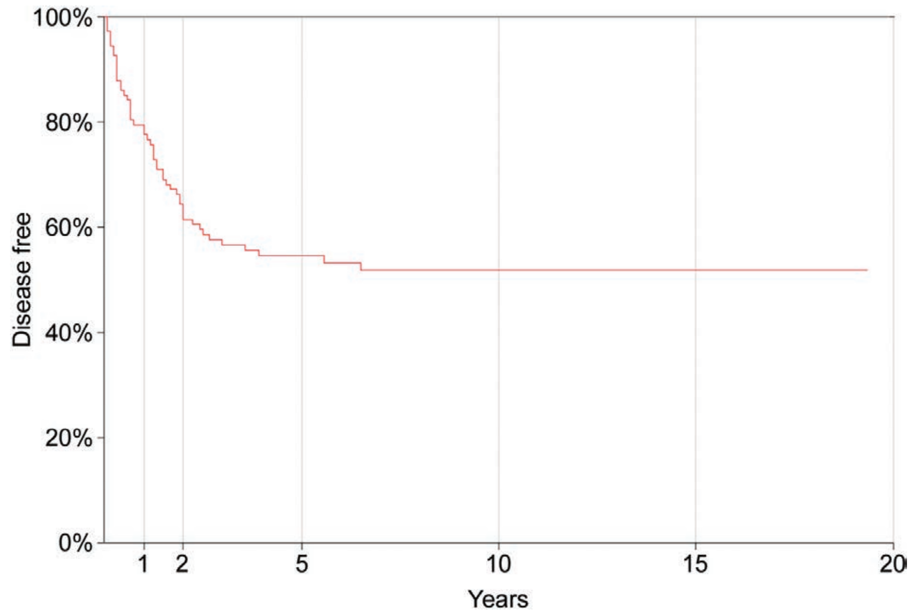

Fig. 5. Disease-free survival for all patients.

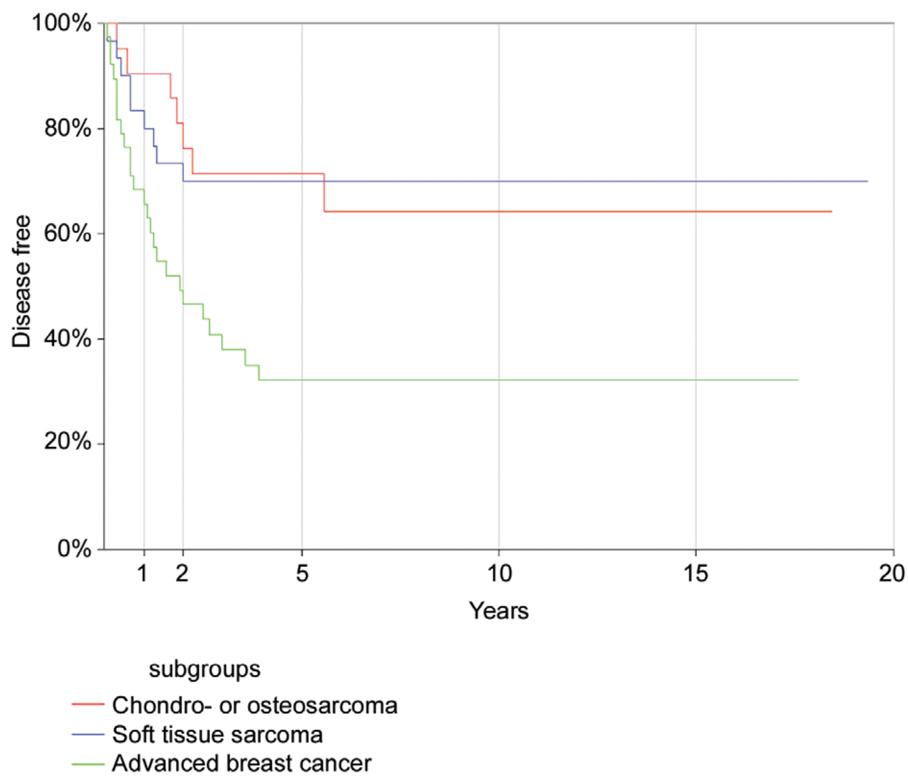

Fig. 6. Subgroup disease-free survival.

chest wall stabilization and coverage with a soft-tissue flap. For stabilization, a mesh or mesh and cement sandwich or ribs were used. In the early years, we used mesh and free avascular ribs in some cases, but nowadays we use a methylmethacrylate cement sandwich between two layers of mesh. Our and other authors'[14,22] experience with methylmethacrylate is very favorable, as it provides a fast, cost-effective, tailor-made prosthesis; is associated with less pain; and does not result in an extra donor site (in contrast to a rib graft donor area).

Weyant et al. reported a higher wound infection rate with methylmethacrylate prostheses than

Table 12. Survival Rates

	All	Osteosarcoma or Chondrosarcoma	Soft-Tissue Sarcoma	Advanced Breast Cancer
No. of patients	135	28	38	44
30-day mortality, %	0	0	0	0
1-yr survival, %	84	96	92	73
2-yr survival, %	82	88	85	68
5-yr survival, %	70	88	71	53

with other prostheses.[23] In our series, the wound infection rate was not higher in patients treated with methylmethacrylate. The traditional sandwich technique seems to work well in our hands. We have always used antibiotic cement, despite the fact that, in most cases, the operative field was not contaminated or ulcerated. We carefully casted and designed our sandwich and fixed the borders on the outer surface of the bony structures to prevent any roughness to compress visceral organs, especially large vessels or the heart.

Bioprosthetic materials are expensive, and long-term results are sparse. These materials have been introduced rather recently. We have used these only in growing children (Askin tumors), but these patients are not in this series.

We did not observe any cases of paradoxical chest wall movement. Local or pedicled flaps were used when possible. If these flaps were unavailable or deficient in size, microsurgical flaps were used instead.

Microsurgical reconstruction in particular warrants good surgical planning to achieve a fast and safe operation. Our median operative time in microsurgical operations was 375 minutes (range, 250 to 495 minutes). In these cases, the patient was maintained in the same position throughout the operation with a two-team approach. Flaps with constant anatomy and large vessels for anastomosis, from areas with no negative effect on breathing, were selected. We did not observe any flap losses, which supports our flap and vessel selection. Free flaps were necessary in 21 percent of our patients, which is somewhat higher than in other series—6 percent,[14] 11 percent,[4] and 10 percent[3]—possibly because of the more extensive resections of tumors.

Complications

We used the Clavien-Dindo classification of surgical complications. The benefit of using the Clavien-Dindo classification is that it standardizes the estimation of surgical complications in different surgical series.[16] However, in other chest wall resection series, authors have not used the Clavien-Dindo classification. In view of this, we also included a conventional complications table to compare our results with those of other surgical series. There were no major differences in complication rates.[2–4,13,14] In our series, we did not estimate Clavien-Dindo grade I (very mild complication) at all, because we thought that it would be difficult, ambiguous, and irrelevant. Late complications occurred in two cases. These consisted of broken titanium barriers requiring removal and one thoracoabdominal case in which reconstruction with only a soft-tissue flap was complicated by the eventual development of a hernia.

Follow-Up and Survival

Median follow-up was 49 months, and only two patients were excluded from the series, because they had moved overseas. Thirty-day mortality was 0 percent in our series, and in other series it has been reported to be 4 to 7 percent.[3–5,13,14] In the literature, reported 5-year survival in different subgroups has been in chondrosarcomas and bone sarcomas (92.3 to 64 percent),[24,25] in soft-tissue sarcomas (89 to 57 percent),[26–28] and in advanced breast cancer (68.5 to 9.4 percent).[6,20,29] In our series, the respective rates were 88, 71, and 53 percent. These survival rates reflect the varying biological behavior of these different malignant diseases, patient material, and selection.

We acknowledge several limitations to this study. The retrospective reviewing of clinical diagnostic data from the medical records, not initially intended for research work, is prone to bias.

CONCLUSION

With careful patient selection, appropriate perioperative and postoperative care, and accurate surgical technique, even extensive chest wall resections and reconstructions are safe.

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CODING PERSPECTIVE

Coding perspective provided by Dr. Raymond Janevicius is intended to provide coding guidance.

19260	Excision of chest wall tumor including ribs
14301	Adjacent tissue transfer or rearrangement, any area; defect 30.1 to 60.0 cm^2
14302	Adjacent tissue transfer or rearrangement, any area; each additional 30.0 cm^2, or part thereof
15734	Muscle, myocutaneous, or fasciocutaneous flap; trunk
15757	Free skin flap with microvascular anastomosis
15756	Free muscle or myocutaneous flap with microvascular anastomosis
20902	Bone graft, any donor area; major or large
32999	Unlisted procedure, chest

- Tumor resection is reported with code 19260. This code does not include reconstruction.
- 14301 and 14302 are used to describe local tissue rearrangements (adjacent tissue transfers), including skin flaps and breast flaps. These codes are reported based on total defect size in square centimeters.
- Pedicled muscle flaps are reported with code 15734.
- Free skin flaps (e.g., anterolateral thigh) are reported with code 15757. Free muscle and myocutaneous flaps (e.g., tensor fasciae latae, rectus femoris, transverse rectus musculocutaneous) are reported with code 15756. One code is reported for each separate free flap.
- If rib grafts are used to stabilize the chest wall defect, code 20902 is reported for each rib graft.
- If a mesh is used for reconstruction, code 32999 is used, as there is no specific code for mesh placement.

CODING PRINCIPLE: Muscle and myocutaneous flap codes (1573X) are global and include the following:

- Muscle exposure, including elevation of skin.
- Design and preservation of skin paddle on muscle flap.
- Elevation of flap, including disorigination and disinsertion of muscle.
- Identification, dissection, and preservation of vascular pedicle(s).
- Transfer of muscle or myocutaneous unit.
- Inset of flap.
- Straightforward closure of donor site.

Disclosure: Dr. Janevicius (janeviciusray@comcast.net) is the president of JCC, a firm specializing in coding consulting services for surgeons, government agencies, attorneys, and other entities.

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