RAPID COMMUNICATION

Surgically-challenging chondrosarcomas of the chest wall: five-year follow-up at a single institution

Daniel Reis Waisberg, Fernando Conrado Abrão, Angelo Fernandez, Ricardo Mingarini Terra, Paulo Manuel Pêgo-Fernandes, Fabio Biscegli Jatene

Division of Thoracic Surgery, Heart Institute (InCor), Hospital das Clinicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP), São Paulo, SP, Brasil.

Email: fernandocabrao@uol.com.br
Tel.: 55 11 30697145

INTRODUCTION

Chest wall primary malignant tumors are among the rarest cartilaginous tumors, accounting for 8% of cases[1]. Additionally, the chest wall is not the most common site for chondrosarcomas (15% of chondrosarcoma cases)[2]. One can reasonably conclude that this lack of cases is responsible for the scarcity of studies on thoracic chondrosarcomas.

The optimal treatment for this tumor has not improved over time; radical surgery remains the only curative option. There is no effective chemotherapy, and the tumor is relatively radio-insensitive. Therefore, the pursuit of wide-margin resections often leads to the need for complex chest wall reconstruction techniques.

Even though this series addresses a small sample of patients, it includes a considerable number of tumors that were surgically challenging due to their large size and/or anatomically unfavorable locations for performance of wide-margin resections.

Case Reports

A total of eleven patients were selected for the study. The series consisted of eight males (72.7%) and three (27.3%) females with a mean age of 51.5 years (range: 24 to 74 years). Eight (72.7%) of the tumors were located in the ribs, and three (27.3%) were in the sternum. Chest computed tomography (CT) scans were used to diagnose the tumor size, its extension to the ribs and sternum and its extension to vessels beyond pleuropulmonary dissemination. The main surgical aspects of the study are summarized in Table 1. All patients had a primary chondrosarcoma and underwent curative surgery. The mean follow-up time was 63 months (range: 15 to 167).

Only three (27.3%) patients noticed a palpable asymptomatic thoracic mass. Eight pre-operative biopsies were performed in 7 (63.6%) cases (cases: 1, 2, 3, 6, 7, 10 and 11). A cartilaginous malignant neoplasm was reported in 7 biopsies.

Rib resection was performed in 8 of the cases (mean: 2.5 ribs, range: 1 to 4) and a subtotal sternectomy in 3. The mean tumor size was 10.66 cm (4 to 21 cm), measured by the largest diameter. Reconstruction techniques included the use of Marlex mesh for 10 cases (90.9%) and a muscle flap for 5 (45.4%) (isolated *pectoralis major* in 3, *rectus abdominis* and *latissimus dorsi* in 1 and *rectus abdominis*, *pectoralis major* and *pectoralis minor* in 1). There was one case in which an isolated *pectoralis major* muscle flap was used during surgery for local recurrence. The surgical margins were intralesional (defined as positive microscopic margins) in 5 patients (45.4%), wide (defined as 4 cm of healthy tissue surrounding the tumor margin) in 4 (36.4%) and marginal (defined as microscopically free from tumor but less than 4 cm from the tumor margin) in 2 (18.2%). High-grade tumors (GIII) were observed in 2 patients (18.2%), intermediate-grade tumors in 8 (72.7%) and low-grade tumors (GI) in 1 (9.1%). The average duration of postoperative hospital stay was 8.81 days (range: 2 to 32).

Four patients are currently alive with no evidence of disease (NED) (cases 8 through 11). There was one perioperative death (case 3), and three patients died due to metastatic disease (cases 1, 4 and 7). It was not possible to retrieve data about the postoperative course for three patients (cases 2, 5 and 6).

Regarding the perioperative death (case 3), the patient developed mediastinitis that was surgically treated, but the patient died five days later due to septic shock.

Regarding the three patients who died during follow-up (cases 1, 4 and 7), the first patient had three recurrences, the first of which occurred nine years later. All of these recurrences were treated surgically. Two years after the last resection, the patient died due to metastatic disease. The second patient (case 4) was identified as lost at the 25-month follow-up. He was alive with NED at the last clinical evaluation performed. The third patient (case 7) underwent *en-bloc* rib resection and lung segmentectomy due to a large grade II chondrosarcoma (20×14×13 cm). One year later, she underwent lung metastasectomy and was scheduled for adjuvant chemotherapy, but she died four months later due to tumor recurrence.

Four patients demonstrated postoperative complications. The complications included the following: mediastinitis followed by death, as previously described (case 3); abdomino-thoracic hernia with liver and bowel protrusion, which was treated with Marlex mesh (case 4); infected hemothorax following surgery, leading to pulmonary decortication (case 6); and an intra-operative internal mammary artery lesion and foreign body granuloma in the sternal wound that was resected 15 months later (case 9).

Table 1 - Characteristics of the 11 patients with chest wall chondrosarcomas.

Case n°	Site	Surgical procedure[a] (resection-reconstruction)	Tumor Size (grade)	Margins	Local recurrence[a]	Recurrence treatment	Follow-up (months)	Status
1	Ribs	Rib resection[2] – MM	7 cm LD (II)	Intralesional	Yes	Rib resection[3× times (3, 2 and 2 ribs)]	167	Dead (metastatic disease)
2[b]	Ribs	Rib resection[4] – MM, *rectus abdominis* and *latissimus dorsi* flap	8.5×7.5×6 cm (II)	Intralesional	Unknown	Unknown	None	Unknown
3	Sternum	Subtotal sternectomy – MM, *rectus abdominis, pectoralis major and minor* flap	18×17×11 cm (III)	Intralesional	No	-	-	Perioperative death (mediastinitis)
4[c]	Ribs	Rib resection[1] – None	4.5×4×3 cm (II)	Wide	No	-	25	Unknown
5	Ribs	Rib resection[1] – MM	5×3.5×3 cm (I)	Wide	Unknown	Unknown	None	Unknown
6	Sternum	Subtotal sternectomy – MM and *pectoralis major* flap	8×7×3.5 cm (III)	Intralesional	Unknown	Unknown	None	Unknown
7	Ribs	Rib resection[3] and lung segmentectomy – MM and *pectoralis major* flap	20×14×13 cm (II)	Marginal	No	Lung metastasectomy	16	Dead (metastatic disease)
8	Ribs	Rib resection[1] – MM	6×4.5×4 cm (II)	Wide	Yes	Rib resection[2]	94	Alive (NED)
9	Sternum	Subtotal Sternectomy – MM	4×3.5×3 cm (II)	Intralesional	No	-	65	Alive (NED)
10	Ribs	Rib resection[4] – MM	21×14×13 cm (II)	Marginal	Yes	Liver Segmentectomy and Rib Resection	59	Alive (NED)
11	Ribs	Rib resection[4] – MM	9,5×6×5 cm (II)	Wide	No	-	15	Alive (NED)

MM, Marlex mesh; LD, largest diameter; NED, no evidence of disease
[a]Superscript numbers represent the number of ribs resected.
[b]Patient referred from another service with local recurrence.
[c]Patient lost at follow-up 25 months after surgery.

Tumor recurrence occurred in 4 of 7 patients (cases 1, 7, 8, 10) after excluding the cases without follow-up (cases 2, 5, 6) and the case of perioperative death (case 3). The mean disease-free interval until recurrence was 43.9 months (12.6 to 115.2). All of the tumors in these patients demonstrated an intermediate degree of differentiation; the margins were intralesional in 1 patient (case 1), marginal in 2 (cases 7 and 10) and wide in 1 (case 8). All of these patients underwent a new surgery. Two of the patients died due to disease progression (cases 1 and 7), whereas two of them are currently alive without any signs of recurrence (cases 8 and 10), with a mean disease-free interval post-recurrence surgery of 51.3 months. For all four of these cases, this interval was 41.2 months (4.3 to 81.2). Survival is indicated in Table 1.

DISCUSSION

In the last 10 years, only three studies have specifically addressed chondrosarcomas of the chest wall[3-5]. Similar to our study, those series addressed a homogenous group of patients over a short period of time.[3,4] However, we acknowledge that the failure to follow-up for three patients calls for a careful analysis of the data. In one study on magnetic resonance (MR) and CT scan evaluations of chondrosarcomas, 90% of the cases revealed cortical destruction, whereas the radiographic assessment revealed a rate of only 65%.[6] Pathological fractures were evident in 36% of the radiographies, 27% of the CT scans and only 10% of the MR images.[6] We thus believe that the lack of magnetic resonance imaging did not influence our approach toward the patients we reported.

Histologically, chondrosarcomas have a distinctive multinodular architecture. The cells are aligned in cords, and the strands lie in a myxoid stroma. The cells have round or oval nuclei and a deeply eosinophilic cytoplasm. Epithelioid cells may be found as well and lead to diagnostic difficulties. Immunohistochemically, the tumor cells exhibit variable expression of vimentin and S100, and epithelial membrane antigens are usually negative for keratins.[7] Because the diagnosis can be facilitated by analyzing different areas within the tumor, some clinicians prefer excisional biopsies over incisional or needle biopsies.[8] When a wide resection does not involve significant morbidity, our group advocates the use of intra-operative biopsy to define whether the lesion is malignant. A pre-operative biopsy (excisional for masses < 5 cm, otherwise incisional or needle) should be performed when a wide resection will result in a complex chest wall reconstruction or a high-morbidity operation due to the presence of a large mass. Following this strategy, we still observed a high incidence of pre-operative biopsies (63.6% of cases), most of them incisional (75%), probably due to the size of the tumors. The mean tumor size was 10.66 cm, whereas other series reported 8 cm.[5]

Intralesional and marginal margins have been identified as risk factors for local recurrence; the hazard ratios are 28.1 and 12.2, respectively, when compared with wide margins, according to Widhe et al.[5] In the present study, we observed a high incidence of intralesional margins (45.4%) and low incidences of marginal (18.2%) and wide (36.4%) margins. We consequently observed a higher recurrence rate compared to other series[2-5] and assumed that this discrepancy

might be due to the presence of large masses (the mean size observed in this study was 10.66 cm) in difficult-to-reconstruct locations. In fact, among the patients treated with curative intent and non-wide margins, 3 of 7 had tumors located in the sternum, and the remaining cases involved procedures with relatively high morbidity and mortality, such those performed at the clavicles, at the cervicothoracic transition and at the *axillary cavum*. Another factor that may have contributed to our recurrence rate was a higher prevalence of GII (72.7%) and GIII (18.2%) tumors, which have been correlated with worse prognoses.[5,8]

We prefer Marlex mesh when bone stabilization is required, and it was used in 90.9% of our patients. Gonfiotti et al.[9] used a prosthetic material in 71% of 41 patients, primarily a 2-mm expanded polytetrafluoroethylene (ePTFE) patch. This material has additional features, such as two antimicrobial preservative agents, a smooth visceral surface to minimize adhesions, and a textured external surface for tissue in-growth, which result in its higher cost. We advocate the use of plain Marlex mesh because no complications were observed in this series. Muscle flaps were used in 5 of the patients (45.4%) in close interaction with the plastic surgery team, which is similar to the rates reported by other studies (12.5 to 29.3%).[3,9]

The treatment goal for chest wall chondrosarcomas must initially be surgical resection, regardless of the size or histological grade of the tumor, as long as it is resectable.[1-5] In this context, the best result is obtained when the resection includes 4-cm margins.[5] There are no known factors that can influence the manifestation of chondrosarcomas in sites unfavorable to resection; however, early detection can reduce the occurrence of unresectable cases.[1-5]

CONCLUSIONS

Despite the limited sample size, higher recurrence rates were observed in our study, mainly due to a high incidence of bulky chondrosarcomas located in anatomically unfavorable locations, such as the clavicles, the sternum, the cervicothoracic transition and the *axillary cavum.*

REFERENCES

1. Sabanathan S, Salama FD, Morgan WE, Harvey JA. Primary chest wall tumors. Ann Thorac Surg. 1985;39:4-15, doi: 10.1016/S0003-4975(10)62515-5.
2. Burt M, Fulton M, Wessner-Dunlap S, Karpeh M, Huvos AG, Bains MS, et al. Primary bony and cartilaginous sarcomas of chest wall: results of therapy. Ann Thorac Surg. 1992;54:226-32, doi: 10.1016/0003-4975(92)91374-I.
3. Briccoli A, De Paolis M, Campanacci L, Mercuri M, Berton F, Lari S, et al. Chondrosarcoma of the chest wall: a clinical analysis. Surg Today. 2002;32:291-6, doi: 10.1007/s005950200040.
4. Fong YC, Pairolero PC, Sim FH, Cha SS, Blanchard CL, Scully SP.Bricolli. Chondrosarcoma of the chest wall: a retrospective clinical analysis. Clin Orthop Relat Res. 2004;427:184-9, doi: 10.1097/01.blo.0000136834.02449.e4.
5. Widhe B, Bauer HC. Surgical treatment is decisive for outcome in chondrosarcoma of the chest wall: a population-based Scandinavian Sarcoma Group study of 106 patients. J Thorac Cardiovasc Surg. 2009;137:610-4, doi: 10.1016/j.jtcvs.2008.07.024.
6. Littrell LA, Wenger DE, Wold LE, Bertoni F, Unni KKKandel R, Sundaram M. Radiographic, CT, and MR imaging features of dedifferentiated chondrosarcomas: a retrospective review of 174 de novo cases. Radiographics. 2004;24:1397-409, doi: 10.1148/rg.245045009.
7. Mukhopadhyay S, Khurana KK, Dexter E, Landas SK. Pathologic Quiz Case. Chest Wall Mass in a 74-Year-Old. ManArch Pathol Lab Med. 2003;127:e413-4.
8. McAfee MK, Pairolero PC, Bergstralh EJ, Piehler JM, Unni KK, McLeod RA, et al. Chondrosarcoma of the chest wall: factors affecting survival. Ann Thorac Surg. 1985;40:535-41, doi: 10.1016/S0003-4975(10)60344-X.
9. Gonfiotti A, Santini PF, Campanacci D, Innocenti M, Ferrarello S, Caldarella A, Janni A. Malignant primary chest-wall tumours: techniques of reconstruction and survival. Eur J Cardiothorac Surg. 2010;38:39-45.