Analysis of Surgical Resection and Prognostic Factors of Primary Chest Wall Chondrosarcomas

Suranjan Haldar¹, Mohammad Zahid Hossain², Kallo Dasekksi³, Minhajuddin Khurrām⁴, Dipimoy Mukhopadhay⁵, Plaban Mukherjee⁶

ABSTRACT

Introduction: Primary chest wall tumours are very rare. Chondrosarcoma represents 40% of all chest wall tumours. Wide local excision with tumour free margins has been the gold standard therapy. We evaluated this therapy in relation to various prognostic factors for anticipating the recurrence of the tumour.

Material and methods: 22 cases of Primary chest wall chondrosarcoma was operated upon from 2009 to 2019 with wide local excision with adequate margins. Male constituted 77.27% and females 22.73% with the tumour size ranging from 5 to 30 cm in size (median 7 cm).

Results: 19 patients were subjected to lateral chest wall resection. 3 cases underwent partial sternectomies. Resection was extended to lungs in 7 cases, diaphragm in 2 cases, vertebral body in 2 cases and clavicle in 2 cases. Reconstruction was done with polypropylene or titanium mesh and a muscle flap coverage. There was no perioperative mortality. Post operative complications occurred in 13.6% (n=3). There was recurrence in 4 cases within 5 years. 5 year disease free survival rate was 81.81%.

Conclusions: Wide local excision with tumours free margins still remains the standard form of therapy. The reconstructive procedures have evolved largely to cover the huge defects following surgery. Post operative adjuvant therapy is guided by various prognostic factors.

Keywords: Primary Chest Wall Chondrosarcomas, Wide Local Excision, Chest Wall Reconstruction, Prognostic Factors

INTRODUCTION

Primary chest wall tumours are uncommon.¹ 15% of chondrosarcomas are located in the thoracic cage, making it to be the most frequent primary malignant chest wall tumour.² 80% originate from the cartilaginous and bony structures of ribs and 20% originate from the sternum.³ ⁴ ⁵ It is a slow growing tumour. Males are affected more commonly. It usually occurs during the third and fourth decade of life. Median survival for these tumours is 2.5% and overall survival is 46%.⁶ Because of its resistance to radiotherapy and most of chemotherapy drugs, wide local excision with adequate tumor free margin is the only curative option for primary chest wall chondrosarcomas.² ⁷ Often a large defect is created in the chest wall following surgery which can lead to chest wall instability and respiratory dysfunction. This necessitates complex reconstructive procedures which have been made possible by advances in surgical technique and in various prosthetic and biological materials to provide chest stability and to reduce respiratory dysfunction.⁸ ⁹ ¹⁰ The aim of our study was to evaluate various surgical techniques along with reconstructive procedures for covering the huge chest wall defects and also to evaluate various prognostic and clinical risk factors.

MATERIAL AND METHODS

A total of 22 cases of primary chest wall chondrosarcoma was operated upon from 2009 to 2019 in the Department of Cardiothoracic Surgery of Medical College Kolkata. Males constituted 77.27% and females 22.73% with the tumour size ranging from 5 to 30 cm in size (median 7 cm) (Fig 1). Data of these patients were reviewed with respect to gender, age, tumour size, localization of tumour, histological grade, type of resection and reconstruction, tumour free surgical margins, adjuvant chemotherapy, recurrence and disease free survival. These patients presented with chest wall mass of varying size and locations. Diagnostic workup included a standard chest x-ray and CT Scan (Fig 2) chest to delineate the extent of tumour. A tissue diagnosis was obtained either with FNAC or a tru cut biopsy. Evidence of distant metastasis was obtained by PET scan. In cases of the tumours extending posteriorly near the vertebrae, MRI was added to the diagnostic spectrum to rule out spinal cord involvement. Surgical excision was performed with skin incision including the site of previous biopsy along with excision of the involved ribs and adjacent lungs. An average of 3 to 7 ribs were excised. Partial sternectomy was done in 3 cases. Adequate resections with approximately at least 3 cm margins around the tumour were done. Small tumours in the posterior aspect did not require any reconstructions. Tumours extending near the vertebral body required neurosurgical expertise for stabilisation of vertebral bodies.
with titanium plates and screws. All the specimen was subjected to histopathological examination and the degree of differentiation recorded. The defects in the lateral chest wall was reconstructed with polypropylene mesh(Fig 3) and reinforced by latissimus dorsi flap mostly(Fig 4). Few cases required reinforcement with titanium mesh and additional reinforcement with stainless steel wires to maintain the chest stability(Fig 5). Anterior defects in addition was reconstructed with pectoralis major flap. After the surgical procedures the patient was extubated and shifted to intensive care unit for a routine post-operative care. 2 patients with large sized tumours were shifted to intensive care unit with endotracheal tube and extubated the next day. After an average of 7 to 10 days hospital stay, the patient was discharged and there was no peri-operative mortality.

Any postoperative complications were noted and recorded and appropriate measures were taken. Tumors with higher grades and inadequate tumour free margins were subjected to post-operative chemotherapy. These cases were routinely followed up in the out patient department and were evaluated for appearance of any local recurrences or distant metastasis.

RESULTS

We had performed surgical resection with reconstruction in 22 cases of PCWC between 2009 to 2019. There were 77.27% males (n=17) and 22.73% females(n=5). The tumour size ranged from 5-30 cm with a median of 7cm. 3 cases with huge anterolateral tumors with partial involvement of sternum underwent partial sternotomies with excision of lower and middle body of sternum. 19 cases underwent lateral chest wall resections without sternal involvement. The median number of ribs resected was 2 with a range from 2 to 7 ribs. Resection was extended to lungs in 7 cases(31.82%), to the diaphragm in 2 cases (9.09%), to the vertebral body in cases (9.09%) and to the clavicle in 2 cases(9.09%). Reconstruction of the anterolateral defects was carried out with polypropylene mesh which was covered with pectoralis major flap or latissimus dorsi flap in 59.09% cases(n=13). Lateral chest wall reconstruction was not required in small and posterior defects less than 7cm in 40.09% cases (n=9). Tumor free margins were obtained in 86.36%(n=19). Post operative histopathological examination revealed a G1 tumor

| Serial no. | Parameters                  | Recurrence/no. of patients | percentage |
|------------|-----------------------------|-----------------------------|------------|
| 1          | Gender                      |                             |            |
|            | Male                        | 4/17                        | 23.52%     |
|            | Female                      | 0/5                         | 0%         |
| 2          | Age >55 years               | 4/17                        | 23.52%     |
| 3          | Negative margins            |                             |            |
|            | yes                         | 1/19                        | 5.26%      |
|            | no                          | 3/3                         | 100%       |
| 4          | Histological grade          |                             |            |
|            | G1                          | 0/9                         | 0%         |
|            | G2                          | 2/10                        | 20%        |
|            | G3                          | 2/3                         | 66.68%     |
| 5          | Adjuvant treatment          | 4/5                         | 80%        |
| 6          | Dimensions > 8cm            | 4/8                         | 50%        |

Table-1: Prognostic factors for recurrences
in 9 cases (40.91%), G2 tumors in 10 cases (45.45%), and G3 tumors in 3 cases (13.64%). There was no perioperative mortality, however a prolonged endotracheal intubation was required in 2 case with a huge anterolateral tumor. 2 cases had prolonged fever which resolved with appropriate antibiotics and 1 case experienced post operative pneumonia. These post operative complications in 3 patients accounted for 13.6%. 5 patients (22.73%) were subjected to adjuvant chemotherapy. Indications for adjuvant chemotherapy was incomplete resection or inability to obtain tumour free margins after surgical resection and a high grade G3 tumours. There were 4 cases of recurrences in 5 years follow up with 1 case having distant metastasis. 5 year disease free survival was 81.80%. There were recurrence in another 2 cases beyond 5 years of follow up. Recurrences in 5 years follow up was seen in males, age >55 year, in tumour size >8cm, in surgical resection without adequate tumour free margins, in high grade tumors and in patients receiving adjuvant chemotherapy (table - 1)

DISCUSSION

Chondrosarcoma is the most frequent primary malignant tumour of the thoracic cage. Though it represents 40% of all chest wall tumours, the incidence is <0.5 cases per million persons per year. They are lobulated tumours of varying sizes. It may grow to massive proportions. They may extend internally to the pleural space and intra-thoracic cavities or externally invading muscle, adipose tissue and skin of the thoracic wall. The patients present with slow-growing mass for several months or years. Palpable mass in thorax is the main symptom in approximately 80% of the patients. Of these, 60% present with associated pain.  The diagnostic tools like Computed tomography (CT) and magnetic resonance imaging (MRI) are important to delineate the tumour and its extension. CT is superior to MRI in demonstrating calcification. MRI is the imaging modality of choice to evaluate the tumour extension and its relationship with adjacent structures. As compared to other forms of malignancy, the surgical management of PCWC have not evolved over time except for the reconstructive surgery to provide chest stability and improved respiratory hemodynamics. There is still no effective induction or adjuvant therapy for chondrosarcoma as it is relatively radio- and chemoresistant. There are few studies on the mechanisms underlying this resistance. Expression of the multidrug-resistance-1 gene, P-glycoprotein, has been reported in most chondrosarcomas leading to resistance to doxorubicin in vitro. The presence of large amount of extracellular matrix may prevent the access of anticancer agents. Chemotherapeutic agents are usually ineffective in chondrosarcoma because of their slow growth in nature. In this regard, surgery is the only effective form of treatment for PCWC, regardless of the size or histological grade of the tumour, as long as it is resectable. The standard form of surgical resection is wide local excision with adequate margin (atleast 3cm of tumour free margins) to prevent local recurrence. The recurrence rate for patients with adequate surgical margins was 10%, compared with 75% for patients with inadequate margins. In our study, 5 year recurrence rate was 5.26%, and 15.79% recurrence beyond 5 years in cases where adequate tumour free surgical margins were obtained and almost all cases with inadequate tumour free margins recurred within 5 years. An inadequate margin of resection was associated with a significantly worse overall survival and a higher chance of having local recurrence develop. The 5-year survival rate in our study for patients with adequate surgical margins was 100%, compared with 50% in patients with inadequate surgical margins. Local recurrence-free survival is around 64%. In our study, 5 year disease free survival was 81.80%.

The extent to which a radical resection is feasible depends on several factors: the localization of the tumour (difficult in the paravertebral area), the involvement of mediastinal structures and the dimension. In our study the median tumour diameter was 7 cm, comparable with 8 cm reported by Widhe et al. The relative large median diameter of the tumour requires more complex and extended resections. Early diagnosis is of utmost importance in order to allow radical resection and reduce the risk of recurrence. The results depend also on the biological aggressiveness of the disease as depicted by histological grades. According to cell differentiation, Campanacci et al. grouped malignant progression into three grades: Grade 1, consisting of well-differentiated cartilaginous cells with rare and doubtful
aspects of atypia; Grade 2, presenting with some atypical cells; and Grade 3, comprising scarce cartilaginous cells in a context of predominant atypia. In our study, G1 comprised 36.36% (n=9), G2 comprised 45.45% (n=10) and G3 comprised 18.18% (n=3). The 5-year survival rates for Grades 1, 2 and 3 were 100, 80, and 33.33%, respectively, in our study and the grading was a significant predictor of survival.

To achieve this goal of radical surgery and to reduce the risk of postoperative complications, resection and reconstruction techniques have to follow some principles: maintenance of chest stability, adequate respiratory dynamics, absence of harmful paradox movements, and an acceptable cosmetic result. A healthy soft-tissue coverage is required to seal the pleural space, to protect the viscera and great vessels and to prevent infection. The choice of prosthetic material is usually based on the surgeon’s preference. Deschamps et al. have shown no significant difference in the postoperative outcome or in complication rate because of this choice. In the case of large anterolateral chest wall defects with or without involvement of sternum, a reconstruction with rigid material is mandatory to restore chest-wall stability. This maintains the geometry of the thoracic cage and offers adequate protection of the surrounding structures. There are four ideal characteristics of prosthetic material, according to LeRoux and Shama: rigidity, malleability, radiculocentricity and inertness. Marlex–methacrylate prostheses satisfies the first 3 criterias. The fourth ideal criteria, inertness, was still lacking, because rigid shields prevents ingrowth of fibrous tissue and limits integration of muscle flaps. This leads to increased dead spaces and the likelihood of infection. A large prosthesis used for large defects increases the rigidity of the chest and patient discomfort. Different centres worked on different techniques or used new materials to expand the possibility of rigid reconstruction, to improve biocompatibility and overcome problems like respiratory failure and local infection. The ‘rib-like’ reconstruction, as used by the Instituto Nazionale Tumori in Milan and the cryopreserved allograft of cadaveric sternum with attached costal cartilage were technical evolutions developed to obtain a biocompatible prosthesis. These new evolutions protected the mediastinum and reproduced the tridimensional sternocostal anatomy. This also allowed favourable respiratory dynamics. After chest wall stabilization, a soft-tissue coverage is used to complete the reconstruction. This controlled infections, obliterate dead space, and cover the synthetic material. Advancements in reconstructive surgery with the use of various muscles or musculocutaneous flaps have been made possible. The selection of the type of flaps was discussed preoperatively with our plastic surgeon. Pectoralis major flap was preferred after partial sternectomies, because of its proximity, reliability and versatility. Because of its length and bulk of muscles it provides to cover extensive defects in chest wall, Latissimus dorsi flap transposed on thoracodorsal vessels was preferred for anterolateral chest wall defects.

CONCLUSIONS

Considering the various advancements and progress in multimodality treatment of different malignancy, the management of PCWC solely relies on wide local excision with adequate tumour free margins and developments in reconstructive procedures and biocompatible prosthesis. Wide surgical resection with tumour free margins is necessary to reduce the incidence of local recurrence. Our experience found that the age of the patient, tumour size, grades of tumour, ability to obtain tumour free margins and adding adjuvant therapy were independent prognostic factors for recurrence and disease free survival.

REFERENCES

1. Liptay MJ, Fry WA. Malignant bone tumors of the chest wall. Semin Thorac Cardiovasc Surg 1999;11:278-84.
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.
3. Vaporicyan AA, Swisher SG. Thoracic malignancies. In: Feig BW, Berger DH, Fuhrman GM, editors The M.D. Anderson Surgical Oncology Handbook; 2nd edition. Philadelphia: Lippincott Williams & Wilkins; 1999:pp109-29.
4. Dahlin DC, Unni KK. Bone Tumors: General Aspects and Data on 8,542 Cases. Springfield: Thomas;1986.
5. Somers J, Faber LP. Chondroma and chondrosarcoma. Semin Thorac Cardiovasc Surg 1999;11:270-7.
6. van Geel A, Wouters M, Lans T, Schmitz P, Verhoef C. Chest wall resection for adult soft tissue sarcomas and chondrosarcomas: analysis of prognostic factors. World J Surg 2011;35:63-9.
7. Briccoli A, De Paolis M, Campanacci L, Mercuri M, Bertoni F, Lari S et al. Chondrosarcoma of the chest wall: a clinical analysis. Surg Today 2002;32: 291–6.
8. Girotti P, Leo F, Bravi F, Tavecchio L, Spero A, Cortinovis U et al. The ‘rib-like’ technique for surgical treatment of sternal tumors: lessons learned from 101 consecutive cases. Ann Thorac Surg 2011;92:1208–15.
9. Marulli G, Hamad AM, Schiavon M, Arzena B, Mazzoleni F, Rea F. Geometric reconstruction of the right hemi-trunk after resection of giant chondrosarcoma. Ann Thorac Surg 2010;89:306–8.
10. Marulli G, Hamad AM, Cogliati E, Breda C, Zuin A, Rea F. Allograft sternochondral replacement after resection of large sternal chondrosarcoma. J Thorac Cardiovasc Surg 2010;139:e69–70.
11. Lee FY, Mankin HJ, Fongdren G, Gebhardt MC, Springfield DS, Rosenberg AE et al. Chondrosarcoma of bone: an assessment of outcome. J Bone Joint Surg Am 1999;81:326–38.
12. Parham FW. Thoracic resection for tumor growing from the bony wall of the chest. Trans Surg Gynecol Assoc 1898; 11:223-63.
13. Fraser RS. The chest wall. In: Fraser RS, Miller NZ, Colman N, Paré PD, editors Fraser and Paré’s Diagnosis of Diseases of the Chest; 4th edition. Philadelphia: W.B. Saunders; 1999:pp3030-2.
14. Albes JM, Seemann MD, Heinemann MK, Ziemer...
G. Correction of anterior thoracic wall deformities: improved planning by means of 3D-spiral-computed tomography. Thorac Cardiovasc Surg 2001;49:41-4.

15. Gefter WB. Magnetic resonance imaging in the evaluation of lung cancer. Semin Roentgenol 1990;25:73-84.

16. Tang A, Dalrymple-Hay M, Weeden D. Images in cardiothoracic surgery: giant chondrosarcoma of the anterior chest wall. Eur J Cardiothorac Surg 2000;17:84.

17. Fong YC, Pairolero PC, Sim FH, Cha SS, Blanchard CL, Scully SP. Chondrosarcoma of the chest wall: a retrospective clinical analysis. Clin Orthopaed Relate Res 2004;427:184-9.

18. Rosier RN, O’Keefe RJ, Teot LA, Fox EJ, Nester TA, Puzas JE et al. P-glycoprotein expression in cartilaginous tumors. J Surg Oncol 1997;65: 95–105.

19. Terek RM, Schwartz GK, Devaney K, Glantz L, Mak S, Healey JH et al. Chemotherapy and P-glycoprotein expression in chondrosarcoma. J Orthop Res 1998;16:585–90.

20. Wyman JJ, Hornstein AM, Meitner PA, Mak S, Verdier P, Block JA et al. Multidrug resistance-1 and p-glycoprotein in human chondrosarcoma cell lines: expression correlates with decreased intracellular doxorubicin and in vitro chemoresistance. JOrthop Res 1999;17:935–40.

21. Widhe B, Bauer HC. Scandinavian Sarcoma Group. 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.

22. Campanacci M. Bone and Soft Tissue Tumors, 2nd edn. New York, NY: Springer;1999, 283–361.

23. Mansour KA, Thourani VH, Losken A, Reeves JG, Miller JJ Jr, Carlson GW et al. Chest wall resection and reconstruction: a 25-year experience. Ann Thorac Surg 2002;73:1720–5.

24. Weyant M, Bains M, Venkatraman E, Downey R, Park B, Flores R et al. Results of chest wall resection and reconstruction with and without rigid prosthesis. Ann Thorac Surg 2006;81:279–85.

25. Chapelier A, Macchiarini P, Rietjens M, Lenot B, Margulis A, Petit JY et al. Chest wall reconstruction following resection of large primary malignant tumors. Eur J Cardiothorac Surg 1994;8:351–7.

26. Deschamps C, Timaksiz BM, Darbandi R, Trastek VF, Allen MS, Miller DL et al. Early and long-term results of prosthetic chest wall reconstruction. J Thorac Cardiovasc Surg 1999;117:588–91.

27. Novoa N, Benito P, Jimenez MF, de Juan A, Luis Aranda J, Varela G. Reconstruction of chest wall defects after resection of large neoplasms: ten-years experience. Interact CardioVasc Thorac Surg 2005;4:250–5

28. Chapelier AR, Missana MC, Couturaud B, Fadel E, Fabre D, Musot S et al. Sternal resection and reconstruction for primary malignant tumors. Ann Thorac Surg 2004;77:1001–7.

29. Soysal O, Walsh GL, Nesbitt JC, McMurtry MJ, Roth JA, Putnam JB Jr. Resection of sternal tumors: extent, reconstruction, and survival. Ann Thorac Surg 1995;60:1353–8.