Original Article

Primary lung cancer with chest wall involvement: Outcomes of a multimodality management approach

Naveen Kumar[1], Prabhat Singh Malik[2], Sachidanand Jee Bharati[3], Mukesh Yadav[4], Deepali Jain[5], Sunil Kumar[1]

[1]Department of Surgical Oncology, BRA-Institute Rotary Cancer Hospital, All India Institute of Medical Sciences, New Delhi, India, [2]Department of Medical Oncology, BRA-Institute Rotary Cancer Hospital, All India Institute of Medical Sciences, New Delhi, India, [3]Department of Oncoanesthesia and Palliative Care, BRA-Institute Rotary Cancer Hospital, All India Institute of Medical Sciences, New Delhi, India, [4]Department of Radiology, BRA-Institute Rotary Cancer Hospital, All India Institute of Medical Sciences, New Delhi, India, [5]Department of Pathology, All India Institute of Medical Sciences, New Delhi, India

ABSTRACT

Introduction: The incidence of lung cancer with chest wall (CW) involvement is approximately 5%. Surgical resection with tumor-free margin is the mainstay of the treatment but these patients generally require multimodality management. CW resection for lung cancer is a complex procedure and requires a balance of radical oncological resection and reconstruction. Herein, we shared an experience of primary lung cancer with CW involvement. **Materials and Methods:** Outcome analysis of a prospectively maintained lung cancer database was done for the patients having primary lung cancer with CW involvement. All the patients underwent radical surgical resection of the primary tumor along with the CW. **Results:** Among the 208 patients undergoing surgery for non-small cell lung cancer, 20 (9.5%) were found to have CW involvement radiologically. The most common symptom was chronic cough. A total of 11 patients received neoadjuvant chemotherapy (NACT) and the rest were taken for upfront surgery. Six patients had a partial response to NACT and none of them had tumor progression during the chemotherapy. All the patients underwent en bloc resection of the CW with anatomical resection of lung and systematic mediastinal lymphadenectomy. The mean duration of surgery was 199 min and the average blood loss was 560 ml. Reconstruction was done with a combination of prosthetic mesh and pedicled muscle flap. Median disease-free and overall survivals were 21 and 26 months, respectively. **Conclusion:** Radical resection with reconstruction is required for optimal long-term oncological and functional outcomes for NSCLC with CW involvement.

KEY WORDS: Chest wall, primary lung cancer, reconstruction

Address for correspondence: Dr. Sunil Kumar, Room No 244, Department of Surgical Oncology, BRA-Institute Rotary Cancer Hospital, All India Institute of Medical Sciences, New Delhi - 110 029, India. E-mail: dr_sunilk@hotmail.com

Submitted: 03-Sep-2020 **Accepted:** 22-Dec-2020 **Published:** 03-Jul-2021

INTRODUCTION

Chest wall (CW) involvement in primary lung cancer is uncommon with an incidence of approximately 5%.[1] As per AJCC 8th edition, primary lung cancer invading the CW is classified as T3 tumor. The tumors <7 cm, invading parietal pleura, and pericardium have also been included in T3 category but the tumors involving the CW account for approximately 45% of all T3 tumors.[2]

Access this article online

Quick Response Code:

Website: www.lungindia.com

DOI: 10.4103/lungindia.lungindia_725_20

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Kumar N, Malik PS, Bharati SJ, Yadav M, Jain D, Kumar S. Primary lung cancer with chest wall involvement: Outcomes of a multimodality management approach. Lung India 2021;38:338-42.

© 2021 Indian Chest Society | Published by Wolters Kluwer - Medknow

The surgical management of lung cancer with CW involvement was first described by Coleman in 1947.[3] Initially, the CW resection in lung cancer was considered a very challenging procedure but currently, it is a standard treatment having low morbidity in high volume centers. The long term survival after the CW resection in node-negative patients is approximately 40%–50%. The prognosis of these locally advanced tumors depends on a margin-free resection status and involvement of mediastinal lymph nodes.

The major challenges in patients with lung cancer infiltrating the CW are a selection of the patient for upfront surgery, expertise in the field of CW resection, and reconstruction to achieve the best oncological outcomes. In this article, we analyzed the treatment outcome of non-small cell lung cancer (NSCLC) with CW involvement in the patients undergoing multimodal management.

MATERIALS AND METHODS

A retrospective analysis of patients managed with surgery with or without adjuvant treatment for lung cancer with CW involvement treated between 2012 and 2018 was done. All potentially operable lung cancer patients were evaluated by a multi-disciplinary team. For this study, patients with histologically confirmed NSCLC and where contrast-enhanced computed tomography (CECT) scan suggested of CW involvement were included. The radiological criteria for predicting the CW involvement were: (1) More than 3 cm of surface contact with the adjacent pleura, (2) obliteration of the extrapleural fat plane, (3) high ratio between the amount of tumor-pleura contact and the tumor diameter, (4) presence of rib destruction, (5) an obvious extension of the mass into the CW soft tissues, and (6) obtuse angle of the tumor with the pleura or CW.[4,5] The preoperative staging consisted of a whole-body positron emission tomography-computed tomography (CT) scan, endobronchial ultrasound-guided transbronchial needle aspiration fine-needle aspiration for mediastinal nodal staging, and magnetic resonance imaging (MRI) brain for brain metastasis. Pulmonary function tests and cardiopulmonary exercise testing (in cases with borderline pulmonary function testing) were done in all cases before taking up for surgery. Preoperative pulmonary function was evaluated as per the European society of thoracic surgeons guideline.[6] Histology was confirmed by an image-guided biopsy.

Management protocol

In a patient with CW involvement, upfront surgery was performed to all surgically fit and node-negative or nonbulky N1 (<3 cm) patients. Neo-adjuvant chemotherapy (NACT) was given to the NSCLC patients with histologically proven positive N2 nodes and expected CW resection of 4 or more ribs. Paclitaxel with Carboplatin was the preferred regimen for squamous cell variant of NSCLC whereas the pemetrexed in combination with Carboplatin was given to the patients with adenocarcinoma. Medically unfit patients (with poor pulmonary function) or patients with unresectable tumors were sent for definitive chemoradiotherapy.

Surgical technique

Posterolateral open thoracotomy was performed in all patients after double-lumen endotracheal intubation with single lung ventilation. The epidural catheter was placed in all patients for postoperative pain management. The latissimus dorsi and serratus anterior muscles were preserved (if uninvolved grossly) for reconstruction purposes. An *en bloc* excision of the CW with anatomical resection of the lung mass (lobectomy/bilobectomy) and systematic mediastinal lymph node dissection was performed. In patients requiring resection up to two ribs, no reconstruction of the CW was performed. In patients undergoing resection of more than two ribs, the CW was reconstructed with either a mesh alone (composed of oxidized regenerated cellulose and nonabsorbable polypropylene mesh) or in a combination with mesh and muscle flap (if uninvolved and available for reconstruction) as shown in Figure 1.

Postoperative management

Postoperative pain was managed with epidural analgesia and intravenous analgesics such as patient-controlled analgesia if required. All the patients were encouraged for early ambulation, incentive spirometry, and chest

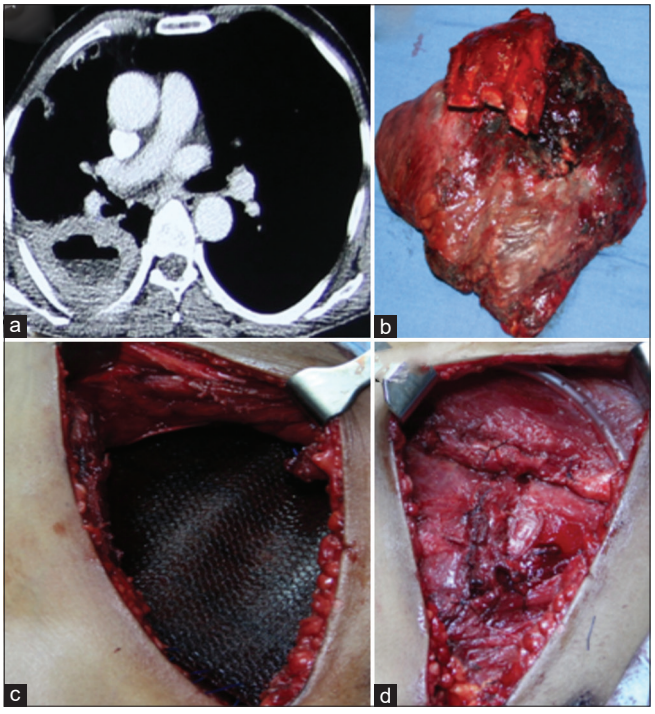

Figure 1: (a) Contrast-enhanced computed tomography chest showing right upper lobe lung mass with internal necrosis and cavitation. (b) Resected specimen of right upper lobectomy with wedge resection of lower lobe and a part of the chest wall. (c) Meshplasty of chest wall. (d) Latissimus dorsi muscle cover over the mesh

physiotherapy. As per our institutional protocol, all patients were discharged after removing the intercostal drainage tube.

Adjuvant treatment and follow-up

Postoperative histopathology was discussed in the thoracic tumor board and adjuvant treatment was planned. Chemoradiotherapy was given to those patients who had a margin positive resection whereas patients with margin negative resection received adjuvant chemotherapy alone. After completion of the treatment, all the patients were followed up routinely with clinical examination, and imaging. CECT scan of thorax and abdomen was the preferred imaging modality for the follow-up. It was done after every 3–6 months for initial 2 years and 6–12 months thereafter.

RESULTS

Out of 208 patients undergoing surgery for lung cancer, 20 patients had CW involvement (as per the radiological criteria mentioned above). These 20 patients formed the study population. The demographic profile and tumor details are described in Table 1. The mean age at presentation was 59.5 years (48–72 years) with a male predominance. The majority of the patients were smokers with smoking index ranging from 144 to 1200. The most common symptom was chronic cough followed by chest pain and hemoptysis. The mean duration of symptoms before presentation was 12 months. Only two patients had hilar involvement directly by the tumor but the distance from carina was >2 cm in both of these patients. A total of 11 patients received NACT because of N2 nodes or expected 4 or more ribs resection. The remaining nine patients underwent upfront surgery. Paclitaxel + carboplatin was the most common chemotherapeutic regimen given as NACT and administered in six patients. Seven patients received all the four intended cycles of chemotherapy before surgery. As per Response evaluation criteria in solid tumors (RECIST) 1.1 criteria, partial response to NACT was seen in six patients whereas the rest of the patients had stable disease after NACT.

Table 1: Demographic profile, tumor location and clinical stage

Variables	Values (%)
Age (years), mean (range)	59.5 (48-72)
Sex	
Female	3 (15)
Male	17 (85)
Smoking	
Yes	18 (90)
Average pack per year	51.4
Symptoms	
Cough	11 (55)
Hemoptysis	6 (30)
Chest pain	9 (45)
Dyspnoea	6 (30)
ECOG	
1	19 (95)
2	1 (5)
Location	
Left lower	2 (10)
Left upper	6 (30)
Right upper	6 (30)
Right lower	6 (30)
Clinical stage	
IIB	9 (45)
IIIA	10 (50)
IIIB	1 (5)
Histological subtypes	
Adenocarcinoma	9 (45)
Squamous cell carcinoma	11 (55)

ECOG: Eastern cooperative oncology group

The mean duration of surgery was 199 min and the average blood loss was 560 ml. Sixteen patients were reconstructed with a combination of a mesh and muscle flap and four patients did not require CW reconstruction. Two patients had intra-operative hypotension because of bleeding from the CW and were managed with blood transfusion. There was no intraoperative mortality. The mean intensive care unit stay was 2 days. In the postoperative period, two patients developed arrhythmia and both were treated conservatively. Seven patients required prolonged oxygen supplementation (ranging from 3 to 6 days). Chest tubes were removed within 4–7 days (maximum at 7th day) and no patient required prolonged drainage. The mean pain score was 5 (numerical pain rating scale). The mean hospital stay was 8 days. None of the patients had postoperative air leak or surgical site wound infection. Two patients developed seroma formation and required needle aspiration.

On final histopathology, two patients had a complete pathological response to NACT. The mean tumor size was 5.6 cms. As per the preoperative assessment, one patient had pathological involvement of the mediastinal lymph node. Microscopic pathological rib involvement was seen in three patients. R0 resection was achieved in all the patients. Five patients were planned for adjuvant chemotherapy and three patients received concurrent adjuvant chemoradiotherapy. Median disease-free survival was 21 months whereas the median overall survival (OS) was 26 months [Figures 2 and 3]. Recurrence occurred in nine patients. Systemic metastasis was seen in four patients whereas loco-regional with and without systemic metastasis were seen in 3 and 2 patients respectively.

DISCUSSION

Lung cancer with CW infiltration generally requires multi-modality management. CW involvement is seen in peripherally located lung tumors. Initially, it starts with the involvement of parietal pleura and gradually it deepens to involve the intercostals muscles and the ribs thus requiring resection of the CW. In the Pancoast (superior sulcus tumor) subtype, the tumor also involves the vessels, nerve, and vertebra and presents with Horner syndrome. In general, the peripheral lung tumors involving only the parietal pleura present with cough and hemoptysis whereas the

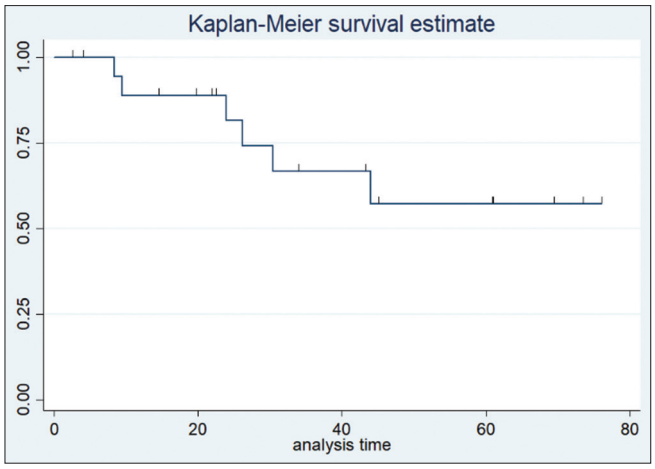

Figure 2: Kaplan–Meier survival curve showing median disease-free survival

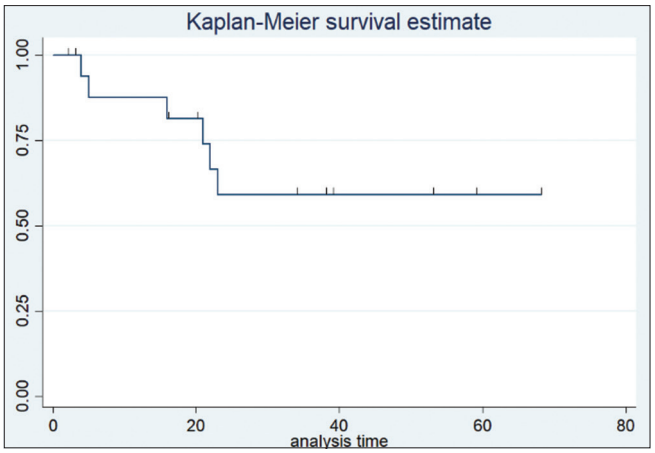

Figure 3: Kaplan–Meier survival curve showing median overall survival

pain is seen in approximately 50% of the patients with CW invasion.[7] Localized chest pain in addition to cough is a more frequent presentation in larger tumors infiltrating the CW grossly. Similar presentations were found in our study as well.

The radiological diagnosis of CW infiltration in cases with just a broad area of contact is difficult; sensitivity and specificity of both CT scan and MRI in the absence of clear tumor infiltration are poor. The accuracy of CT scan in the diagnosis is ranged from 50% to 90%.[8,9] Various radiological criteria for predicting CW infiltration have been proposed but none of them can accurately predict the infiltration. However, the majority of them have proposed several parameters that include pleural thickening adjacent to the tumor, increased extrapleural fat density, CW soft-tissue asymmetry adjacent to the tumor, fixation of the tumor during breathing, soft-tissue mass invading into the CW, and presence of rib destruction.[10] The accuracy of these parameters is lower in cases with smaller size tumors. In our study, the accuracy of CT scan for CW infiltration was 92%, possibly because of the presence of large tumors with mostly gross involvement of the CW.

The management of primary lung tumors with CW infiltration is complex and it depends on several factors such as the location of the tumor, the extent of the lung and CW resections, and the presence of mediastinal lymph nodes. Induction chemoradiation followed by surgery is a standard treatment for Pancoast tumors whereas the upfront surgery followed by adjuvant treatment or NACT/chemo-radiotherapy followed by surgery (particularly in larger tumors) is recommended for tumors involving lower CW which do not involve mediastinal lymph nodes.[7] We followed the policy of NACT because of the limitations of the logistics required for concurrent chemoradiotherapy. Neoadjuvant treatment is indicated to reduce the extent of the CW resection.[11] As the extent of CW resection (number and the length of ribs resected) has a direct bearing on postoperative morbidity in the form of poor respiratory mechanics and the need for mechanical ventilation, neoadjuvant therapy may help in reducing these morbidities. In our study, 32% of the patients had a good response to NACT leading to a reduced extent of the CW resection.

For surgical resection, an extrapleural resection can be sufficient for the tumors involving parietal pleura only however, the chances of pathological margin involvement by tumor remain high. A full-thickness CW resection is required for deeper invasive tumors. The surgical approach is crucial for radical CW resection. In our study, the most common surgical approach was postero-lateral thoracotomy. This approach is also helpful to resect the transverse process of the vertebra if it is required intraoperatively. The anterolateral approach is required for the tumors infiltrating anterior CW.

Reconstruction of the CW is a complex procedure and principles are: maintenance of anatomical stability, protection of adjacent vital organs from the cut end of ribs, and maintaining the ventilatory mechanisms. Reconstruction is required in 40%–60% of the patients and it depends on the location of the tumor and the number of ribs resected.[12,13] In general, single-rib excision does not require any rigid reconstruction. Monofilament meshes such as polypropylene or polytetrafluoroethylene are the common materials used for CW reconstruction after an extensive resection. The rigid reconstruction with bone cement is not recommended since rigid prosthesis tends to penetrate the adjacent tissues due to respiratory movements.[1] It should be avoided particularly in cases where a vascularized muscle cover is missing and postoperative radiation is required. Complications are common after CW resection and it ranges from 24% to 60%. The most commonly reported complications are wound infection, dehiscence, postoperative atelectasis, pneumonia, and mesh exposure. The local infection is one of the serious complications and may require the removal of prosthetic material.[14] In our experience, a combination of Collagen and Polypropylene mesh and local muscle flap (latissimus dorsi or pectoralis major) is a suitable and

cost-effective option for reconstruction. Seroma formation is a common complication after CW reconstruction.[15] In our patients, no local infection/wound dehiscence occurred and patients having seroma were managed with aspiration only. Three patients received postoperative radiotherapy and none had wound-related complications/mesh extrusion.

Other methods for rigid reconstruction are three-dimensional printed prosthesis. In this technique, CT image data are extracted in the preoperative period that provides an adequate mapping of the expected defect so that precise prosthesis can be designed for reconstruction. It reduces the operating time and has less potential for intraoperative errors and provides good cosmesis. However, it has disadvantages of having a very high cost and being available at only a few centers.[16]

Local-regional recurrence after radical excision is reported in 10%–30% patients. Factors associated with local-regional recurrence are adequacy of resected margins, lymph node status, and ability to complete the intended multimodal treatment. OS after multimodality treatment has been reported as 25–30 months.[17] In our study, median disease-free survival and OS were 21 and 25 months, respectively. The majority of the patients had systemic metastasis.

CONCLUSION

Radical surgical resection is the mainstay of treatment for primary lung cancer with CW involvement. Multimodality treatment is required for optimal long-term oncological and functional outcomes. A combination of radiological criteria helps predict the CW involvement and planning for surgical resection.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Stoelben E, Ludwig C. Chest wall resection for lung cancer: Indications and techniques. Eur J Cardiothorac Surg 2009;35:450-6.
2. Filosso PL, Sandri A, Guerrera F, Solidoro P, Bora G, Lyberis P, *et al*. Primary lung tumors invading the chest wall. J Thorac Dis 2016;8:S855-62.
3. Coleman FP. Primary carcinoma of the lung, with invasion of the ribs: pneumonectomy and simultaneous block resection of the chest wall. Ann Surg 1947;126:156-68.
4. Pennes DR, Glazer GM, Wimbish KJ, Gross BH, Long RW, Orringer MB. Chest wall invasion by lung cancer: Limitations of CT evaluation. AJR Am J Roentgenol 1985;144:507-11.
5. Riquet M, Arame A, Le Pimpec Barthes F. Non-small cell lung cancer invading the chest wall. Thorac Surg Clin 2010;20:519-27.
6. Brunelli A, Charloux A, Bolliger CT, Rocco G, Sculier JP, Varela G, *et al*. ERS/ESTS clinical guidelines on fitness for radical therapy in lung cancer patients (surgery and chemo-radiotherapy). Eur Respir J 2009;34:17-41.
7. Induction Chemoradiation and Surgical Resection for Superior Sulcus Non-Small-Cell Lung Carcinomas: Long-Term Results of Southwest Oncology Group T. PubMed-NCBI. Available from: https://www.ncbi.nlm.nih.gov/pubmed/17235046. [Last accessed on 2019 Oct 24].
8. Comparison of Imaging TNM [(i) TNM] and Pathological TNM [pTNM] in Staging of Bronchogenic Carcinoma. PubMed-NCBI. Available from: https://www.ncbi.nlm.nih.gov/pubmed/9288511/. [Last accessed on 2019 Oct 24].
9. Assessment of the Accuracy of Diagnostic Chest CT Scanning. Impact on Lung Cancer Management. PubMed-NCBI. Available from: https://www.ncbi.nlm.nih.gov/pubmed/8803712/. [Last accessed on 2019 Oct 24].
10. Suzuki N, Saitoh T, Kitamura S. Tumor invasion of the chest wall in lung cancer: Diagnosis with US. Radiology 1993;187:39-42.
11. Sedrakyan A, Van Der Meulen J, O'Byrne K, Prendiville J, Hill J, Treasure T. Postoperative chemotherapy for non-small cell lung cancer: A systematic review and meta-analysis. J Thorac Cardiovasc Surg 2004;128:414-9.
12. Doddoli C, D'Journo B, Le Pimpec-Barthes F, Dujon A, Foucault C, Thomas P, *et al*. Lung cancer invading the chest wall: A plea for en-bloc resection but the need for new treatment strategies. Ann Thorac Surg 2005;80:2032-40.
13. Akay H, Cangir AK, Kutlay H, Kavukçu S, Okten I, Yavuzer S. Surgical treatment of peripheral lung cancer adherent to the parietal pleura. Eur J Cardiothorac Surg 2002;22:615-20.
14. Hazel K, Weyant MJ. Chest Wall Resection and Reconstruction: Management of Complications. Thorac Surg Clin 2015;25:517-21.
15. Allen MS. Chest wall resection and reconstruction for lung cancer. Thorac Surg Clin 2004;14:211-6.
16. Chest-Wall Reconstruction with a Customized Titanium-Alloy Prosthesis Fabricated by 3D Printing and Rapid Prototyping. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5759864/. [Last accessed on 2020 Apr 23].
17. Murali AN, Radhakrishnan V, Ganesan TS, Rajendranath R, Ganesan P, Selvaluxmy G, *et al*. Outcomes in lung cancer: 9-Year experience from a tertiary cancer center in India. J Glob Oncol 2017;3:459-68.