Journal of Orthopedic Oncology
ISSN: 2472-016X
Roma, J Orthop Oncol 2024, 10:6
Opinion
Open Access

Preserving Function and Oncological Safety: Modified Tikhoff-Linberg Procedure for Scapular Chondrosarcoma

Roma Le*

Orthopedic Surgery, Georgetown University, USA

Abstract

Dedifferentiated chondrosarcomas are aggressive, malignant tumors characterized by growth potential and a lytic soft tissue component.Radical resection is the recommended treatment protocol, but can be difficult depending on anatomic involvement and location of each tumor. We describe a modification of the Tikhoff-Linberg procedure for resections in the shoulder girdle, in which a scapulectomy is performedwithout resection of the proximal humerus, and extensive skeletal and soft tissue reconstruction is utilized to maintain adequate functional and aesthetic outcome.

Keywords: Scapular chondrosarcoma; Tikhoff-Linberg procedure; modified Tikhoff-Linberg procedure; oncological safety

Introduction

Chondrosarcomas represent a wide spectrum of tumors that are characterized by cartilage generation and growth potential. These tumors can be classified as low-grade, intermediate grade, high-grade, and dedifferentiated. Dedifferentiated chondrosarcoma (DCS)is amongst the most aggressive and rare bone tumors [1].It constitutes approximately 10% of all chondrosarcomas, and is defined by its bimorphichistological components: a low-grade cartilage component adjacent to a lytic, high-grade component. The high-grade component has been found to dedifferentiate into other bone tumors such as osteosarcoma, fibrosarcoma, and malignant fibrous histiocytoma. DCS typically has a poor prognosis, with 5-year survival rates reported to be as low as 10%. Considering the high risk of metastasis and the lack of response to chemotherapy, radical surgical resection of the DCS has been recommended as the mainstay of treatment [2]. Both central and peripheral DCS have been described based upon the lesion from which the DCS originated from. Central DCS, located within the intramedullary of the bone, are thought to arise from enchondromas. Peripheral DCS are usually located on the surface of the bone and are thought to arise from osteochondromas. In a case series of their 65 patients with central DCS also had Ollier's disease with known previous enchondromas. Of the 8 patients with peripheral lesions, 5 had a history of osteochondromas that underwent malignant conversion and 1 patient had a known history of multiple hereditary exostoses [3]. Multiple hereditary exostosis has been linked to a higher rate of transmission of osteochondromas into peripheral DCS. Bertoni et al in a series of 7 patients with peripheral DCS, all 7 had previous radiographic evidence of an osteochondroma that later dedifferentiated into a high-grade aggressive soft tissue mass; three of their patients had a history of multiple hereditary exostoses. In their series of 18 patients with peripheral DCS, Staals et al. had 8 patients with a history of MHE. They demonstrated a 29% 5-year survival rate with wide surgical resection combined with adjuvant chemotherapy [4].

We report the case of a peripheral DCS arising from a benign osteochondroma in the left scapula of a 32-year-old male. The patient had a history of multiple hereditary exostoses. The most commonly involved sites for DCS in order of decreasing frequency are the pelvis, proximal femur, proximal humerus, distal femur, and ribs. The prevalence in the scapula is low, and there are few reports for surgical treatment of chondrosarcomas in this location. Due to the unique location and high histological grade of this tumor, we describe an operative technique in which weresect the scapula while maintaining elbow and hand function,modifying the Tikhoff-Linbergprocedure. A 32-year-old male presented with 4 months of severe left arm pain [5]. He described the pain as sharp and throbbing, most noticeable at night. Patient's past medical history was significant for multiple hereditary exostoses. X-rays of the left scapula showed an irregular, hyperdense bony mass extending posteriorly from the inferior posterior aspect of the scapula. An MRI of the left scapula showed a 7.9 cm mass with 10 mm cartilage cap and destruction of inferior border of left scapula with associated soft tissue components. The CT scan shows a lesion emanating from inferior aspect of left scapular body exhibiting internal calcification [6] . The core needle biopsy showed a peripheral dedifferentiated chondrosarcoma arising in the setting of multiple hereditary osteochondroma. Tumor cells showed positive immunostains for vimentin, CD68, CD163, and focally Ki637. These findings were consistent malignant transformation to a dedifferentiated chondrosarcoma.The decision of a radical surgery was reached after extensive discussion with patient about risks, complications, and recovery. Prosthetic replacement was discussed, but would have delayed the procedure for this very aggressive tumor and offered minimal functional benefit over elected procedure. Scapular resection with humeral suspension was deemed the best option for higher chances of negative margins and adequate function. The post-operative protocol included physical therapy with sling for 6 weeks, with no extension of the elbow beyond 90 degrees. After a gradual increase in the range of motion, the patient began a 12-week strengthening routine with a 10-pound weight limit. The post-operative X-Ray of the left scapula shows the humerus suspended in a stable position [7].

Discussion

We have described a modification of the Tikhoff-Linberg procedure for an aggressive tumor of the left scapula which included scapular

***Corresponding author:** Roma Le, Orthopedic Surgery, Georgetown University, USA, E- mail: romale@gmail.com

Received: 01-Nov-2024, Manuscript No: joo-25-159599, **Editor Assigned:** 04-Nov-2024, Pre QC No: joo-25-159599 (PQ), **Reviewed:** 18-Nov-2024, QC No: joo-25-159599, **Revised:** 25-Nov-2024, Manuscript No: joo-25-159599 (R), **Published:** 30-Nov-2024, DOI: 10.4172/2472-016X.1000296

Citation: Roma L (2024) Preserving Function and Oncological Safety: Modified Tikhoff-Linberg Procedure for Scapular Chondrosarcoma. J Orthop Oncol 10: 296.

resection as well as skeletal and soft-tissue reconstruction. The classical Tikhoff-Linberg procedure described resection of the deltoid, trapezius, scapula, proximal humerus, and distal clavicle, followed by humeral suspension from the clavicle. The procedure was first performed by Dr. Tikhoff in 1922 and Dr. Linberg in 1928 gaining notoriety in the literature [8].Despite an overall complication rate of up to 74% the Tikhoff-Linberg procedure, the procedure affords higher functional and oncological outcomes compared to forequarter amputation. This procedure allows for maintenance of shoulder stability and elbow and hand function while minimizing risk of recurrence. We have found no other reports in the literature of the Tikhoff-Linberg procedure used for isolated resection of the scapula. This is likely because of frequent involvement of the proximal humerus and glenohumeral joint by the tumor, and the low incidence of tumors in the scapula. The patient was placed in the right lateral decubitus position. An axillary roll was placed, and the upper extremity was prepped and draped in a sterile manner. A utilitarian shoulder incision was used as described by Wittig et al., From the lateral axillary line, the incision was extended posteriorly and inferiorly along the lateral border of the scapula, finally curving medially just distal to the tip of the scapula. Medial and lateral skin flaps were raised to expose the underlying musculature. The musculature around the scapula was released with electrocautery, starting from the latissimus dorsi at the interior tip of the scapula and extending to the trapezius muscle. Upon encountering the rhomboid muscles, a margin was sent to pathology for frozen section analysis [9]. This analysis revealed neoplastic disease. A wider resection of the rhomboids was thus performed. The levator scapulae and omohyoidmuscles were released, and the scapula was retracted to the chest wall to release the serratus anterior followed by the teres major. The deltoid was elevated off the scapular spine and the acromion. And the trapezius was elevated off the clavicle, exposing the supraspinatus fossa and exposing the distal end of the clavicle. The surrounding soft tissues and coracoclavicular ligaments were released form the distal one-third of the clavicle. The clavicle was transected along its distal one-third, which allowed for better mobilization and visualization of the scapula. Extensive soft tissue reconstruction was then performed. A second incision was made from the iliac crest proximally and connected with the distal aspect to the first incision. Skin flaps were raised to expose the latissimus dorsi and it wasdettached from the iliac crest area extending from posterior to anterior and distal to proximal until the entire latissimus dorsi was freed and rotated into the axilla. The latissimus dorsi was rotated up to fill the dead space under the deltoid muscle, between the humeral head and deltoid musculature. This helped to fill in the dead space where the scapula was removed and achieved a better aesthetic outcome [10].

Conclusion

The oncologic objective of limb-sparing resections of the shoulder girdle is to achieve local tumor control. Distant metastasis is always possible and cannot be ruled out. The technique we present optimizes both tumor and functional control, without requiring a prosthesis. It is a valuable approach to scapular resection that maintains adequate elbow and hand function as well as aesthetic appearance. For aggressive tumors of the shoulder girdle, a variety of approaches and options must be considered. The utilitarian shoulder approach allows for extensive exposure and access to the shoulder girdle. Due to the variance in location of tumor and availability of soft tissues, it is essential to be familiar with various techniques/modifications such as scapular resection with humeral suspension.

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