

It's All in How You Slice It: Chondrosarcoma of the Tibia

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Abstract:

The case presented is that of a 66-year-old man with a history of a pathologic fracture of the right tibia due to chondrosarcoma, a malignant neoplasm originating from cartilaginous structures. The 41 cm tumor arose from the proximal tibia, extensively involving adjacent structures, including the majority of the volume of the right lower extremity, right knee, and distal portions of the right thigh. The size of the tumor is of particular note as it requires critical thinking by the Pathologists' Assistant when choosing how to process and section the specimen.

Background:

Chondrosarcomas are malignant neoplasms originating from cartilage. Four variants of chondrosarcoma exist: conventional, clear cell, dedifferentiated, and mesenchymal. These variants can be intramedullary or juxtacortical. Conventional is the most common of the variants, and is the topic of this case presentation. Most chondrosarcomas arise de-novo; rare tumors develop from malignant transformation of pre-existing benign cartilaginous tumors such as osteochondromas and enchondromas. Chondrosarcomas can arise in any bone, with the proximal femur being the most favored site. Additionally, the bones of the pelvis and long tubular bones are often affected. Local pain and swelling are the most common symptoms. With an incidence of 1 in 200,000 people per year, chondrosarcomas are the third most prominent malignant tumor of bone following osteosarcoma and multiple myeloma. Chondrosarcomas typically occur in individuals over 40 years of age and are more prominent in men than females (2:1).^{1,2} As the site of involvement, tumor size, and tissues involved can vary greatly, the approach to grossing chondrosarcoma specimens varies. Large chondrosarcomas involving extensive soft tissues are often complicated to approach. Care must be taken to preserve the soft tissue to allow for collection of high quality sections and to maintain the relationship between anatomic structures and the tumor. This can be achieved by freezing the specimen and carefully choosing an optimal plane in which sections are sliced.

Methodology:

A 66-year-old male presented with right knee pain and prominent soft tissue edema at the proximal tibia after hyperextending his knee and then falling into a hole three months prior. An x-ray revealed a pathologic fracture of the right proximal tibia with a cartilaginous appearing bone lesion that occupied the entire tibial metaphysis. Additional forms of imaging and a biopsy were performed, which indicated chondrosarcoma. Subsequent amputation of the right leg was performed.

Upon receiving the surgical specimen, the Pathologists' Assistant froze the entire specimen, serially sectioned the leg along the axial plane, thawed the resultant slices by submersion for several hours, and then carefully placed the slices in formalin for fixation overnight. Vascular and nerve margins were taken fresh before freezing.

Results:



Figure 1: Mottled areas of the leg and thigh skin that correlate with the extent of the underlying tumor

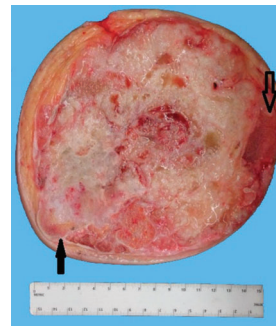


Figure 2: Inferior to superior view of tibia plateau. Open arrow indicates obliteration of muscle and gelatinous tissue. Closed arrow indicates tibia plateau with extensive tumor involvement.

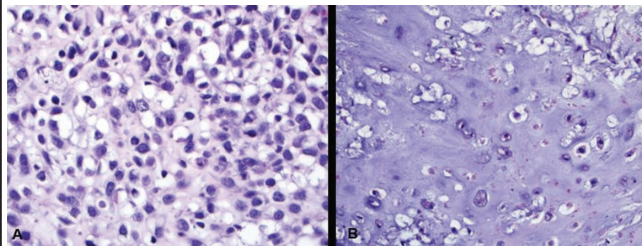


Figure 3: A. Chondrosarcoma with hypercellular area. B. Area of lower cellularity.

Gross Description: Labeled: (right leg) Received without fixative and placed in formalin is a right above-the-knee amputation measuring 25.5 cm in foot length, 74 cm from heel to resection margin, 19.5 cm in calf diameter and up to 21 cm thigh diameter. The specimen is oriented with a double long stitch designating medial, double short stitch designating posterior, single long proximal.

Sectioning reveals a 17.5 cm from medial to lateral, 15 cm from anterior to posterior and 41 cm from superior to inferior infiltrating mass involving the skeletal muscle of the lower leg, the tibial bone extending to the tibial plateau, surrounds the knee joint, abuts the fibula and femur distally. The mass has a tan-white firm to translucent and mucinous cut surface with focal hemorrhage and necrosis (approximately 10%). The mass measures 15 cm from the bone margin, 4.5 cm to the closest anterior soft tissue margin and greater than 4.5 cm from the remaining skin and soft tissue margins. The skin is tan, mottled with a raised area overlying the mass. A flower band tattoo is identified at the ankle. The five digits are present with intact nails.

Also received in a separate container is a 1.8 x 1.5 x 0.8 cm sciatic nerve and 6.5 x 0.8 x 0.5 cm tibial mass.

(Representative sections, 19 caps; ink key: soft tissue inked blue, skin margin inked green, and stitch of nerve inked black, opposite end of nerve inked yellow)

BLOCK KEY:

B1	Vasculature margin	B8	Sciatic nerve
B2	Anterior soft tissue, closest	B9-11	Tumor to anterior thigh soft tissue and skeletal muscle
B3	Anterior skin and soft tissue	B12,13	Tumor to lower leg skeletal muscle
B4	Posterior skin and soft tissue	B14	Mass to vasculature of lower leg
B5	Medial skin and soft tissue	B15	Mass to tibial and fibular bone
B6	Lateral skin and soft tissue	B16-18	Mass to tibial bone
B7	Tibial nerve	B19	Necrotic portion of mass

Discussion:

This case is noteworthy because of the Pathologists' Assistant's choice to freeze the specimen, which is an uncommon practice at the facility where this case was processed. Given the large size of the specimen (74 cm from heel to resection margin), and the gelatinous nature of the soft tissue, the specimen was frozen to firstly preserve the soft tissue and allow for collection of high-quality sections with less likelihood of contaminated margins by tumor cells. Secondly, the decision to freeze the specimen was made to also preserve the anatomy of the leg in relation to the tumor. A combination of soft tissue palpation and reference of prior radiographic imaging were used to approximate tumor location before a Stryker saw was used to amputate the lower leg and upper thigh 10 cm away from the tumor. The lower leg and thigh were placed in formalin for soft tissue, skin, and muscle margins. The midportion of the specimen containing the tumor was frozen, transversely sectioned, individually thawed by submersion for several hours, and placed in formalin for fixation overnight. Of note, the choice to transversely section the specimen, instead of longitudinally section, highlights an important processing decision that deviates from the American Association of Pathologists' Assistants (AAPA) Grossing Guidelines. Traditionally, a full section through the long axis of the bone is necessary to demonstrate the relationship between anatomic structures and the tumor and to better evaluate necrosis, particularly in osteosarcoma. However, in this case transverse sections allow for relationships to vessels, nerves, and bone to be more precisely observed and allows the Pathologists' Assistant to determine the size of the tumor, which is critical for staging with greater accuracy.

The American Joint Committee on Cancer (AJCC) staging of chondrosarcomas is based on size, grade, location of tumor, and presence and location of metastases.³ With the current tumor being 41 cm, the T category assigned to this case was pT2, which is defined as tumor > 8 cm in dimension.³ Regional lymph nodes could not be assessed and distant metastasis was not applicable. Microscopically the tumor shows varying areas of differentiation. An area of hypercellularity shows malignant cells with hyperchromatic nuclei, a high N:C ratio, and scant chondromyxoid matrix, all of which are characteristics of histologic Grade II (Fig. 3A). Conversely, areas of lower cellularity exhibit well-differentiated chondrocytes in lacunae surrounded by typical chondroid matrix and are characteristic of histologic Grade I (Fig 3B). Although both grade I and grade II characteristics were observed, the majority of the tumor showed grade II elements and was designated as such. Overall, TNM and grade categories of this case are pT2NX, Grade 2, with a stage group of IIB.

Conclusion:

Chondrosarcomas are malignant neoplasm originating from cartilage and those involving extensive soft tissues can be complicated to approach. The case presented revealed a 41 cm tumor arising from the proximal tibia, extensively involving adjacent structures, including the majority of the volume of the right lower extremity, right knee, and distal portions of the right thigh. The Pathologists' Assistant's choice to freeze and process the specimen, as described in the discussion, allowed for the collection of high-quality sections with less likelihood of contaminated margins by tumor cells and also the preservation of the anatomy of the leg in relation to the tumor. These important features contributed to the accurate TNM grade and category of this case; pT2NX, Grade 2, with a stage group of IIB.

References:

- 1: Kim MJ, Cho KJ, Ayala AG, Ro JY. Chondrosarcoma: with updates on molecular genetics. *Sarcoma*. 2011;2011:405437. doi:10.1155/2011/405437
- 2: Kumar, V, Abul, K, Aster, J. *Robbins and Cotran Pathologic Basis of Disease*. Ninth Edition. Philadelphia, PA: Elsevier; 2015: 1202.
- 3: Edge, SB, American Joint Committee on Cancer. *AJCC Cancer Staging Manual*. Eighth Edition. New York, NY: Springer; 2017