22 Bone

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General Comments

The hardness of bone introduces three challenges that are unique to the dissection of bone specimens: (1) Many lesions involving bone are not easily appreciated simply by palpating and inspecting the intact specimen. This inability to pinpoint the lesion may frustrate attempts to demonstrate its size and location when cutting the bone specimen. (2) Bone specimens cannot be easily dissected and sampled with standard knives and scalpels. (3) Since the microtome blade also cannot penetrate bone, bone cannot easily be sectioned in the histology laboratory. Fortunately, each of these obstacles can be overcome. Specimen radiographs (Table 22-1) allow one to visualize the extent and location of the pathologic process so that the specimen can be cut in the proper plane; appropriate saws (Table 22-2) allow one to cut bone without destroying the specimen; and finally, special solutions (Table 22-3) can demineralize bone making it easier to section for microscopic evaluation. Thus, the successful dissection of bone specimens requires that the prosector master the use of radiography, special techniques, instruments, and a variety of chemical solutions.

TABLE 22-1. X-raying specimens.

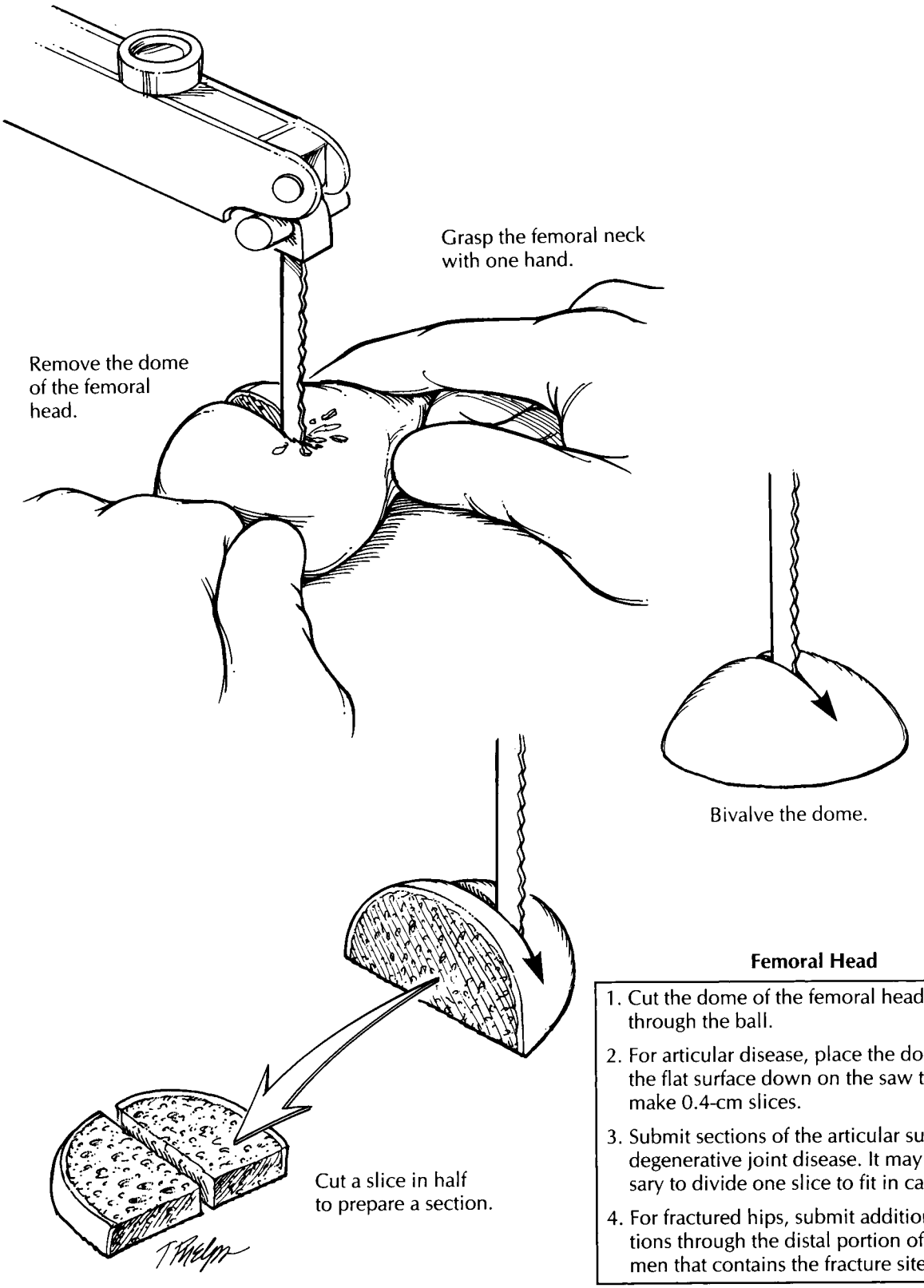
- An ideal x-ray source is the Faxitron machine—an x-ray machine that is small enough to be kept in the surgical pathology cutting area.
- Take two radiographs of the specimen: one to show the antero-posterior view and the other to show the lateral view.
- Using the findings of the radiograph, cut the specimen in the plane that best demonstrates the lesion. For example, if the lesion is best seen in the antero-posterior view, then cut the specimen in the coronal plane.

Small Bone Fragments

Whether dealing with bone biopsies, currettings, or the removal of small bones, there is always the danger of overdecalcifying the tissue. Efforts to minimize the time in decalcification solution and to separate out tissue fragments that do not require decalcification will reap great rewards when evaluating these tissues microscopically. When it is necessary to cut a bone fragment before processing, orient and cut the bone to show as much surface as possible. For example, small tubular bones such as metatarsals or ribs should be cut longitudinally rather than in cross section. When articular cartilage is present, sections should be taken to show its relationship to cortical bone. For specimens consisting of multiple pieces of tissue, soft tissues should be separated from bone and processed routinely in formalin without decalcification, while pieces of bone should be grouped in cassettes according to size and density to allow for uniform decalcification.

Large Bone Specimens

Femoral heads are the most common example of large bone specimens. They are usually removed because of either osteoarthritis or a hip fracture. Consequently, it is particularly important to identify, inspect, and sample the articular surface



Femoral Head

1. Cut the dome of the femoral head midway through the ball.
2. For articular disease, place the dome with the flat surface down on the saw table, and make 0.4-cm slices.
3. Submit sections of the articular surface for degenerative joint disease. It may be necessary to divide one slice to fit in cassettes.
4. For fractured hips, submit additional sections through the distal portion of the specimen that contains the fracture site.

TABLE 22-2. Cutting specimens.

- Always wear eye protection.
- Choose the right saw:

Vibrating table saw	Band saw
Minimizes artifact that is due to bone dust or crushing of the tissue.	Creates bone crush and bone dust artifact.
Relatively safe.	**Dangerous!** (Keep your hands away from the blade.) Have an assistant help hold and guide the specimen.
Inadequate for very large specimens or very dense bone.	Cuts large specimens and dense bone with ease.

- Do not use the band saw to cut through soft tissues (unless the soft tissues are frozen solid).
- Cut the bone longitudinally in the plane that shows the maximum area of diseased bone.
- When serially sectioning bone, the bone slices should be of uniform thickness, not to exceed 3–4 mm.
- Remove bone dust from the cut surfaces of the specimen. Gentle rinsing with saline or water and brushing with a soft toothbrush works quite well.

and any fracture site. Measure the specimen and describe the articular cartilage, noting whether it is eroded, frayed, pitted, or absent. The presence of osteophytes should also be noted. As illustrated, separate the dome of the femoral head from the neck, then place the cut surface of the head on the table saw, and section it into 4-mm slices in a plane perpendicular to the articular cartilage. Note the density of the bone and the thickness of the cartilage. In a similar manner, serially section the femoral neck. Look for the presence of blood clot, marrow hemorrhage, or a neoplasm.

Sampling for histology should be guided by the clinical history and gross findings. For cases of osteoarthritis, sample the femoral head to show cartilage destruction and the reaction of the underlying bone. In cases of fracture, direct your attention to the fracture site; most of the sections should come from this area. Always submit at least one cassette of soft tissue including the synovial membrane and capsule.

TABLE 22-3. Decalcifying specimens.

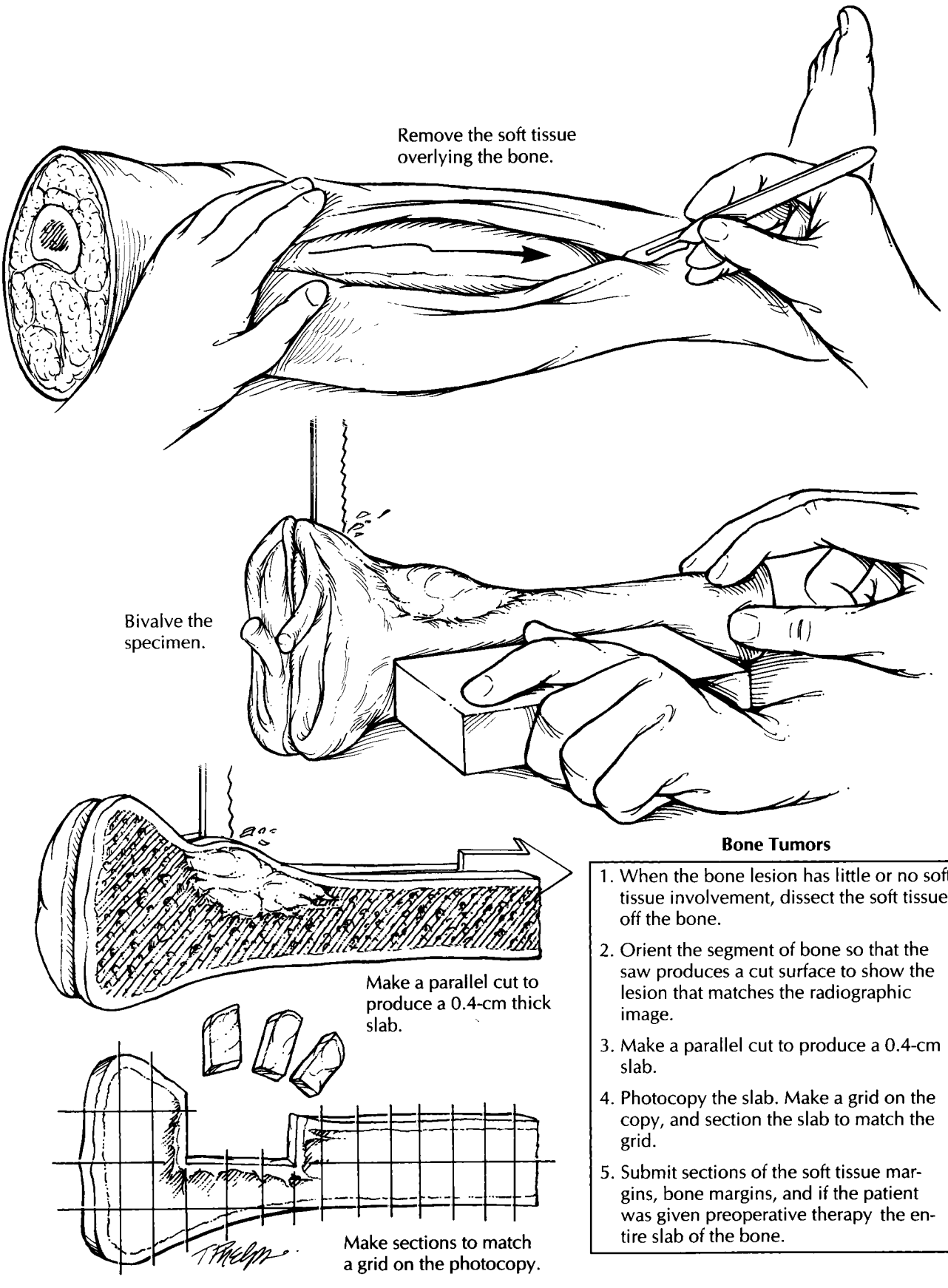
- Fix tissues in formalin before decalcifying.
- Decalcification obscures cellular detail:
  Never decalcify a specimen over the weekend. Specimen decalcification should be monitored daily.
  If the tissue permits, submit at least one section of tumor without decalcification. This section may be more suitable for histologic evaluation and immunohistochemical analysis.
- Thin sections of uniform thickness permit a faster and more even decalcification process.

Segmental Resections and Amputations for Neoplasms

Segmental Resections

Segmental resections of bone are performed for malignant neoplasms and aggressive benign tumors. Because local recurrence is an important complication, the margins of resection need to be carefully evaluated. The soft tissue margins are best sampled while the specimen is intact and still easy to orient. After inking the soft tissue resection margin, sample the margin using perpendicular sections from those areas for which there is gross or radiologic suspicion of margin involvement (see Chapter 8 for a description of sampling margins from a complex specimen).

After soft tissue margins are sampled, decide which plane of section will best demonstrate the lesion. The radiographic findings will help guide this strategy. For the saw to cleanly pass through the bone, expose the surfaces of the bone as illustrated by cutting through and peeling back the soft tissues in this plane. Next, bisect the bone in the appropriate plane (usually the coronal plane) using a band saw. Inspect the cut surface. The extent of the lesion should then be measured and described. In addition, the presence of cortical penetration and soft tissue extension should be noted. Look for noncontiguous ''skip'' lesions in the medullary canal, and measure the distance from the edges of the tumor to the bone resection margin. Scoop a small amount of marrow from the end(s) of the bone, and submit this marrow as the bone margin(s).



Bone Tumors

1. When the bone lesion has little or no soft tissue involvement, dissect the soft tissue off the bone.
2. Orient the segment of bone so that the saw produces a cut surface to show the lesion that matches the radiographic image.
3. Make a parallel cut to produce a 0.4-cm slab.
4. Photocopy the slab. Make a grid on the copy, and section the slab to match the grid.
5. Submit sections of the soft tissue margins, bone margins, and if the patient was given preoperative therapy the entire slab of the bone.

An alternative method is to freeze the entire specimen. The frozen specimen does not require removal of the soft tissues before cutting the bone. Thus, the relationship of the bone neoplasm to soft tissue spread is better preserved.

Now you are ready to cut a slab from the face of the bone cut surface. Place one half of the bisected specimen on the band saw, and cut a complete 4-mm-thick slab, then photograph and x-ray the slab. Ideally, this slab should be thin, uniform, and represent the greatest surface area of the tumor. Before sectioning the slab further, make a representation of the slab to map the precise location of each section submitted for histology. One method is to photocopy the slab and then to draw grids slightly smaller than your cassette size on the photocopy. The entire slab can then be blocked out and submitted for microscopic examination according to the grids on the photocopy.

When the patient has received neoadjuvant chemotherapy, the entire face of the slab should be evaluated microscopically to determine the percentage of tumor necrosis. When the patient has not received neoadjuvant chemotherapy, you may be more selective in the sections that you submit for histology. Important areas that should always be sampled include: (1) the intramedullary component of the neoplasm; (2) penetration of the tumor through the cortex; (3) extension of the tumor into soft tissues; (4) the interface of the tumor with normal bone; (5) involvement by the tumor of an articular surface and/or joint space; and (6) the bone margin(s).

Amputation Specimens

Although amputations for tumor appear more complex than segmental resections as a result of their size and bulk, they can be dissected along the same guidelines given for segmental resections. Indeed, after margins are sampled, the portion of the limb containing the bones and joints not involved by the neoplasm can be removed. This, in essence, converts the specimen to one that is similar to the segmental resection.

The dissection of amputations performed because of gangrene is described in Chapter 45.

Important Issues to Address in Your Surgical Pathology Report on Bone Tumors

- What procedure was performed, and what structures/organs are present?
- What type of neoplasm is present?
- What are the size and histologic grade of the neoplasm?
- If the patient received neoadjuvant chemotherapy, what is the percentage of tumor necrosis?
- Is there any cortical penetration or soft tissue invasion?
- What is the status of the soft tissue and bone margins of resection?
- Is a skip lesion present?