Traumatic fracture callus

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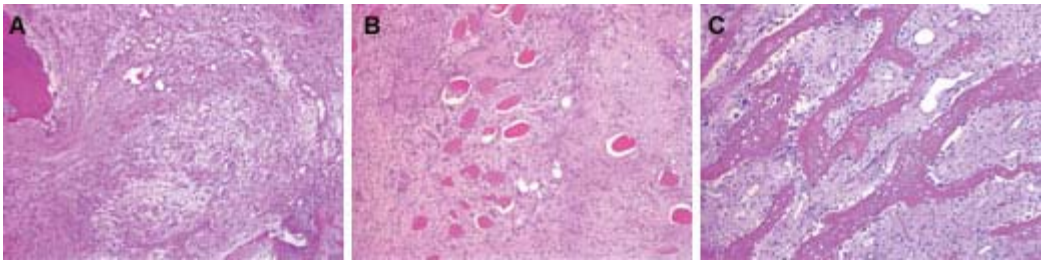

Figure. ***A:*** *Low-power photomicrograph shows the early stage of fracture callus formation. Undifferentiated spindle cells are surrounded by delicate new vessels, and trabecular bone is being actively resorbed.* ***B:*** *Low-power view shows the middle stage of fracture healing. Muscle fibers are surrounded by well-formed vessels, islands of cartilage, and delicate wisps of new bone formation.* ***C:*** *Low-power micrograph shows a fracture callus in clinical union. Well-formed bone is undergoing active resorption, culminating in a full biomechanical union.*

Bones of the craniofacial region are frequently broken, traumatically or iatrogenically. Whereas traumatic fractures can be readily identified clinically and radiologically, they can represent a diagnostic challenge histologically. A short discussion about the histologic evolution of traumatic fractures will help a pathologist know what to expect histologically, based on the time frames of development. The repair process follows a predictable histologic evolution of five distinct phases: *culatory, cellular, vascular, metabolic, and mechanical:*

- The circulatory phase is the initial manifestation. It is characterized by active hyperemia, resorption of bone fragments, and muscular injury. These events are closely associated with closure of the wound and formation of a primitive callus (blastema). A callus is a loosely organized hemorrhagic lake that contains an abundance of red cells and scattered inflammatory cells.
- The cellular phase begins a few days later, as the hematoma begins to organize with a noticeable proliferation of undifferentiated spindle-cell blastema cells. These undifferentiated cells are recruited from the surrounding bone, connective tissue, muscle, and bone marrow (figure, A).
- Next, a vascular spindle forms, initiating the vascular phase of fracture callus formation. This occurs at the periphery of the lesion, where there is active hyperemia; in the center of the organizing hematoma, in an area of low or passive hyperemia, initial osteoblastic activity is noticed (figure, B). This activity represents the transition to the metabolic phase.
- During the metabolic phase, there is a reinforcement of the primary callus and conversion of the procallus to callus, which effectively immobilizes the bone fragments. This occurs approximately 10 days to 2 weeks into the process. Histologic diagnosis is most difficult during the metabolic phase.
- During the mechanical phase, the united bone is remodeled over the course of months to years, culminating in a clinical union (figure, C).

Suggested reading

Claes L, Eckert-Hubner K, Augat P. The effect of mechanical stability on local vascularization and tissue differentiation in callus healing. J Orthop Res 2002;20:1099-1105.

Gerstenfeld LC, Cullinane DM, Barnes GL, et al. Fracture healing as a post-natal developmental process: Molecular, spatial, and temporal aspects of its regulation. J Cell Biochem 2003;88:873-84.

Stein H, Perren SM, Cordey J, et al. The muscle bed—a crucial factor for fracture healing: A physiological concept. Orthopedics 2002;25:1379-83.
Thompson Z, Miclau T, Hu D, Helms JA. A model for intramembranous ossification during fracture healing. J Orthop Res 2002;20:1091-8.