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| **Pathology Question:** |
| What are the pathological steps for natural bone healing in a post-extraction socket, and what are the pathological steps for bone formation in a bone grafting site? |
| **Report:** |
| The extraction of a tooth initiates a series of reparative processes that involve both hard and soft tissues. These reparative processes are defined by four distinct wound healing stages: hemostasis, inflammation, proliferation, and remodeling, respectively. During hemostasis, erythrocytes and leukocytes become embedded in a fibrin network to form blood clots. During inflammation, soft tissues become rich in newly formed vascular structures, inflammatory cells, erythrocytes, and immature fibroblasts to form granulation tissue. During proliferation, soft tissues present densely packed mesenchymal cells, collagen fibers, and vessels to form a provisional connective tissue matrix. The provisional connective tissue matrix is comprised of fingerlike projections of immature bone embedded in a primary spongiosa. Hard tissues then penetrate the matrix to form woven bone. During remodeling, the lamellae of mature, mineralized bone harbor secondary osteons surrounded by marrow spaces rich in vessels, adipocytes, mesenchymal cells and inflammatory cells to form lamellar bone. It is important to note that these wound healing stages overlap. Implants are typically placed 6-8 weeks following an extraction when the socket is comprised of about 34% woven bone, 62.2% provisional connective tissue matrix, and 3.8% granulation tissue. During this interval, the presence of osteoblasts reaches its peak and remains stable thereafter, making this the optimal time for implant placement.  However, the wound healing stages are accompanied by inevitable bone dimensional changes which may compromise the integrity of the implant. Following tooth extraction, the alveolar ridge undergoes osseous deformities, including reductions in volume, height, and width. Both horizontal and vertical bone loss occur following tooth extraction, however, the alveolar ridge experiences greater resorption in the horizontal plane. Furthermore, these osseous deformities of the alveolar ridge produce hard and soft tissue defects within the alveolar socket. The severity of these bone dimensional changes may pose a problem for clinicians in two ways: it creates an esthetic problem in the fabrication of an implant-supported restoration; and it may make the placement of an implant challenging (if not unfeasible). It is possible to minimize such problems by carrying out ridge preservation procedures in post-extraction sockets using bone grafting materials.  Bone grafting is a surgical procedure that replaces missing bone with material from the patient’s own body, or an artificial, synthetic, or natural substitute. Bone grafting is possible because bone tissue has the ability to regenerate completely if provided with the adequate space needed to grow. Bone grafts promote bone formation and preservation in post-extraction sockets by carrying out three biologic mechanisms: osteoconduction, osteoinduction, and osteogenesis. Osteoconduction occurs when the graft material provides a porous scaffold to support or direct bone formation. Osteoinduction occurs when the graft material induces differentiation of stem cells (osteoprogenitor cells) into osteogenic cells (osteoblasts). Osteogensis occurs when the graft material provides stem cells with osteogenic potential, thus directly laying down new bone. As natural bone grows, it replaces the graft material completely, resulting in a fully integrated region of bone.  Several studies have examined alveolar ridge resorption patterns in post-extraction sockets that have undergone natural bone healing versus bone grafting. In a 2014 systematic review and meta-analysis by Avila-Ortiz et al, grafted sockets on average preserved 1.89 mm in buccolingual width, 2.07 mm in midbuccal height, 1.18 mm in midlingual height, 0.48 mm in mesial height, and 0.24 mm in distal height compared to ungrafted sockets. This study observed nonmolar teeth, specifically. This study, along with others, concludes that bone grafting is effective in limiting alveolar ridge reduction as compared with natural bone healing alone. The overall success of dental implants depends on whether there is a suffucient volume of healthy bone at the recipient site at the time of implant placement. Therefore, proper bone grafting has the ability to increase the probability of implant success. |
| **References:** |
| 1. Avila-Ortiz, G., Elangovan, S., Kramer, K.W., Blanchette, D., & Dawson, D.V. (2014). Effect of alveolar ridge preservation after tooth extraction: a systematic review and meta-analysis.*Journal of dental research,*93(10), 950-8. 2. Farina, R., & Trombelli, L. (2012). Wound healing of extraction sockets. *Endodontic Topics,* 25(1), 16-43. 3. Irinakis, T. (2006). Rationale for socket preservation after extraction of a single-rooted tooth when planning for future implant placement.*Journal (Canadian Dental Association),*72(10), 917-22. 4. Kumar, P., Vinitha, B., & Fathima, G. (2013). Bone grafts in dentistry.*Journal of pharmacy & bioallied sciences,*5(Suppl 1), S125-7. 5. Trombelli, L., Farina, R., Marzola, A., Bozzi, L., Liljenberg, B., & Lindhe, J. (2008). Modeling and remodeling of human extraction sockets.*Journal of clinical periodontology,*35(7), 630-9. |