Single-stage repair of tibial segmental bone defect with combined autograft, allograft and platelet-rich fibrin – case report

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Single-stage repair of tibial segmental defect with combined autograft, allograft and platelet-rich fibrin - case report

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Segmental defects in long bones are challenging. Defects may arise due to resection of neoplasia, debridement of osteomyelitis or atrophic non-union following fracture repair. Limb-salvage options include distraction osteogenesis, vascularised bone grafts, combinations of demineralised bone matrix, autogenous or allogeneous grafts with or without use of bone morphogenic proteins, similar growth factors or stem cells, and staged repair following induction of an ectopic membrane around the defect.

Case presentation: A 9.7 y/m old entire female Coton de Tulear presented with a 4-month history of left coxofemoral and right femorotibial joint luxation following a road traffic accident. A concurrent comminuted left tibial fracture had been managed with a plate, lag screws and cerclage. Radiographs revealed atrophic non-union of the tibial fracture with a central diaphyseal defect of ca. 22% of the tibial length. The owner declined euthanasia or amputation as options. Coxofemoral joint stabilisation and femorotibial joint arthrodesis were performed, and a grafting procedure planned for management of the tibial defect.

Outcome: Postoperative radiographs (right) showed good filling of the defect with a mixture of radiopaque and radiolucent material. Due to unrelated health problems, the patient was euthanased 5 weeks postoperatively. Radiographs obtained post-mortem showed maintenance of the graft volume with a reduction in radiopacity (not shown).

Further investigations: Ultrasoundography (G) identified a hyperechoic graft structure extending out from the level of the proximal and distal cortices. On dissection, a solid, flexible tissue was found joining the proximal and distal fragments with the gross appearance of fibrocartilaginous tissue (H).

Following preservation in formalin, the tibia was decalcified for 10 weeks in 22% formic acid before cutting into sagittal sections and embedding in paraffin wax. Representative sections were stained with HE, Masson Trichrome, Safranin O, Gram and Von Willebrand's stains. Non-mature osteoid with a woven collagen structure dominated the bone ends towards the segmental defect (I). Cartilage formation was also observed in this area (J). Within the defect, multiple necrotic bone pieces, with empty lacuna, were seen surrounded by fibrosis (K). Despite the massive fibrotic response a regular pseudoarthrosis formation was not observed. No evidence of infection was observed. Angiogenesis and vascularization was observed between the allograft fragments (L).

Conclusions: Modern low-speed platelet-rich fibrin preparations contain large numbers of activated platelets and leucocytes (1), and slowly release growth factors such as PDGF, VEGF, TGF and IGF-1 over a period of 10 days (2). Platelet-rich fibrin can improve soft-tissue healing (3) and has been shown to speed bone healing in oral surgery (4). Normally, a segmental bone defect will heal due to new bone formation coming from differentiation of pluripotent stem cells located in the end- and periosteum. However, a reduced amount of oxygen will result in differentiation towards chondrocytes and, thereby, cartilage formation which over time will be remodelled to bone tissue by endochondral ossification. However, this is a slower healing process in comparison to direct intramembranous ossification. Thus, the presence of cartilage indicates non-optimal vascularization, which may reflect delayed vascular ingrowth into the relatively large graft volume. There are limited data available on healing of large mixed grafts in vivo; however, the initial loss of radiopacity seems consistent with other case reports. The maintenance of graft volume and evidence of vascularization suggests that progression to full healing may have occurred with more time. Potentially, this mixed platelet-rich fibrin and allograft/autograft approach may permit simple, single-stage repair of segmental or other large defects.