In the intramedullary group, there was no significant difference between the intramedullary group and the extracortical group in terms of mechanical properties.

**DISCUSSION:** These results indicate that bone allografts treated with OP-1 and a type I collagen carrier have superior healing in terms of torsional stiffness and maximum torque as well as periosteal callus compared to untreated allografts. Furthermore, it appears that that when OP-1 and type I collagen are delivered extracortically there is more bone formation as evidenced by more periosteal callus than when they are delivered in the medullary canal. However, since the periosteal callus was only measured in the extramedullary area, the periosteal callus does not reflect the intramedullary bone formation. Actually, the delivery in the intramedullary space may be more effective as there is a trend towards greater maximum torque and torsional stiffness in the intramedullary group compared to the extramedullary group. Osteogenic protein-1 increased bone formation and torsional stiffness and maximum torque in this canine bone allograft model. Clearly, bone allograft healing needs to be studied in greater detail with various BMPs and carriers to delineate the most efficacious method for the healing of large bone defects.

**INTRODUCTION:** Structural bone allografts are most commonly used clinically for large bone defects after tumor resection or osteolysis related to aseptic total joint replacement loosening. However, the complication rates with the use of large structural allografts at least after tumor resection are very high. A recent study showed infection rates of 11%, fracture rates of 18%, and nonunion rates of 19%.

Part of the reason for the high fracture and nonunion rates is a lack of host bone incorporation into the allograft. In fact, the host bone normally invades and is incorporated into only several millimeters of the periphery of the allograft. Osteogenic proteins are members of the bone morphogenetic protein family (OP-1=BMP-7). Osteogenic protein-1 has been shown to induce bone and cartilage by many investigators. In addition, it has become clear that Osteogenic protein-1 induces more bone in the presence of type I collagen in the rat subcutaneous and other bone formation assay. The purpose of this study was to examine bone formation and healing in canine bone allografts with Osteogenic protein-1 and an adhesive type I collagen carrier. The carrier was applied either inside or outside the bone allograft (intramedullary or extracortical) to further delineate if a change in the location of delivery of the OP-1 and collagen affected bone formation.

**MATERIALS AND METHODS:** Bilateral resection of a 4-cm segment of the femoral mid-diaphysis and reconstruction with the same size allograft was performed in 16 mongrel dogs. The allografts were plated laterally and anteriorly. The lateral plate was fixed with 8 bicortical screws and the anterior plate with 3 unicortical screws. The right side was used as the control and the left side as the treatment side. On the control side, mean±SEM).

**RESULTS:** Gait analysis: In the intramedullary group, there was no significant difference between the OP-1 treated side and the control side. In the extracortical group, the dynamic weight bearing was significantly higher in the OP-1 treated side at 2, 4, 6, 8, 10, and 12 weeks after surgery.

Radiographic examination (Fig. 1): In the intramedullary group, the peristeal callus area was significantly higher on the OP-1 treated side at 4, 6, 8, 10, and 12 weeks following surgery. In the extracortical group, the peristeal callus area was significantly higher on the OP-1-treated side at 2, 4, 6, 8, 10, and 12 weeks following surgery. In this group, the callus area reached its maximum value at 4 weeks after surgery and decreased with time thereafter. The peristeal callus area on the OP-1 treated side in the extracortical group was significantly higher than that in the intramedullary group at 2, 4, and 6 weeks after surgery.

Mechanical testing (Fig. 2): In both the intramedullary and the extracortical groups, maximum torque and torsional stiffness were significantly higher on the OP-treated side than the control side. There was no significant difference between the intramedullary group and the extracortical group in terms of mechanical properties.


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