Relevance to Musculoskeletal Condition: Segmental bone loss often requires multiple surgical interventions in order to achieve fracture healing. This study addresses the healing effects of recombinant porcine growth hormone (r-pGH) in a standardized gap model in the tibia in micropigs.

Introduction: Treatment of segmental bone loss in long bones is one of the most challenging problems in orthopaedic surgery. Multiple procedures, such as bone grafting or bone transport are required in order to achieve healing of the severely injured limb. However, these procedures implicate a considerable donor site morbidity (1), may cause transmission of infectious agents and require a long treatment period. A previous study clearly could demonstrate acceleration of regenerate consolidation in intramembranous bone formation using an animal model with distraction osteogenesis and recombinant growth hormone (2). Bone formation in distraction osteogenesis predominantly is achieved by intramembranous bone formation without the occurrence of cartilage, while secondary fracture healing is primarily achieved by chondral ossification (3). Up to now the effect of r-pGH on secondary fracture healing in a large animal model with a segmental bone defect remains unclear. To address this problem we asked following research question: Does systemic administration of recombinant growth hormone accelerate bone formation in a defect model with secondary fracture healing?

Methods: 18 mature Yucatan micropigs were ranked according to their age and weight and equally distributed into two treatment groups. The animals in the study group received a daily subcutaneous injection of r-pGH (100 μg/kg bodyweight) starting the day of surgery, while the animals in the control group received sodium-chloride as a placebo. All procedures were carried out under ethical permission of the animal rights protection authorities. A standardized 1cm defect in the mid-shaft area of the right tibia was created with an oscillating saw. The periosteum was incised longitudinally and sutured before stabilizing the osseous defect with plate fixation. Full weight bearing was allowed postoperatively. The animals were sacrificed 6 weeks post surgery. The tibiae of the r-pGH-treated group exhibited 72% higher torsional failure load and torsional stiffness values of the GH-group were 6.3 Nm; placebo: 10.7 Nm; p < 0.05) (Figure 1).

Figure 1: torsional failure load and torsional stiffness

To analyze the properties of the newly formed bone, quantitative CT measurements of the callus in the defect zone were performed. The biomechanical data demonstrate that the administration of r-pGH increases both, the torsional stiffness as well as the torsional failure load in this model. These results confirm previous investigations where in distraction osteogenesis systemic administration of growth hormone resulted in an accelerated regenerate consolidation (2).

To analyze the properties of the newly formed bone, quantitative CT measurements of the callus in the defect zone were performed. Although the difference between the groups concerning the BMC in the defect was not statistically significant, a clear trend for a larger amount of mineralized tissue could be observed in the GH treated group. The BMC values for both groups were similar, indicating that the structure of the callus tissue in both groups are comparable. These data are in contrast to other studies, where the callus formed during GH treatment presented an extremely loose structure (4). To clarify this, further histological evaluation of the callus area will be necessary.

Our results strongly suggest that systemic administration of homologous growth hormone accelerates new bone formation in secondary fracture healing. This could be a future clinical tool for cases of segmental bone loss to prevent delayed union or pseudarthrosis.

Figure 2: BMC and BMD of the defect zone

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