Bone Regeneration with 3D-Printed Hybrid Bone Scaffolds in a Canine Radial Bone Defect Model

Department of Plastic and Reconstructive Surgery, Yeouido St. Mary's Hospital, College of Medicine
The Catholic University of Korea
Yoon Jae Lee, M.D., Ph.D.*, Jong Won Rhie

Purpose

The repair of large bone defects remains a significant challenge in clinical practice and requires bone grafts or substitute materials. In this study, we developed a unique hybrid bone scaffold comprising a three dimensional (3D)-printed metal plate for weight bearing and a biodegradable polymer tube serving as bone conduit. We assessed the long-term effect of the hybrid bone scaffold in repairing radial bone defects in a beagle model.

Methods

Bone defects were created surgically on the radial three beagle dogs and individually-tailored scaffolds were used for reconstruction with or without injection of autologous bone and decellularized extracellular matrix (dECM). The repaired tissue was evaluated by X-ray, micro-computed bone of tomography, and histological observation 6 months after surgery. The functional integrity of hybrid bone scaffold-mediated reconstructions was assessed by gait analysis.

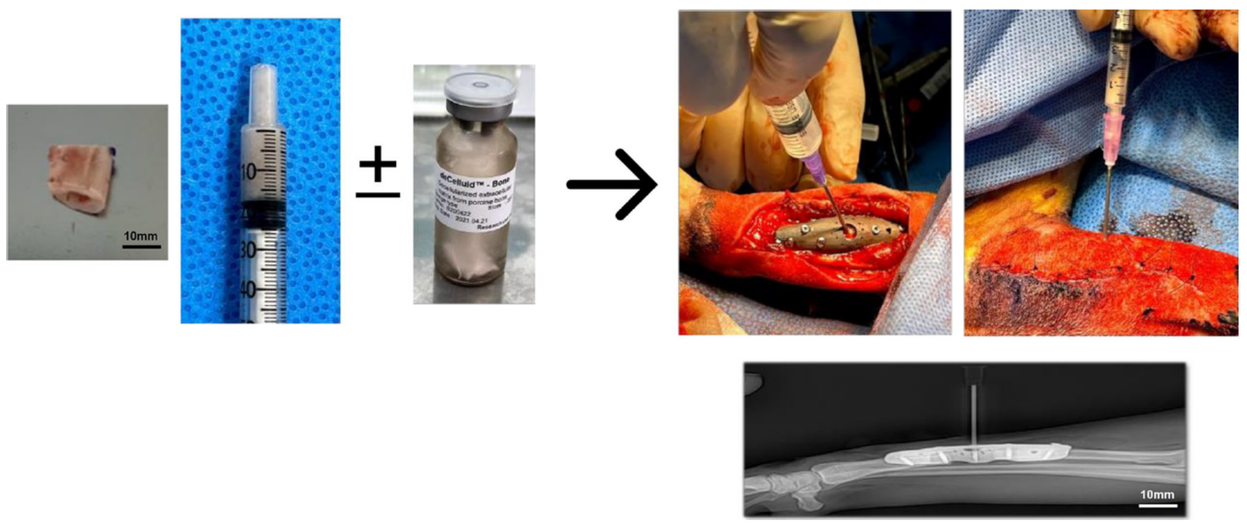

Fig.3 Experimental procedure for injecting autologous bone and dECM through the hole in the metal plate

Fig. 1 Fabricated hybrid bone scaffold based on 3D printing. **A** Photograph of the porous titanium metal plate. **B** Photograph of the biodegradable polymer tube. **C** Schematic illustration of the 3D-printed scaffold tailored for bone regeneration in a beagle defect model

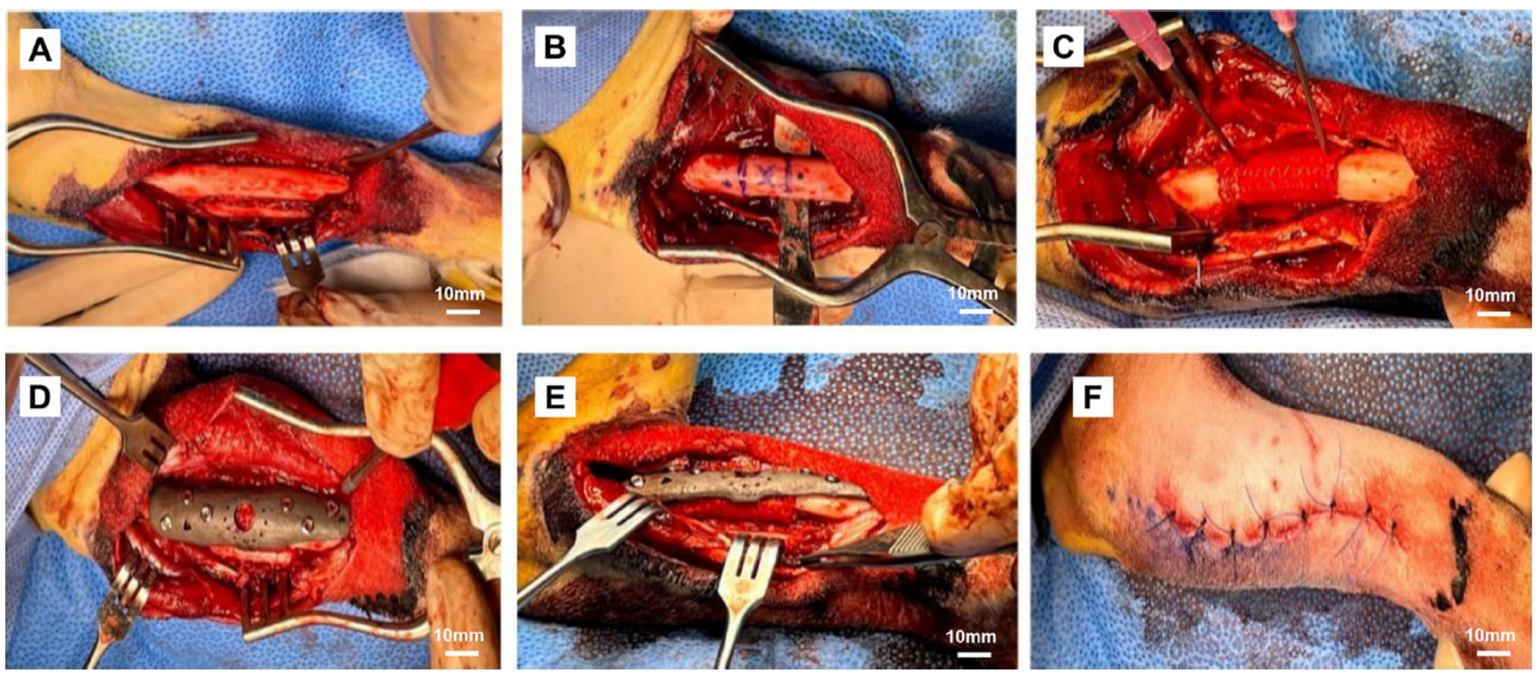

Fig.2 Experimental procedure for creating a beagle radial bone two ends of the bone defect. **D** The metal plate was fixed to the bone defect model and implanting the hy hybrid bone scaffold was implanted in the radial bone of the beagle was exposed. **B** A 15-mm-long bone defect was bone defect. **F** The muscle and skin were closed by suture marked. **C** The biodegradable polymer tube was inserted between the

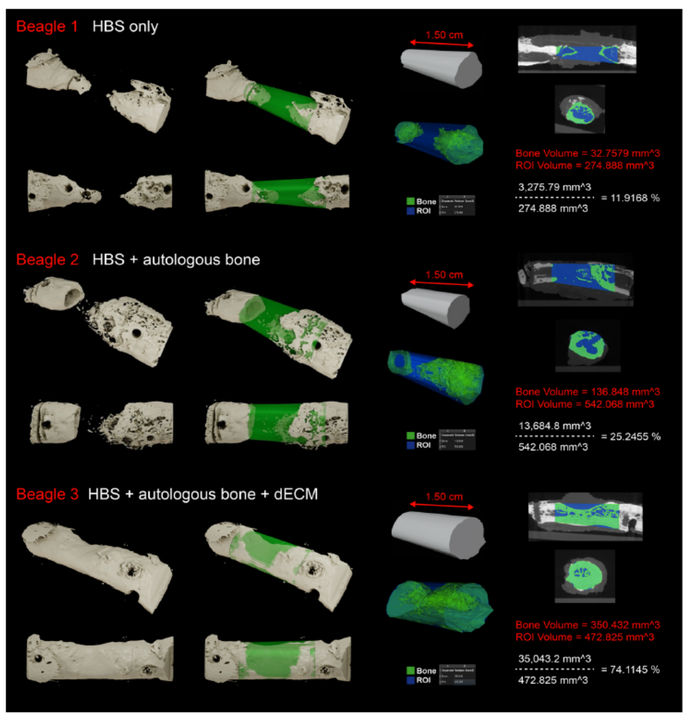

Fig.6 3D-reconstructed bone regeneration in the beagle radial bone defect model. 3D micro-computed tomography images demonstrating heal

Results

In vivo analysis showed that the hybrid bone scaffolds maintained the physical space and bone conductivity around the defect. New bone was formed adjacent to the scaffolds. Addition of autologous bone and ECM in the polymertube improved healing by enhancing bone induction and osteoconduction. Furthermore, the beagles' gait appeared normal by 4 months.

Conclusion

The future of bone healing and regeneration is closely related to advances in tissue engineering. Bone production using autologous bone and dECM loaded on 3D-printed hybrid bone scaffolds can successfully induce osteogenesis and provide mechanical force for functional bone regeneration, even in large bone defects.