Mechanical Performance of Bioglass Osteotomy Wedges and Clinical Outcomes in Deformity Correction

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Introduction

Bioglass 45S5 is a synthetic, absorbable, and osteoconductive material. Bioactive Precontoured Wedges (BPWs) made from bioglass 45S5 promote rapid mineralization and provide a resorbable scaffold for new bone formation in osteotomies.
Aim: To evaluate the mechanical performance of BPWs under simulated physiological conditions and assess clinical function and safety in foot reconstruction using BPWs.

Methods

BPWs (NovaBone®, Alachua, FL) underwent simulated aging (n = 5) to mimic physiological conditions. Dissolution and compression studies assessed mass loss and mechanical strength. Dynamic loading evaluated response to physiological stresses over time. Clinically, four cases were assessed. Three female patients (age: 30–69 years, BMI: 43.5–47.8) with Posterior Tibial Tendon Dysfunction (PTTD) underwent osteotomy with BPW implantation, bone putty augmentation, and tendon procedures. One 15-year-old male with painful flexible flatfoot had bilateral procedures using BPW (left) and allograft (right). Meary's and talar-second metatarsal angles, and adverse events were recorded.

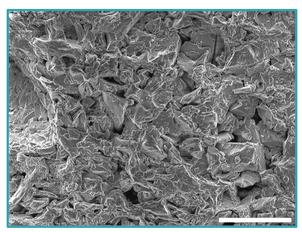

Figure 1. Internal Structure of BPW. Scanning electron micrograph showing BPW microstructure and porosity. Scale bar = 200 µm.

Results

During simulated aging of BPWs, mass loss and compression strength declined approximately linearly over time (Fig. 2A, 2B), while stiffness and elasticity were maintained throughout resorption (Fig. 2C).

Clinically, all patients showed improvement and reported functional progress at a minimum follow-up of 3 months. PTTD patients improved average Meary's angles (pre-op: 9.9° to post-op: 0.8°, Fig. 4). In the juvenile flatfoot case, talar-second metatarsal angle improved from 23.7° to 12.7° on the BPW side and from 30.3° to 20.3° on the allograft side. This patient stated a preference for the BPW side. No adverse events or implant failures occurred in any patient during the follow-up period.

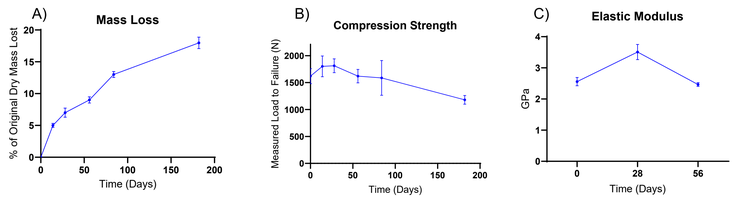

Figure 2. Simulated Resorption Effects on BPW Properties. **Dissolution and Compression Studies**: A) Mass loss of wedges was approximately linear with time; B) Loss of compression strength was approximately linear over time. **Elasticity Studies**: C) Average elastic modulus over 1000 completed cycles of a biologically relevant load.

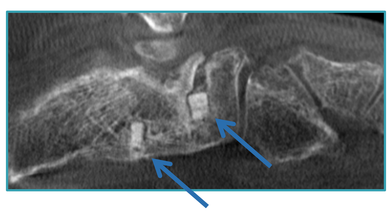

Figure 3. CT scan, sagittal view of right foot 6 months post-osteotomy with BPW (arrows) implantation.

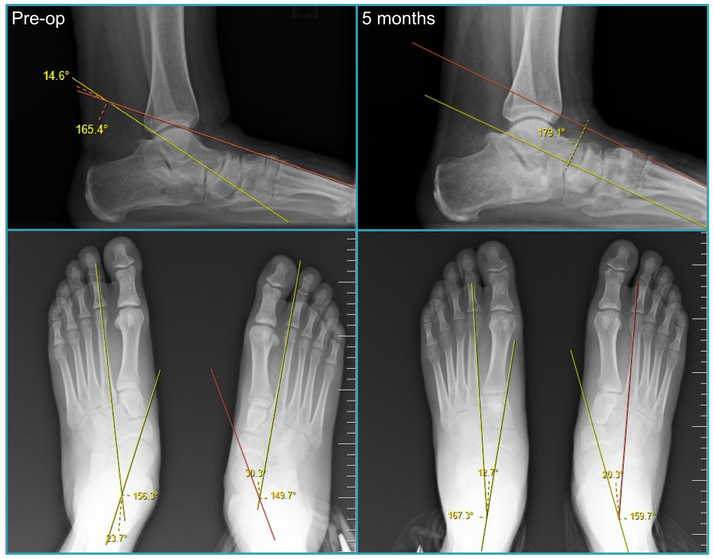

Figure 4. Radiographic Outcomes. Representative pre-operative and 5 months post-operative radiographs. Top: Meary's angle of right foot. Bottom: Talar-second metatarsal angles, right foot operated.

Conclusions

BPWs demonstrated mechanical reliability under simulated physiological loads and promoted clinical and radiographic improvement post-osteotomy. Although limited by small sample size, findings suggest BPWs are a safe, effective void filler and osteo-stimulative scaffold that may enhance surgical site stability and reduce graft failure risk. Further research is warranted to determine the long-term efficacy of porous bioglass in deformity correction.

Acknowledgements

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