Using Nanotechnology as Stand-Alone Bone Grafting in Open Fracture Bone Defects and Nonunions

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Purpose: Our objective was to review outcomes and complications of open fracture defects and nonunions treated with nanotechnology-derived, stand-alone synthetic bone graft.

Methods: This was a retrospective review of open fracture defects and nonunions treated with the addition of a novel, advanced bone grafting material that utilizes nanocrystalline particles of hydroxyapatite (HA) that resemble the size, chemistry, and morphology of human HA particles. The HA particles are contained within an amorphous silica gel matrix. The matrix is highly nanoporous, hydrophilic, and releases silicon dioxide, which triggers angiogenesis and initial bone formation. The synthetic bone grafting material is Nanobone (Artoss, Inc). It was used in cases between 2017 and 2019 by a single surgeon at a Level-I trauma center. The preoperative and postoperative imaging was reviewed by a fellowship-trained orthopaedic traumatologist. Patients were treated by a single surgeon using standard bone grafting techniques while utilizing the synthetic product in open fractures with bone defects and radiographically defined nonunions.

Results: 17 patients underwent the application of the synthetic nanocrystalline HA particles—9 patients with open fracture defects and 8 patients with nonunions. 7 of 9 open fracture defects (78%) were within the tibia, 1/9 (11%) was within the radius, and 1 of 9 (11%) was within the distal humerus. The nonunions included 3 of 8 distal femur (38%), 4 of 8 tibia (50%), and 1 of 8 calcaneus (12%). The average age was 37 years (range, 22-83). Patients were observed for an average of 13 weeks postoperatively (range, 8 weeks to 26 months). There were no patients lost to follow-up. Union was observed in 9 of 9 (100%) of the open fracture defects and 8 of 8 of the nonunions. The average time to union was 7.5 weeks (range, 6-12 weeks) when including open fracture defects and nonunions. There were no intraoperative or late complications. Early postoperative complications included a superficial infection of the radius open fracture that required oral antibiotics with resolve.

Conclusion: Using nanotechnology with nanocrystalline HA particles that are contained in a silica gel matrix is a successful treatment as stand-alone bone grafting in both open fracture defects and nonunions. Our preliminary data show evidence of low complication rates, high union rates, and early healing. Our data suggest that using nanocrystalline HA particles may be an alternative to other methods of autologous bone grafting, allografting, and/or synthetic bone grafting. Although we did not quantify the bone density healing, our clinical series show more subjective bony consolidation at much earlier stages of healing when compared to our previous gold standard when using autologous bone grafting. With our results, we have switched from using autologous bone grafting to mainly using the nanocrystalline HA particles, as we believe the preliminary findings show high and early healing rates with the reduction of risks and comorbidities associated with autologous bone graft.