Radioprotection of Bone Allograft Using Tocopherol and Ascorbic Acid

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Introduction/Aim: Despite advances in biomaterials, bone tissues remain necessary allograft materials in orthopaedics. In hip arthroplasty, allografts unite biologically, and achieve mechanical properties that provide good long-term clinical outcomes. Following total joint replacement, the strength of bone tissue used for structural allografts is a key factor in long-term success. Gamma irradiation is used to terminally sterilize bone allografts. Unfortunately, this negatively affects the mechanical properties of bone; and therefore the outcome of revision joint replacement surgery. Our aim was to determine if tocopherol (Vitamin E) and ascorbic acid (Vitamin C) can preserve mechanical properties of bone allograft during gamma irradiation. Methods: Ten femurs were collected from The Queensland Bone and Skin Bank (QBSB). Femurs were processed according to QBSB standard protocols. Each femur provided three cortical portions, which were each sectioned into 5 beams (40 x 4 x 2 mm) using a low speed saw. Cortical bone specimens were infused with a mixture of Vitamins E and C, and saline (controls), for 4 hours at room temperature. Processed and vitamin infused bone samples were equally grouped in five gamma irradiation doses: 0 kGy, 10 kGy, 15 kGy, 25 kGy, and 50 kGy, and irradiated under frozen conditions at Steritech, Narangba, Australia. Control specimens (0 kGy) remained in a freezer. Cortical bone specimens were mechanically tested for 3-point bending using an Instron 8722 servo-hydraulic material testing machine. Structural properties from load-displacement curves, were used to calculate material properties such as stress, strain, and toughness. Results: A dose-dependent reduction in toughnness was observed in non-treated groups. We showed that cortical beams treated with antioxidants, Vitamins E and C, significantly improved toughness in comparison to non-treated groups. Cortical bone specimens treated with Vitamins E and C irradiated at lower gamma irradiation doses of 10 kGy and 15 kGy, had the same properties as fresh frozen bone allograft. Conclusion: