Stem Cells Harvested from Bone Marrow and Adipose Tissue Demonstrate Equivalent Healing Potential in a Murine Model of Irradiated Mandibular Fracture Healing

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PURPOSE: In the context of irradiated bone repair, bone marrow stem cells (BMSCs) have demonstrated value via cellular replacement and restoration of new bone formation. Although effective, BMSCs require a difficult aspiration and subsequent processing. Adipose-derived stem cells (ASCs), on the other hand, are readily available, easily harvested, and can be refined in the operating room for greater translational potential. As such, we aim to compare the regenerative potential of ASCs to BMSCs in order to lend support to their alternative use. We hypothesize that ASCs will provide similar biomechanical and mineralization healing outcomes to BMSCs in irradiated mandibular fracture repair.

METHODS: Male Lewis rats were randomized into two groups: BMSC (n=12) and ASC (n=16). All animals were administered a fractionated, human-equivalent dose of 35Gy over 5 days, comparable to a 70Gy dose for human patients. After a two week recovery period, the animals received a mandibular osteotomy and external fixation. Surgifoam scaffolds loaded with either BMSCs or ASCs were placed intraoperatively directly into the fracture site. Following a 40-day healing period, the mandibles were dissected, grossly assessed for bony union, underwent microCT to analyze mineralization, and lastly were biomechanically tested to failure.

RESULTS: Upon dissection, the BMSC group demonstrated a 66% (8/12) bony union rate whereas the ASC group had a 94% (15/16) union rate. No statistically significant differences were seen between the groups in regard to mineralization capacity. These metrics included bone mineral density, tissue mineral density, and bone volume fraction. While no statistically significant differences were noted from biomechanical testing, the ASC group demonstrated higher numerical values than the BMSC group for yield (59.8 N vs. 43.0 N), ultimate load (73.7 N vs. 55.5 N), and energy (57.1 Nmm vs. 35.0 Nmm).

CONCLUSIONS: In the context of irradiated mandibular fracture repair, our results demonstrate comparable healing outcomes using BMSCs and ASCs. ASCs provide a higher union rate and improved biomechanical results beyond BMSC therapy, although the differences are not statistically significant. We are currently examining the histologic and vascular protection afforded by these therapies in order to further bolster these results. Based on this direct comparison, clinicians interested in cell-based therapies for irradiated bone repair should consider ASCs as a promising option, given their abundance and ease of acquisition.