

Biomechanical Study Of Bone Allograft Irradiated At 11 kGy

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INTRODUCTION:

Risk of infection and disease transmission remain a concern in application of bone allograft in Orthopaedic surgery. Terminal sterilization by means of gamma irradiation remains the most practical and widely used method to reduce the risk however, it carries the possibility of weakening of the mechanical properties and studies has shown that it is dose-dependent. We studied a lower dose of gamma irradiation at 11 kGy instead of the standard at 25 kGy for sterilization of the allograft.

METHODS:

In total, 13 long bones (5 femurs and 8 tibias) were used. Only the diaphysis was used and each bone was divided into three equal-length segments of at least five centimeters and randomly allocated into three groups; non-irradiated, irradiated at 11 kGy and irradiated at 25 kGy.

RESULTS:

Based on our findings, the median yield and ultimate strength of bone irradiated at 11 kGy were 58.8 MPa (IQR 24.83 MPa) and 81.17 MPa (IQR 22.55 MPa) respectively while the non-irradiated bone was 60.96 MPa (IQR 10.34) and 90.09 MPa (IQR 17.68 MPa). Not surprising, the bone irradiated at 25 kGy had a lower yield and ultimate strength of 46.89 MPa (IQR 6.05 MPa) and 61.2 MPa (IQR 10.74 MPa). The difference between the non-irradiated bone and bone irradiated at 11 kGy was not statistically significant while the difference was significant in between the non-irradiated bone and bone irradiated at 25 kGy.

	Yield Strength (MPa)	Ultimate Strength (MPa)	% Difference with non-irradiated bone
Non-irradiated Bone	60.96	90.09	
Bone with 11 kGy	58.8	81.17	3.54/9.9 (<i>p value = 0.61</i>)
Bone with 25 kGy	46.89	61.2	23.08/32.07 (<i>p value = 0.001</i>)

DISCUSSIONS:

Gamma irradiation reduces the strength of allograft due to increasing protein and collagen denaturation as the dose increases. Multiple studies showed the relation mainly at doses upward of 25 kGy (industry standard) thus we undertaken the chance to show the result of radiation at 11 kGy. Furthermore, the allografts used in this study were structural allografts in comparison to other studies that used wafers or rings of the allograft. However, we do admit that a bioburden (microbiological) analysis should be done to really confirm the efficacy of the 11 kGy radiation dose in sterilization of the bone.

CONCLUSION:

Bones irradiated at 11 kGy retained their mechanical strength and this level of gamma irradiation should be considered in the preparation of the bones for clinical use.

REFERENCES:

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