

3D Printed Titanium Alloy Parts Manufactured by Selective Laser Melting (SLM) for Potential Orthopaedic Applications: *In-vitro* Genotoxicity Outcome

¹Mohd Jan NH; ¹Ibrahim MZ; ¹Zulkifly AH; ²Omar MA; ²M. Azmiruddin; ²M. Jabir; ²H. Johari; ²Z. Zainon; ²N.A. Norrifin; ²B.Meh; ²M. Yusrin

¹Department of Orthopaedic, Kuliyyah of Medicine, International Islamic University Malaysia, Kuantan, Pahang, Malaysia,

²SIRIM Berhad, Kulim Hi-Tech Park, Kulim, Kedah.

INTRODUCTION:

Selective laser melting (SLM) is a type of Additive Manufacturing (AM) technology that deposits materials layer by layer towards production of a 3D structure. In orthopaedic field, titanium (Ti) based implants is widely used in orthopaedic surgery due to their excellent properties and biocompatibility. This study aimed to investigate the cell mutagenic effect after exposed with 3D printed titanium alloy (Ti6Al4V) parts through SLMed technology.

MATERIALS & METHODS:

The bacterial tester strains (TA98, TA100, TA1535, TA1537 and WP2) were used to evaluate mutagenicity of different concentrations of Ti6Al4V in the presence and absence of metabolic enzyme. Negative control was 0.9% NaCl. The positive controls were 4-Nitro-o-phenylenediamine, sodium azide, and 9-aminoacridine methyl methanesulfonate. A total of 0.1ml of each concentration of THF was mixed with 0.5ml of buffer/S9 mix followed by addition of 0.1ml of each tester strain suspension. The mixture then was shaken in water bath for 20-30 minutes at 37°C. The samples then were incubated at 37°C for 48 hours. The revertant colonies then were counted.

RESULTS DISCUSSIONS:

Figure 1 shows the number of colonies grown on the plates (revertant bacterial colonies counts) in all strains. Results revealed that the number of revertant colonies treated with the Ti6Al4V orthopaedic implant through SLMed technology did not exceed twice the number of the negative control either in the presence or absence of metabolic activation. The negative and positive controls used in this study responded as expected. The outcomes of this study showed that Ti6Al4V orthopaedic implant through SLMed technology did not demonstrate a mutagenic effect on all bacterial strains, which indicated that Ti6Al4V orthopaedic implant

through SLMed technology can be used safely as treatment option for fracture management in orthopaedic field.

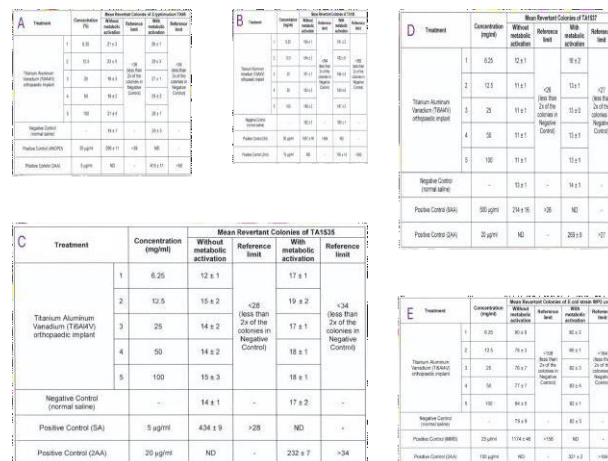


Figure 1: Revertant colonies A: *S. typhimurium* TA98 B: *S. typhimurium* TA100 C) *S. typhimurium* TA1535 D) *S. typhimurium* TA1537 and E) *E. coli* strain WP2 uvrA induced by Ti6Al4V orthopaedic implant through SLMed technology in the present and absence of metabolic activation system.

CONCLUSION:

Based on the findings of this study, Ti6Al4V orthopaedic implant through SLMed technology is non-mutagenic effect and biocompatible. This outcome shows that fabrication of implant through SLMed technology is a potential candidate in fracture management in future.

REFERENCES:

1. Wang et al., Journal of Clinical Medicine 2023; Vol 12; 444.
2. Mohammad Samiel et al.; Investigating the Mutagenic Effects of Three Commonly Used Pulpotomy Agents Using the Ames Test; Adv Pharm Bull, 2015, 5(1), 121-125.