

Comparative Mechanical Testing Of Additively Manufactured Titanium Screws.

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Additive manufacture (3D printing) in titanium alloy offers potential benefits for patient specific implantation. Fixation of a plate/device can be with traditionally manufactured screws but unique additively manufactured screw designs are also possible. However additively manufactured implants may have different biomechanical characteristics and may suffer from brittleness therefore we sought to compare additively manufactured screws to the Kyon Locking screws (ref).

Accurate replication of the design of a 4.0mm KLS Locking Screw was performed using the company KYON data sheet by Nexus 3D. This model will then be exported to an STL file and printed on an SLM Solutions 280HL in titanium-64 at RAM 3D. Six screws of traditional manufacture TM were then compared to six additively manufactured screws (AM) in both pullout and cycling loading tests.

A screw pullout jig was created using a U-shaped shackle to hold the screw head mounted in an Intron device. The 40mm long screws were inserted into a 40 mm cube of polyurethane foam (SawboneTM, 1522-03, 20 PCF). Pull-out tests were performed to failure of the construct which in all cases was fracturing of the sawbone block. There was no significant difference in force to failure between AM and TM screws. For the cyclic loading tests

A custom jig using a roller cam to create a bending stress was then engineered. A custom 3D printed "plate" was designed to accept the morse taper head design of the Kyon screws. Either a AM or a TM screw (N=6 per style) was screwed through the plate hole into a composite plastic rod of 27mm outer diameter and 7mm wall thickness (SawboneTM 1403 absolute 4th Gen). The plate block had two additional holes to allow it to be bolted to the linkage of the load device. An electric motor raised and lowered the plate block using a worm gear, with the rod secured in a locking frame, this subjecting the screw to bending as would occur in-vivo. The rig measured travel with optical sensors and was loaded with a 20kg working weight. Each screw was cycled to failure

Data is still pending

1. S Polak, L Beever, A Wade, M Fukuoka & A J Worth. Biomechanical comparison of titanium alloy additively manufactured and conventionally manufactured plate-screw constructs, *New Zealand Veterinary Journal*, 2024, 72:1, 17-27, DOI:10.1080/00480169.2023.2264805.

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