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The use of Additive Layer Manufacturing (ALM) for the fabrication of specialized limb salvage implants

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Additive Layer Manufacturing (ALM) is becoming an important fabrication technique for orthopaedic implants and is particularly suited to specialised implants such as those used in limb salvage. ALM has already proven its capability for producing small complex components for the aerospace industry. The ALM process uses a high-powered laser or electron beam to selectively sinter fine powder such as titanium alloy in ultra-thin layers enabling complex free-form components to be built layer by layer. ALM is ideal for one off components such as ingrowth lattices that would be impossible using conventional subtractive manufacturing techniques.
This aim of this study was to describe the adoption of ALM into the design and fabrication process of titanium alloy limb savage devices.
Prior to the clinical use of ALM, extensive metallurgical and mechanical testing was undertaken.
The first clinical application of an ALM titanium alloy implant was undertaken in November 2010. A 62 year old male with a chondrosarcoma of periacetabulum required an extensive resection of the ilium and sacro-iliac joint saving only a small part of the superior pubic ramus. A 3-dimensional model was created from CT scans from which the implant was designed. Key design features included extensive lattice structures at the SI joint and pubic ramus bone interfaces, transverse sacral bolts and a large medialised acetabular socket. The lattices were hydroxyapatite coated and the device was implanted with the aid of navigation. Following an uneventful rehabilitation, at 6 months the patient was full weight bearing with a stick. At 24 months the patient remains active and radiographically there is the appearance of bony ingrowth into the lattice structure.
To date, 7 scapula and 11 pelvic replacements have been implanted. The early use of this advanced manufacturing route for patient specific limb salvage implants has been very encouraging as it enables the engineer to produce a more anatomical conforming implant with integral 3D lattice structures for bone and soft tissue integration. It is anticipated that laser-based ALM will be a key process in the development of the next generation of limb salvage implants.

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