Microstructural comparison of additive manufactured and conventional implants components made of Ti6Al4V.

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**Objective/Aim/Hypothesis**:

Ti-6Al-4V is the most common alloy used for biomedical application, especially in the orthopedic world. This alloy is characterized by low density, superior corrosion resistance, good osseointegration and lower elastic modulus when compared to other commonly used alloys such as CoCrMo and 316L stainless steel. Ti-6Al-4V alloy is also focus of the additive manufacturing (AM) technology, which has enabled affordable and quick production of personalized implants suitable for specific patient needs. This technology is already developing implants for total joint arthroplasty and spinal use. However, little attention has been given to the alloy microstructure which is affected by manufacturing processes and the subsequent heat treatments applied. Additionally, the alloy microstructure combined with chemical composition, is well known for dictating the mechanical properties.

**Design/Approach/Methods:**

This study aims to compare the microstructure of Ti-6Al-4V alloy of AM and the conventional retrieved orthopedic implants such as acetabular cups, tibial trays, femoral stem and modular necks by means of electron backscatter diffraction (EBSD). It was used 19 devices (16 retrieved and 3 AM devices) supplied by 5 different manufacturers.

**Results and Conclusion:**

The preliminary results showed that despite the same chemical composition, all implants have a wide variation of microstructure features. The retrieved implants microstructure was classified in 3 groups: equiaxed grains alloys (Fine and Coarse), bimodal grains alloys and dendritic grains alloys and the additive manufactured alloys were classified in one additional group which consist of a ribbon-like microstructures - similar to Widmanstätten patterns, Fig. 1. Additionally, the alloying elements are not homogeneously distributed, especially for the AM alloys where the β phase was located along the alpha boundaries in a network like fashion and manufacturing defects such as pores were observed. The AM microstructure may have implications on the fatigue and corrosion behavior due to large elongated grains, β phase network and pores existence.

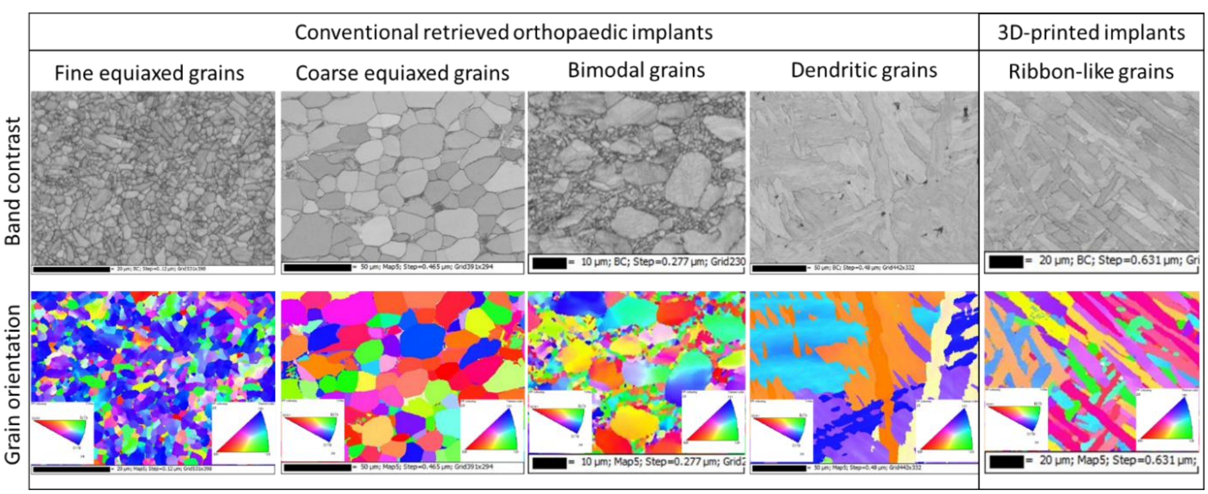


Fig. 1 - Band contrast and grain orientation maps of the four different types of microstructure observed within contemporary orthopedic implant components and additive manufactured (3D printed) implants made from Ti-6Al-4V.