Preliminary assessment of dry electropolishing technology on a novel additive manufactured Ti-6Al-4V implant abutment

Ben Kalman[1] & Les Kalman[2]

[1]BMSc Candidate • Western University

[2] Restorative Dentistry • Schulich School of Medicine & Dentistry • Western University

Figure 1. Novel dental implant abutment scaled against a Canadian nickel (with 20mm diameter).

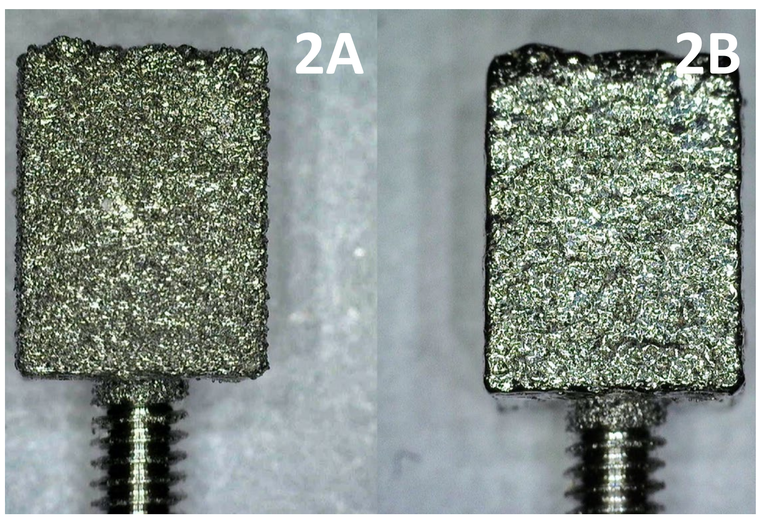
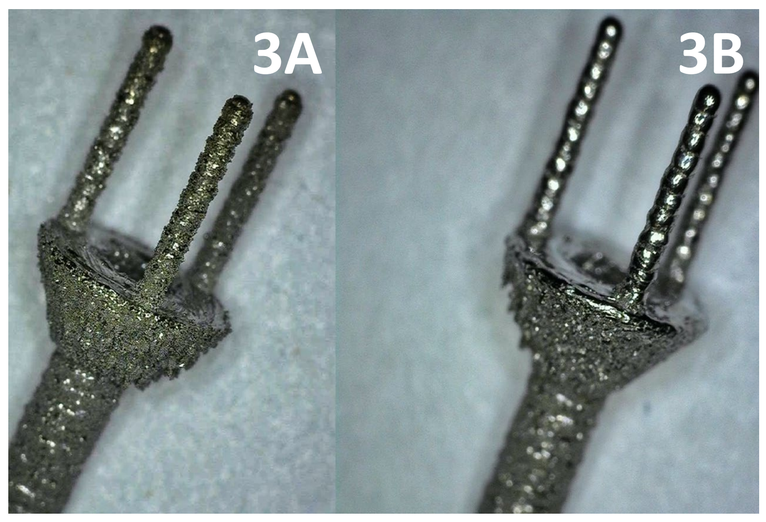
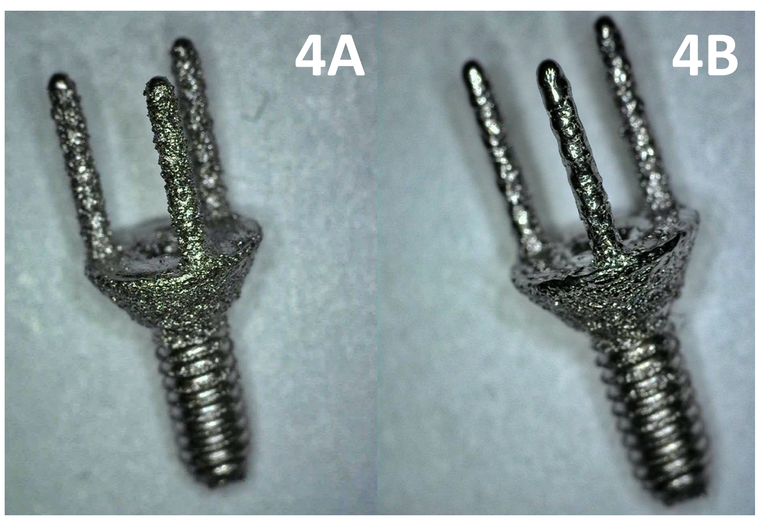


Figure 2A. Implant abutment component before DET and **2B** component after DET. Width of component is 4.5mm



Figures 3A. Implant abutment before DET and **3B** abutment after DET. Maximum width of abutment is 4.5mm.



Figures 4A. Finalized implant abutment before DET and **4B** abutment after DET. Maximum width of abutment is 4.5mm

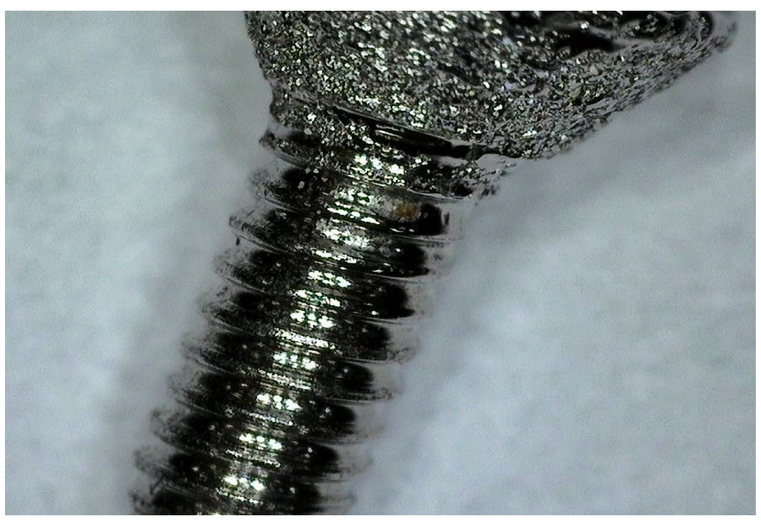
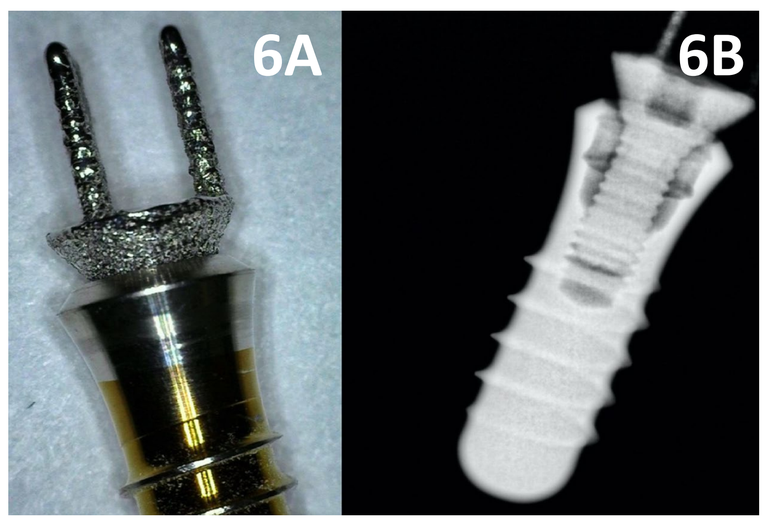


Figure 5. Abutment threads. Width of shaft is 2.1 mm.



Figures 6A. Illustrates the post-DET abutment and implant fit, **6B** is a radiograph of the post-DET abutment and implant.

INTRODUCTION

Background

- Dental prosthesis require a smooth finish to prevent the formation of biofilms
- Unprocessed products fabricated by metal AM are too rough for immediate implementation and must be finished to allow proper physical contact, fit and suitability
- Standard polishing protocols use hand tools and rotary instruments to remove material, which is labour and time intensive and may not be possible due to the size and geometry of the component.
- Dry electropolishing technology (DET) is a novel form of polishing maintaining homogeneity across the entire surface of the object

Aim

- To explore and assess DET in vitro on a novel titanium alloy dental implant abutment

MATERIALS & METHODS

- Several implant abutment components (Figures 2-4) were fabricated with AM using Ti-64
- Components were designed with Fusion 360 software, were optimized and printed in dental grade titanium Ti-64 using Selective Laser Melting (SLM) technology
- Post-processing involved heat treatment, bead blasting and fixation with a custom stabilization jig for thread placement
- Components were not physically polished, due to the small size and intrinsic geometry
- Components were photographed prior to DET, then were delivered to DLyte facility, underwent standard DET protocols and then returned.
- Polished components were photographed in the same orientations to evaluate polish.
- Finalized version of the novel dental abutment was further evaluated using a preclinical assessment including:

(1) threading the abutment into an implant analogue and assessing the fit and play
(2) by hand torquing to approximately 15 Ncm
(3) evaluation with a digital radiograph to identify the seating and any micro gaps

Abutment workflow animation

RESULTS

- DET appears to smooth out the surface roughness, i.e. reduce the coarseness, but there is still surface topography
- DET provided significant polishing of the pin projections and the abutment surface, but minimal polishing of the abutment circumference (Figures 2A and 2B)
- Significant polishing of the pin projections, abutment surface and circumference (Figures 3A and 3B), threads seam to remain unaffected (Figures 4A and 4B)
- No tactile evidence of thread slippage or excessive play and a dental explorer could not detect any micro gaps (Figure 6A)
- Polished abutment threaded into an abutment, fit seemed clinically acceptable and unaffected (Figure 6B)

DISCUSSION

- Surface topography is desirable in some dental implant components, to maximize retention of prosthesis
- DET provides an adequate surface polish, but retains surface topography and does not affect the threading
- AM components may require the incorporation of a ‘sprue’ to permit proper submersion for complete polishing of titanium and cobalt-chromium
- Surface finish is required to prevent biofilm accumulation and the development of inflammation
- Surface polish or smoothness would require further research through assessment and evaluation with greater magnification (SEM), a larger sample size, microbiologic and corrosion assessments

CONCLUSION

- DET provided a surface polish subtle enough to significantly improve the finish, without impacting structure, topography, fit or threading of an abutment
- Provided a simple and predictable post-processing technique for a novel additive manufactured Ti-64 dental implant abutment

REFERENCES

Available on request.

QR Code For Video Presentation

Presented at the 98th Annual Session of the Greater New York Dental Meeting in 2022