Fast & Injurious: Reducing thermal osteonecrosis regions in the drilling of human bone with multi-objective optimization

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ABSTRACT

Excessive heat generated from wrong combinations of bone-drilling parameters could kill the bone cells (thermal osteonecrosis). This paper combines numerical, experimental, and statistical approaches to investigate the induced thermal damages by bone-drilling parameters. Bone-drilling was simulated in the finite element method (FEM) software DEFORM-3D, and the results were validated with the experimental bone-drilling. Response surface methodology (RSM) and desirability analysis were used to evaluate and optimize the parameters (rotational speed and feed). Results revealed that the optimized bone-drilling parameters reduced maximum bone temperature (Tmax) (8.9–85.8 °C) osteonecrosis diameter (OD) (5.16–10.07 mm), and osteonecrosis depth (OH) (3.35–5.50 mm) more than previous studies. With these advantages, the optimization offers a promising solution for minimum thermal damage and low-cost bone-drilling process.

KEYWORDS

Necrosis; Bone drilling; Multi-objective; RSM; Optimization; Parameter

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