Drilling of bone: thermal osteonecrosis regions induced by drilling parameters

Mohd Faizal Ali Akhbar[1] and Ahmad Razlan Yusoff[2]

[1]Faculty of Industrial Management(FIM), Universiti Malaysia Pahang, 26300 Kuantan, Pahang, Malaysia
[2]Faculty of Mechanical and Manufacturing Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia
E-mail: mfaizalaa@ump.edu.my

ABSTRACT

In bone-drilling research, thermal osteonecrosis regions have only begun to be investigated. This study evaluates the thermal osteonecrosis regions and bone temperature elevations induced by drilling parameters in drilling of human cortical bone. The finite element method (FEM) was used to simulate the drilling simulation. The simulation results were then validated with the experimental bone-drilling test. A new method called dimensionless weightage was proposed to evaluate the parameters that generate minimum thermal injury in bone-drilling. The FEM results displayed the thermal injury in the bone as a function of osteonecrosis diameter (OD), osteonecrosis depth (OH) and maximum bone temperature elevation (Tmax). These results allow precise evaluation of bone-drilling parameters' influences on thermal damage. Results revealed that with the recommended parameter ranges, Tmax, OD, and OH could be reduced up to 110.0 °C, 9.96 mm and 4.56 mm, respectively. This work represents a step toward the optimization of bone-drilling parameters, which can provide an accurate approximation of thermal damage in bone-drilling compared with previous research. Moreover, this work contributes valuable insights for engineers and clinicians to identify the favorable ranges of bone-drilling parameters in bone surgeries.

KEYWORDS

Osteonecrosis, bone drilling, thermal necrosis, temperature, FEM, drilling parameter, osteonecrosis regions

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