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A PCA based quality loss approach for minimum drilling induced bone tissue damage

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The present work uses a novel optimization technique combining PCA with quality loss concept for the selection of best setting of bone drilling parameters for minimum drilling induced bone tissue damage. Experiments were conducted with different drill bits, spindle speed and feed rate each at five levels using L25 setting of the orthogonal arrays. The responses considered to evaluate the damage are bone drilling temperature (T), thrust force (F), surface roughness (SR) and the percentage of the mechanical damage around the drilled hole (MD). Principal component generated the uncorrelated linear combinations of original response which then used to derive combined quality loss, i.e., bone drilling performance index (BDPI). Response table, response graph and the analysis of variance (ANOVA) were used to determine the optimal setting and the influence of bone drilling parameters on the BDPI. The results obtained from the above analysis are validated by performing confirmation experiments. This investigation uses an algorithm involving the combination of PCA with quality loss function and Taguchi methodology for the optimization of multiple response characteristics in the bone drilling process. Based on the above analysis, the following conclusions can be made: The investigation shows that the feed of 30 mm/min, the speed of 500 rpm and at helix angle 15°, point angle of 90° drill are the recommended settings for bone drilling to minimize the temperature, force, surface roughness and delamination simultaneously; the highest contribution to the multiple performance bone damage index (BDPI) is of feed rate followed by drill bit and the spindle speed respectively; strong correlations exists between response pairs T~F, D~D and SR~D; first two principal components (PC1 and PC2) can take care data variation with cumulative accountability proportion 92.05% and method is successfully validated through confirmation test.