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Optimization of bone drilling parameters using grey-based fuzzy algorithm

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Abstract. In this article a modified algorithm (grey based fuzzy algorithm) is used to optimize multiple performance characteristics in drilling of bone. Experiments have been performed with different cutting conditions using full factorial design. The quality parameters considered are temperature, force and surface roughness. Grey relational analysis (GRA) coupled with fuzzy logic is employed to obtain a grey fuzzy reasoning grade (GFRG) combining all the quality characteristics. The highest GFRG is obtained for the feed rate of 40 mm/min and the speed of 500 rpm and is the optimal level. Analysis of variance (ANOVA) carried out to find the significance of parameters on multiple performance characteristics revealed that the feed rate has the highest contribution on GFRG followed by the spindle speed. The optimum level of the process parameters obtained is validated by the confirmation experiment.

Keywords: Grey relational analysis (GRA); Fuzzy logic; Optimization; Multiple performance characteristics; Bone drilling; Analysis of variance (ANOVA).

1 Introduction

Bone fracture is a common feature of everyday life. Bone fracture treatment usually involves restoring of the fractured bones to their initial position and immobilizing them until the repair and reconstruction takes place [1]. Drilling of bone is one of the principal operations which are extensively used in bone fracture treatment to produce holes for screw insertion to fixate the fractured parts. In past, various authors have studied the process of bone drilling and its effect on fracture healing [1-6], but still the problem of high heat affected zone, micro crack formation and surface finish of the drilled hole remains the challenge in this field. High heat effected zone and the micro cracks causes damage to the bone cells which can result in their death or delay the process of healing whereas the improper surface finish hampers the proper engagement of the screws with the bone surrounding the drill site and can lead to the misalignment of the fixation. Therefore, multi response optimization of the bone drilling process can contribute momentously to minimize the drilling induced bone tissue damage.

Grey system initiated by Deng [7] has emerged as a powerful tool for dealing with the poor, incomplete and uncertain data [8-9]. In recent years, the researchers have successfully

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