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Cutting Rate Effect on Temperature During Cortical Bone Sawing

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INTRODUCTION

When bone is cut the occurrence of thermal damage to the bone is of major concern to the surgeon. If the temperature exceeds 44°C for longer than 1 min, bone repair is impaired (Eriksson et al, 1984) and necrosis may occur.

Repeated use of cutting blades may reduce the cutting efficiency (Wevers et al, 1987; Toksvig-Larsen et al, 1992). Wevers et al also found that there is a greater force required to cut cortical bone using a blunt saw compared to new one.

MATERIALS AND METHODS

Experiments were conducted from the mid diaphysis of bovine cortical tibia. Two series of tests were performed. In the first series (EXP1) the whole tibia was cut by hand transversely using 3M Maxi Driver® reciprocating saw and P512 blades.

In the second series (EXP2), beams of bone of approximately 90×15×7.5mm were used. A bone fixture was mounted on a Kistler dynamometer, on a Hounsfield machine and the blade was fed to the sample at 3 different rates of 1, 2, and 3 mm/min.

Temperature measurements were made by means of T-type thermocouples bonded into drilled holes in the bone and a data logger recorded the temperature changes. Details of experimental setup are previously described (Khalili Parsa et al., 2005). While measuring temperature, force was also monitored. No irrigation was used in all experiments.

RESULTS

Figure 1 illustrates the average maximum temperatures for 20 tests in three different zones at 3, 6, 9 mm away from the sawing zone (EXP1) and the extrapolated temperature at the saw blade. As it would be expected temperatures are higher closer to the sawing location. Average maximum temperature of 78, 60, and 52°C were observed in zone 1, 2, and 3, respectively. Figure 2 shows the average maximum temperatures which were observed in 3 zones for experiments conducted at various rates (EXP2).

Blunting of the tip and the edge of blades were observed using SEM and the rate of blunting appears to become more pronounced on the cutting tooth between the forth and fifth cutting trial.

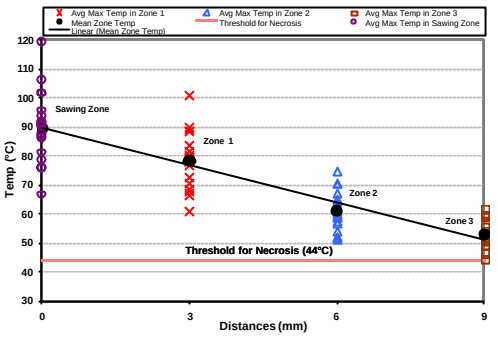

Figure 1: Comparison of necrosis threshold with average maximum temperatures at distances from the sawing zone.

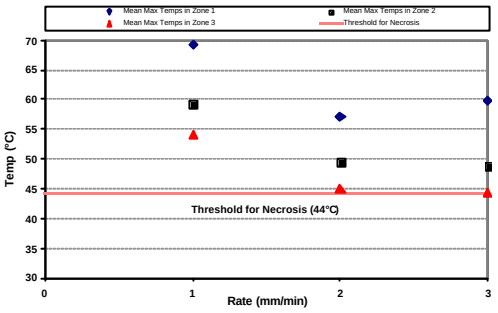

Figure 2: Average maximum temperatures for 3 zones for cutting at different rates.

DISCUSSION

It may be concluded that there will be a region of bone 9 mm either side of the cutting blade with impaired bone regeneration as temperatures in this region exceeded the threshold temperature for necrosis. The cutting rate of 2 mm/min appears to be the optimum rate for cutting of bone using a reciprocating saw as consistent load was observed for this rate alongside minimum cutting temperatures.

REFERENCES

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