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An Investigation of the Heat Affected Zone in Cortical Bone Sawing


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AN INVESTIGATION OF THE EXTENT OF THE HEAT AFFECTED ZONE IN CORTICAL BONE SAWING

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INTRODUCTION

Surgical procedures such as osteotomy and hip replacement involve the cutting of bone with the aid of various manual and powered cutting instruments including manual and powered bone saws.

Frictional rubbing between the blade of the saw and the bone results in the generation of localised heating of the cut bone and increased cutting forces (Ark et al, 1997). Overheating in localised areas can cause bone necrosis and have an impact on the rate of healing of the bone post operation and overheating also affects the sharpness life of the blade. A review of the literature indicates that work has been complete on temperature in the immediate cutting zone. This study is focusing on the size of the overheated zone relative to the cutting position.

MATERIALS AND METHODS

Cutting experiments were conducted on portions of the mid diaphysis of bovine tibia. The temperature measurements were performed with Copper-Constantan thermocouples (Type T). Thermocouples, 0.4 mm in diameter, were inserted and glued into drilled holes at a depth of 5 mm and positioned on a 2mm grid in bands as shown in Figure 2. Temperature recording was achieved by means of a data logger (Grant Instruments, Cambridge, UK).

The bone specimen was fixed in a holding device in order to exclude any undesirable vibration during the sawing procedure. Transverse cuts across the tibia specimens were performed by hand until the saw blade had cut more than half way through the bone section. A 3M Maxi Driver and Reciprocating Blade (P512) without saline or lubricant were used in this first series of tests.

RESULTS AND DISCUSSION

Figure 1 shows the temperature measured during sawing for each of the eight thermocouples. Data recorded during the experiment shows that the temperature was greatest in the first measurement band where an average maximum temperature of 51°C was recorded. This is in line with previously published

values (Toksvig-Larsen et al, 1992) while lower peak temperatures for other bands were recorded with an associated time lag due to heat transfer in the bone.

This initial work indicates that the zone affected by temperatures likely to cause thermal necrosis may extend beyond the immediate cutting zone as temperature in the second band is also approaching this critical temperature of 44°C.

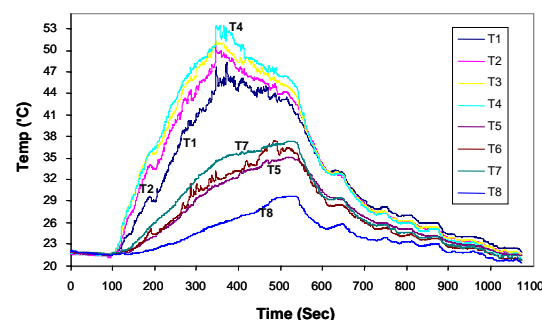


Figure 1: Temperature recorded in bone during cutting

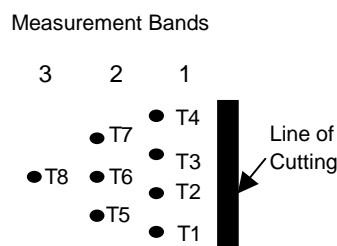


Figure 2: Thermocouple positions relative to the cutting zone

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