ABSTRACT

Radiographic techniques are regularly employed to image fractures however patients are exposed to ionising radiation as a consequence. Vibration analysis provides a non-ionising method to monitor bone fracture. This study has found that the resonant frequency of a "healthy" sheep tibia decreased by 47.13% (S.D. 11.63%) following the creation of a 9mm deep fracture in the mid diaphysis. This study was confined to in vitro testing therefore future work will focus on monitoring fracture in vivo.

INTRODUCTION

Background:

The inpatient cost of fall related hospitalisations among older persons was estimated at €59 million in 2008. Current radiographic imaging techniques expose patients to harmful radiation. Vibration analysis is used extensively in industrial applications to monitor machine condition however the first reported use of this technique in orthopaedics was in 1932. Since then it has been employed in a variety of studies ranging from diagnosis of; implant loosening, bone integrity and fracture healing.

Aim:

This study aims to investigate the ability of vibration analysis to detect damage in bone.

METHODOLOGY

1. Sheep tibiae were obtained from a local abattoir and soft tissues were removed before testing.
2. The resonant frequencies of "healthy" (undamaged) tibiae were measured by exciting the tibiae with an electrodynamic shaker and measuring the response of the bones (Figure 2).
3. A fracture in the mid-diaphysis was simulated by cutting the bones normal to the axial direction of the tibia (Figure 3), again the resonant frequencies were measured in the same way as above.
4. The depth of the fracture was incrementally increased and resonant frequencies were measured subsequent to each increase in depth.

RESULTS

- As the depth of the fracture was increased, the resonant frequency monotonically decreased with an approximately linear relationship as seen in Figure 4.
- Tibiae showed similar responses with an overall difference in resonant frequency of 47.13% (S.D. 11.63%) between healthy and damaged bone.

CONCLUSION

- This study has shown that vibration analysis can detect damage in bone.
- However as yet only in vitro testing has been carried out therefore in vivo tests will need to be conducted if the technique is to be applied in a clinical setting.
- If vibration analysis can reliably detect damage in vivo it could be an alternative to current diagnostic techniques. This would eliminate patient exposure to harmful radiation and it is envisaged that the cost of instrumentation will be more affordable than existing instruments, thereby reducing hospital operating costs.