An Investigation into Damage Accumulation in Bone as a Result of Cyclic Loading on Hard and Soft Surfaces

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Abstract

This research project investigated the effect of cyclic loading on bone as a result of loading on hard and soft surfaces. The results show that there is a substantial difference in the amount of damage accumulated in the bone as a result of the two tests. However there is a concerns that the amplitude of the loading during the soft test didn't fully match the amplitude of the loading in the hard test. Thus, more tests need to be carried out.

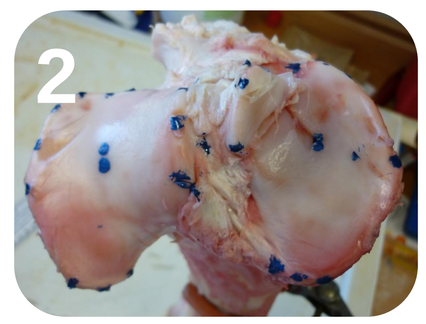
Introduction

Fatigue failure is defined as a load which does not cause failure when applied once but could cause failure after a number of cycles. Such failures are known clinically as stress fractures, and they are common in thoroughbred race horses, athletes, and military personnel. One characteristic which all the above have in common is intense training, but if this training is common between individuals, why are some individuals effected and others not? As part of this research project a number of bone and loading parameters have been identified and their contribution to damage accumulation in bone from cyclic loading will be quantified . The parameters in question are:

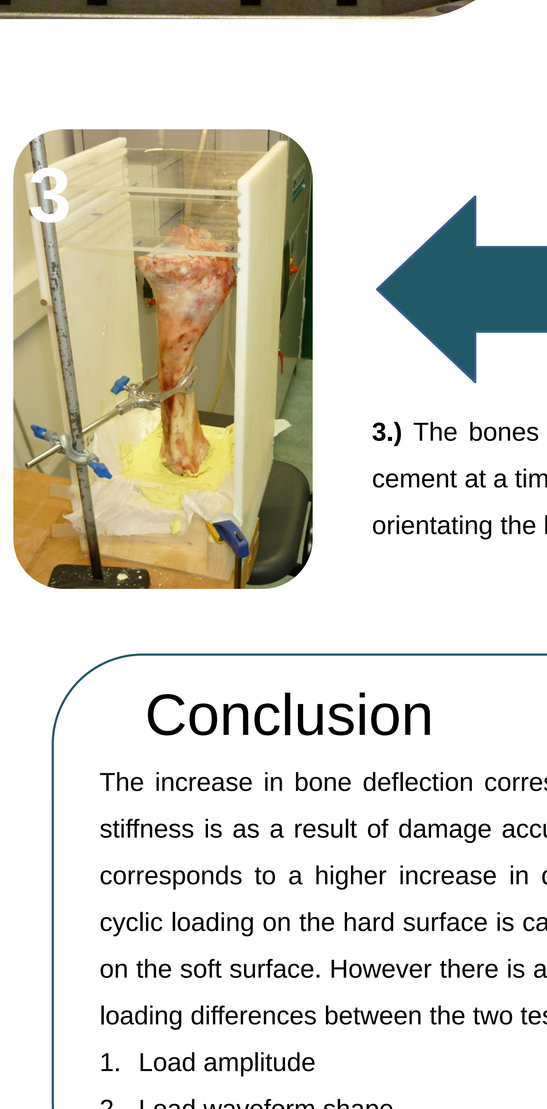
1) loading on hard and soft surfaces
2) variation in bone mineral density
3) variation in bone size,
4) variation in loading frequency,
5) variation in waveform pattern
6) age

Methodology

1.) Bovine tibiae were sourced from a local abattoir, carefully disjointed from their corresponding femurs and cleaned of all soft tissue .



2.) The tibiae were then marked out to find the centres of the articulating surfaces in order to orientate the bones in a replicable manner for moulding.

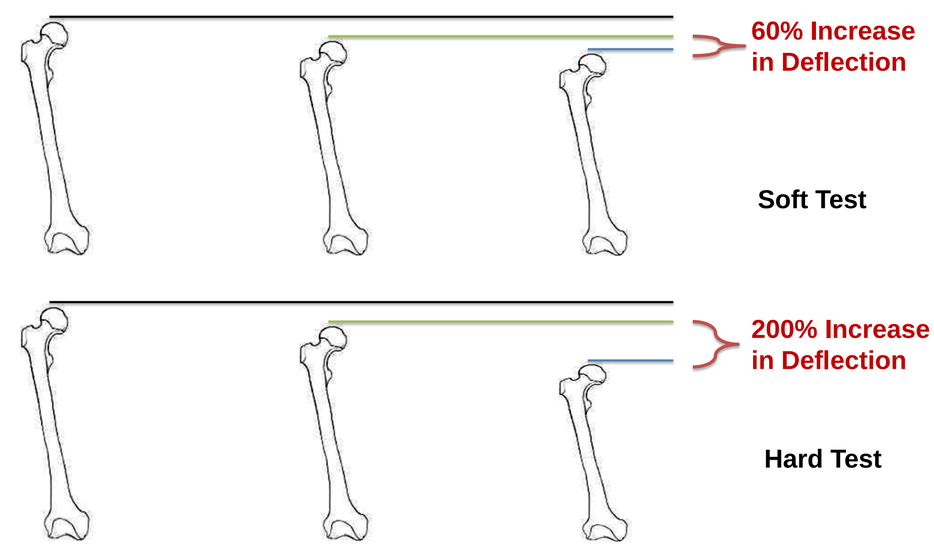


3.) The bones were then clamped in position and one end was moulded in dental cement at a time using a custom built rig which was capable of shaping the mould and orientating the bone in a replicable manner.

4.) The bones were then extracted from the mould rig and covered in vaseline to preserve the water content in the bone for the duration of the test.

5.) The moulded bones were then clamped into position on the Instron 8874 servo hydraulic materials testing machine using a custom built rig. Each rig had the capacity to mimic either a hard surface or a soft surface depending on whether springs were installed or not. Each bone was then cyclically loaded for 50,000 cycles and the change in deflection between start and finish measured.

Results



Conclusion

The increase in bone deflection corresponds to a reduction in the bones stiffness. This reduction in bone stiffness is as a result of damage accumulation in the bone. A large accumulation of damage in the bone corresponds to a higher increase in deflection under loading. Therefore, from the results presented, the cyclic loading on the hard surface is causing a larger amount of damage to the bone than equivalent loading on the soft surface. However there is a concern that the difference between the results may be as a result of loading differences between the two tests , differences such as:

1. Load amplitude
2. Load waveform shape

Thus further testing is required to refine the test procedure so as to obtain objective results.

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