# CHARACTERISATION OF ROUGHNESS AND SHAPE OF LONG BONE FRACTURES

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## Introduction

Fractures of the long bones are extremely common and most heal without complication. However, 10% ~ 15% do not heal successfully and can require a second surgical intervention. Despite the fact these fractures have been studied in the past, neither the mechanical behaviour of the fracture interface, or the complexity of its shape and/or properties have been fully characterised.

Therefore, the aim of this study was to develop a method for generating transverse fractures in vitro using porcine specimens and a computational code capable of characterising the shape, waveform and mechanical parameters of the fractures.

## Methods

A drop-weight rig was developed that enabled transverse fractures to be artificially generated in porcine femoral specimens. Four paired porcine specimens were fractured, and then scanned using micro computer tomography (µCT) [XtremeCT, Scanco Medical]. The images generated where then imported to image processing software (Image J, http://imagej.nih.gov/ij/) and transformed into binary files. The first image of the stack of images for each specimen was then selected and a medial circumference was drawn using a skeletonise function. A code was then written (Matlab 2009b, Mathworks) to project each point on the circumference to the surface of the fracture to determine the height. The height projections were then smoothed using a Gaussian Filter and different kernel sizes in order to observe the effect of the filter in the resultant smoothed curve. Finally, the smoothed curve was then subtracted from the original to enable different sizes of feature to be characterised. An overview of the methods is shown in Figure 1 and Figure 2.

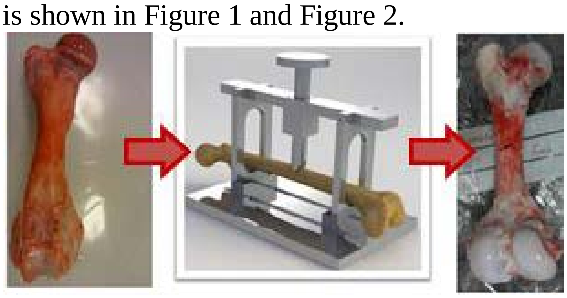

*Figure 1: Fracture generation on porcine specimens. The drop-weight rig is shown in the central image.*

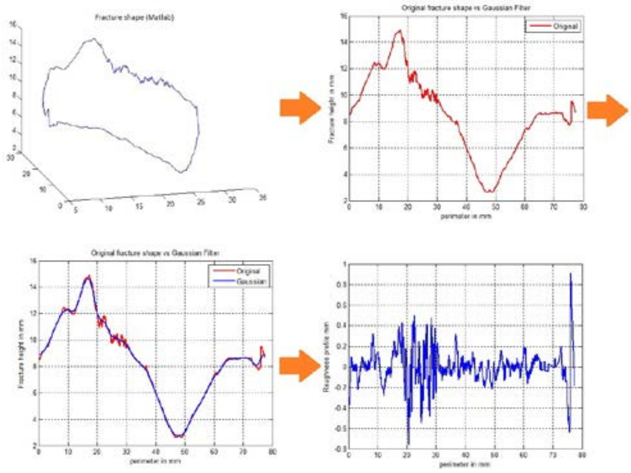

*Figure 2: Overview of the methods. The resultant roughness profile is shown in the bottom-right image.*

## Results

Using small kernel sizes, the roughness of all the specimens was similar; however the larger shape of the fractures differed from one specimen to another (Table 1). At a large scale, the fractures varied in amplitude from 6 mm to 16 mm.

| **Specimen#** | **Kernel Size** | | | |
|---|---|---|---|---|
| | 3 | 13 | 23 | 53 |
| **SP24** | 0.0449 | 0.3030 | 0.4126 | 0.6459 |
| **SP25** | 0.0319 | 0.0663 | 0.0820 | 0.1277 |
| **SP26** | 0.0302 | 0.0690 | 0.0893 | 0.1388 |
| **SP27** | 0.0341 | 0.0962 | 0.1149 | 0.1770 |

*Table 1: Calculated roughness (in mm) for four specimens. The roughness is obtained from the integration of the subtraction of the original waveform and the filtered one using different kernel sizes.*

## Discussion

From the results, it is clear that the fractures vary in overall shape but are more similar in terms of their roughness at a smaller length scale. These characteristics will now be used to develop computational models of different fracture types. The understanding of these factors will help researchers to improve the design of implants and aid the healing process, reducing the probabilities of having a second surgical intervention or another possible fracture.