Visualizing synthetic dental biofilm on teeth using dual energy micro-CT

N. Vyas, A. D. Walmsley, H. Dehghani, R.L. Sammons, L. Grover, E. Pecheva

Objectives

Ultrasonic scalers are used to remove plaque and calculus from teeth to reduce the risk of dental disease (Figure 1).

Imaging plaque and calculus on the whole tooth would indicate areas where it is most resistant to removal, and a 3D overview could show us how effective ultrasonic scaling instruments are, and help to improve their efficiency. This study uses micro-CT for the first time to image an artificial biofilm made from a hydrogel on a tooth in 3D.

Methods

Macedo et al. (2014) [1] have formulated a hydrogel for mimicking biofilm in the root canal. An identical gel was made, but by substituting 10 ml of water for 10 ml of Lugol’s stain (iodine and potassium iodide) to enhance contrast.

A SkyScan 1172 micro-CT scanner (SkyScan, Kontich, Belgium) was used. A range of dual energy scans were performed and combined so both hydrogel and the mineralised bone tissue could be seen and segmented.

Noise Reduction

A range of filters were applied in Fiji to reduce noise. Images taken at 50 kV had the most contrast, and the median, minimum and ‘removed outliers’ filters seem to increase the contrast the most.

Conclusions

We have developed methods for 3D imaging of artificial biofilm on teeth using micro-CT by implementing image processing techniques to remove noise in low energy images, which enables segmentation of the artificial biofilm from the tooth using dual energy imaging. This work opens possibilities for imaging natural biofilm grown on teeth using micro-CT. We will look at improving the segmentation tools and imaging a mineralised hydrogel to mimic dental calculus more effectively, with the eventual aim of imaging disrupted biofilm on teeth.

References: