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A mCT Comb Based Approach to Standardize Sampling Locations of the Coronal Suture

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Abstract

Computed tomography scans are often used to evaluate areas of complex structures, are non-destructive, and can provide additional methods to assess trauma. However, few studies have examined sutural microscopic trauma patterns in adult human crania. In this study, we seek to establish a protocol for standardization of sampling sites along sutures using Avizo segmenting software and present a microcomputed tomography (mCT) comb-based approach to standardize sampling sites along the coronal suture. Six human cranial trauma cases and three control specimens housed at the Southeast Texas Applied Forensic Science (STAFS) facility in Huntsville, Texas and the Forensic Anthropology Center (FAC) in San Marcos, Texas were used in this study. Specimens were mCT scanned at the University of Texas High-Resolution X-ray Computed Tomography (UTCT) and FAC facilities. To standardize data collection, Type-1 landmarks were used with imaging of the coronal sutures beginning at sphenion and terminating at bregma. Avizo 9.7.0 imaging software was used to measure and define the chord distance between sphenion and bregma where twenty equidistant points were plotted along the chord. From these defined points, sampling sites at orthogonal angles from the chord line were placed along the coronal suture. Utilizing a cord bound by landmarks to define the spacing and placement of sampling sites along a 3D, curved, tortuous feature like the coronal suture, allows for both precision and replicability between studies. This methodology is time efficient and can be applied to other complex features of the skull where sampling site standardization may be difficult.

Introduction

Imaging technologies such as mCT scans have increased the ability of forensic investigators to analyze trauma nondestructively (1,7). While mCT images are created in 3D, any 2D slice of the scan can be extracted, viewed, and analyzed (1,3,4). Due to the tortuous nature of the sutures of the crania, this study presents a novel mCT comb-based approach to standardize sampling sites along the coronal suture to test for the presence of asymmetrical separation.

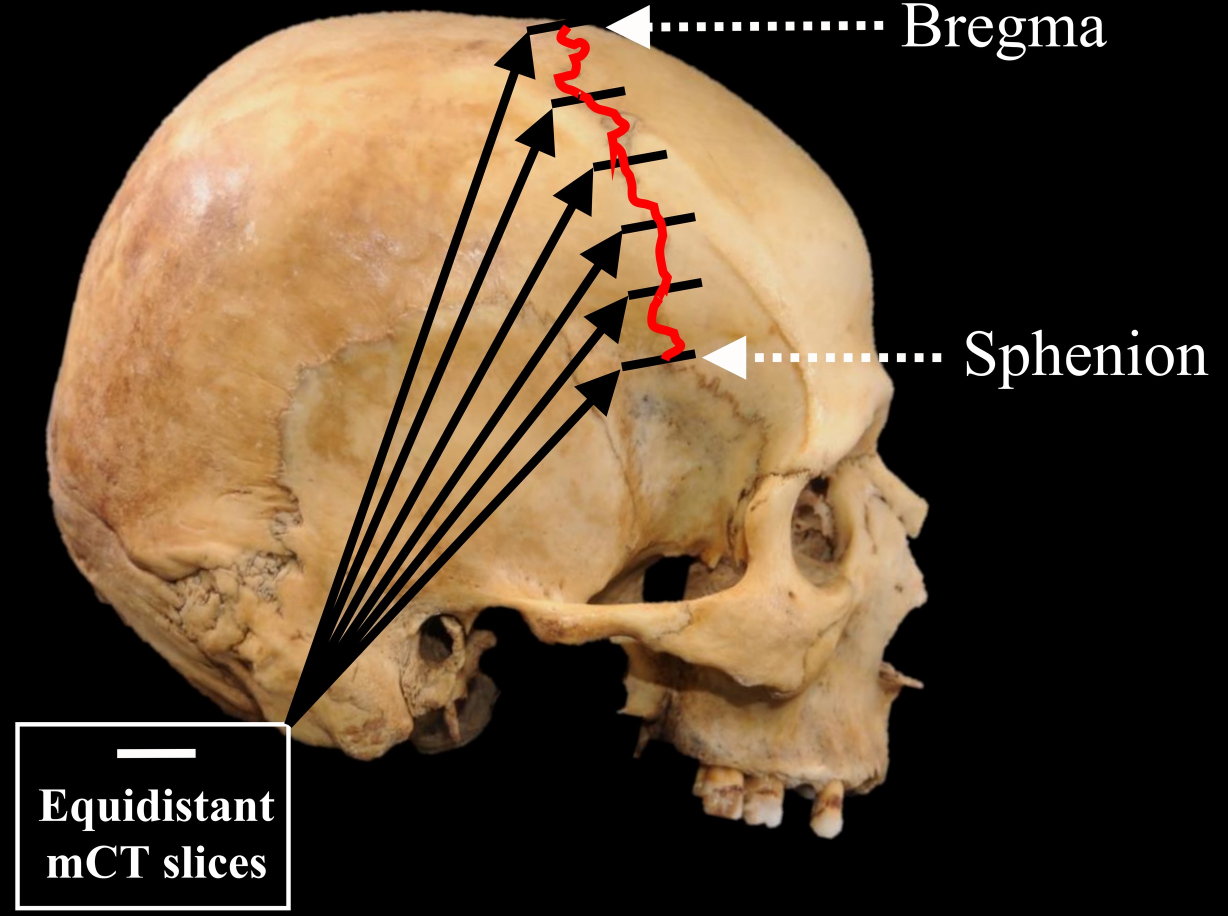

Figure 1: *Coronal suture with equidistant sampling sites.*

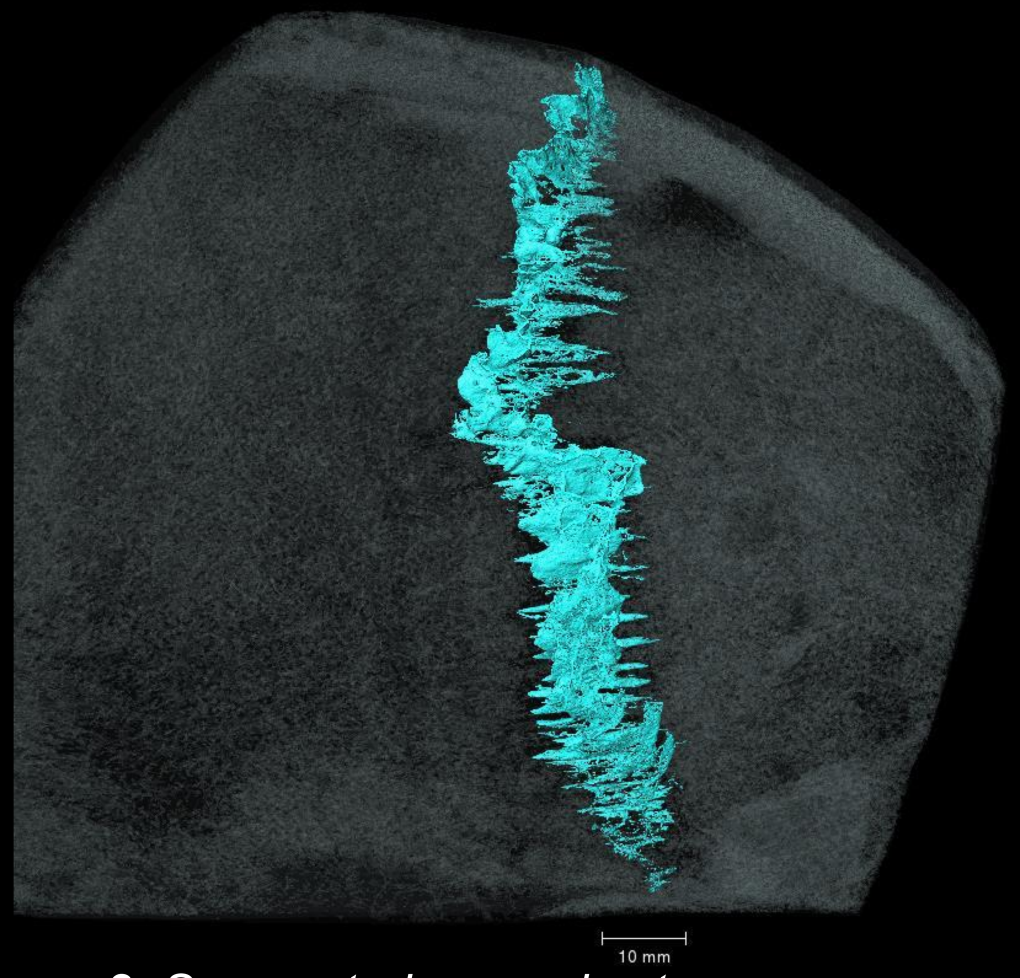

Figure 2: *Segmented coronal suture.*

Materials and Methods

Six human cranial trauma cases and three control specimens from the STAFS and FAC facilities were used in this study. Trauma cases included three intraoral gunshot wounds and three blunt force trauma specimens. All specimens are adult males >56 years of age. To standardize data collection, Type-1 landmarks were used with imaging of the coronal sutures beginning at their origin sphenion and terminating at bregma (Fig. 1-2). A comb-based approach was used to standardize sampling sites. Avizo imaging software was used to measure and define a chord length between bregma and sphenion, which allowed for the placement of twenty equidistant sampling sites at orthogonal angles from the chord line along the coronal suture (Fig. 3-5). An orthogonal CT slice plane was used to visualize and render the coronal suture and total open sutural area per slice was calculated (Fig. 6).

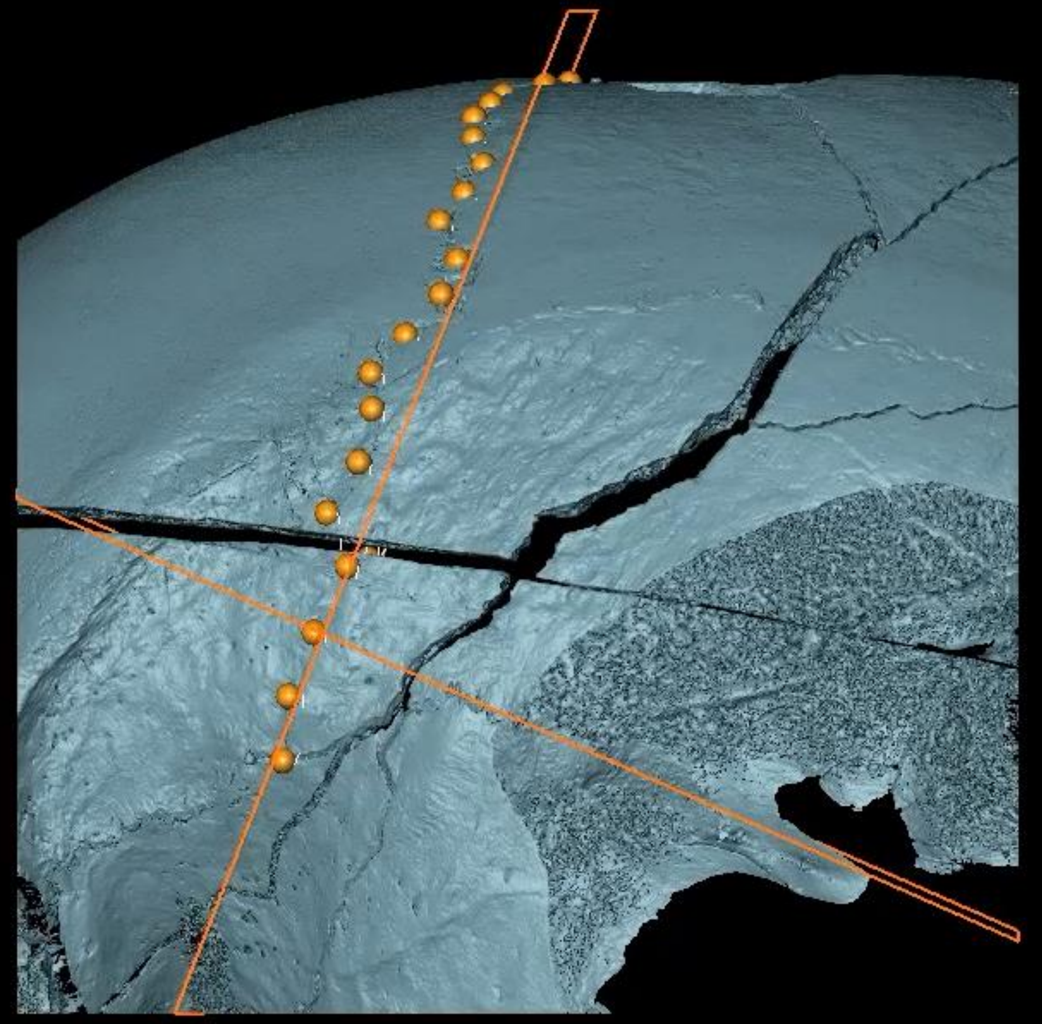

Figure 3: ***C****hord and orthogonal CT slice planes.*

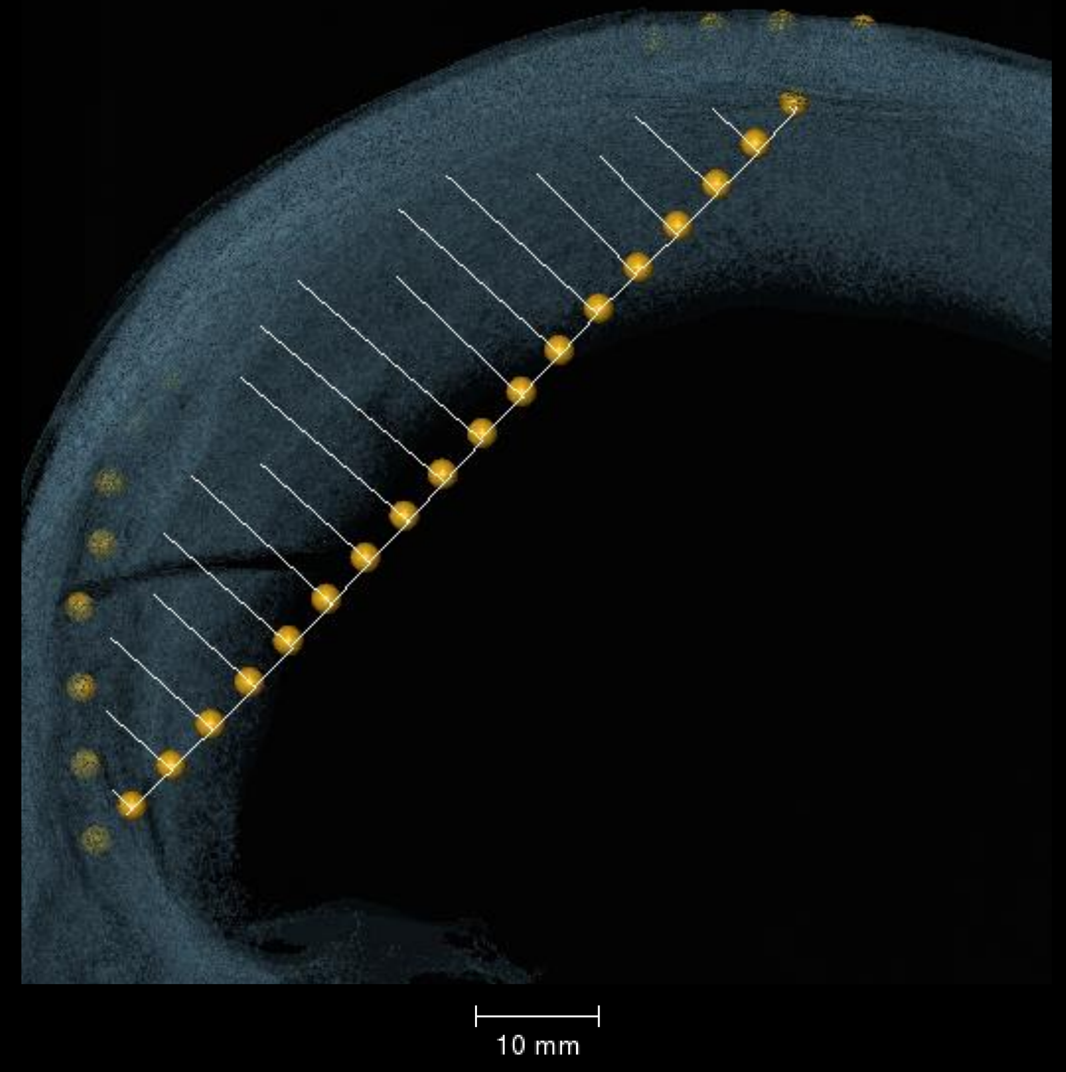

Figure 4: *Comb-based sampling approach.*

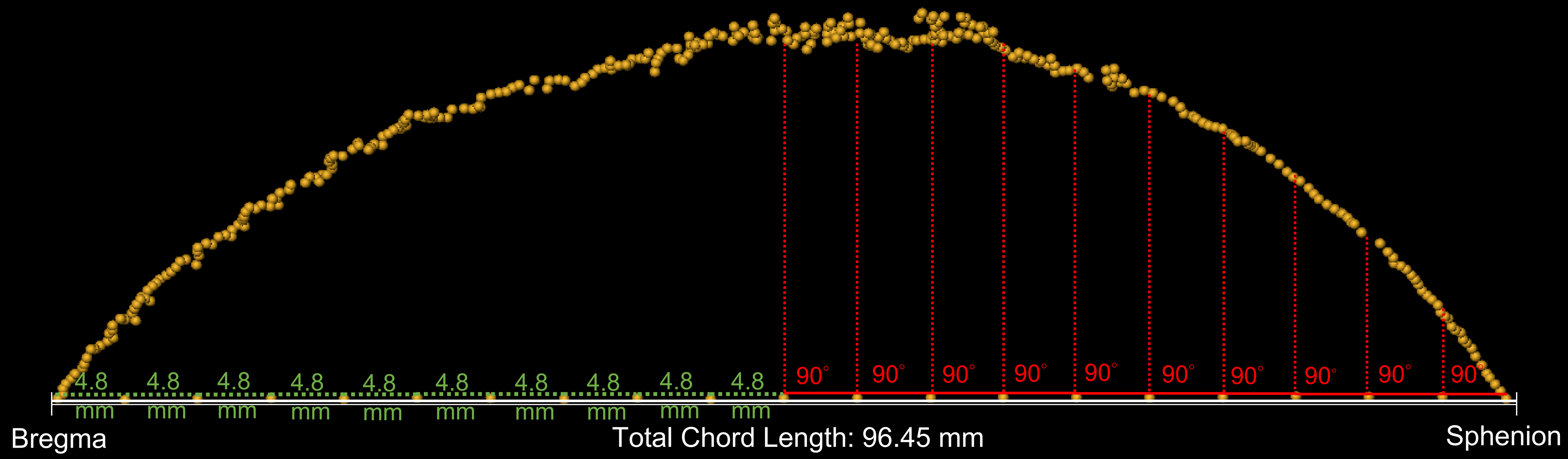

Figure 5: *Total chord length and orthogonal equidistant sampling sites along coronal suture.*

Results

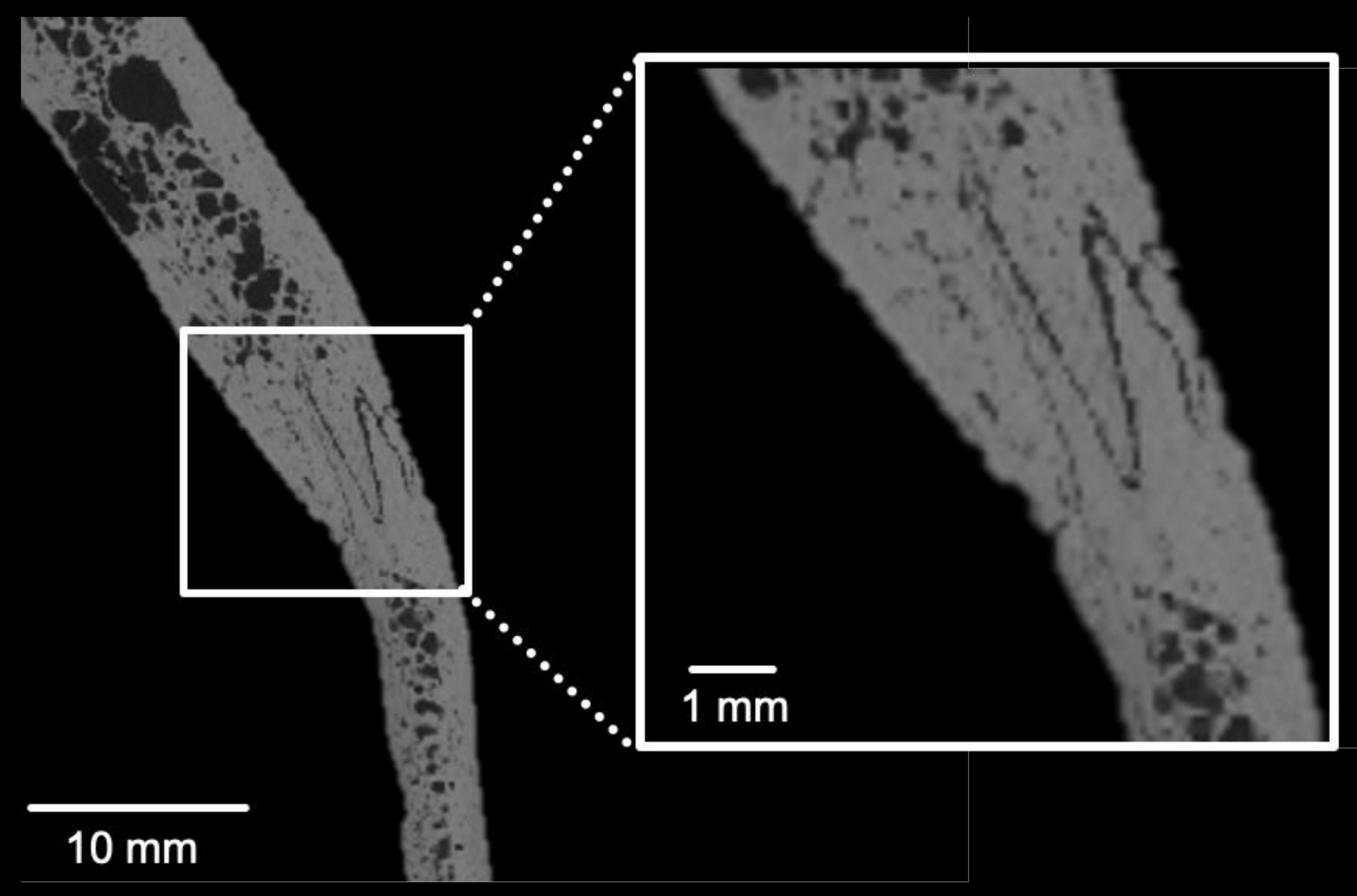

Figure 6: *CT orthogonal slice of suture.*

Discussion

Our results indicate that the methodology used is reliable enough to expand the scope of our project. This methodology may be applicable to other complex sutures of the skull where sampling site standardization may be difficult. Further studies will include additional trauma specimens and other sutures of the cranium.

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For any questions or comments, please contact sab030@shsu.edu

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