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CASE REPORT

Three-dimensional reconstruction of the spinal cord of thoroughbred

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Öz

Bolat D. İngiliz atı omuriliğinin üç boyutlu modellenmesi.

Bu çalışmanın amacı safkan bir İngiliz atının omuriliğinin servikal kısmının histolojik kesitleri üzerinden stereo investigator yazılımının 3d yapılandırma modülü ile üç boyutlu olarak modellenmesidir. Office masaüstü tarayıcı kullanılarak taranan görüntüler, stereo investigator'da görüntü yığınları olarak açıldı. Kesitlerin gerçek ölçümleri göz önüne alınarak, substantia grisea, alba ve canalis centralis sınırları planimetrik yöntemlerle çizildi. Bu prosedür, ardışık kesitler üzerinde gerçekleştirildi. Çizilen tüm çizgiler, bahsedilen yazılım kullanılarak birbirleriyle eşleştirildi. Son olarak, segmentlerin üç boyutlu rekonstrüksiyonu 3D yeniden yapılandırma modülü kullanılarak elde edildi. Yüzey alanı, kesit alanı ve segmentlerin hacmi Neurolucida explorer yazılımı ile hesaplandı. Üç boyutlu modellerden elde edilen sonuçlar tablo biçiminde verildi. Gerçek ölçülere sahip elde edilen üç boyutlu modellerin, ilgili alanların anatomisine katkıda bulunacağı, dijital eğitim materyali olarak kullanılabileceği ve üç boyutlu modellerin 3D yazıcılara aktarılması ile elde edilecek katı materyallerin anatomi eğitim ve öğretiminin kalitesini arttıracağı düşünülmektedir.

Anahtar kelimeler: 3 boyutlu modelleme, servikal segment, at.

Abstract

Bolat D. Three-dimensional reconstruction of the spinal cord of thoroughbred.

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The aim of this study was to three-dimensional reconstruction of cervical part of the spinal cord of a thoroughbred horse using its histological sections with the help of 3d reconstruction module of stereo investigator. Scanned images using Office flatbed scanner were opened as image stacks in stereo investigator. Considering real measurements of the segments, borders of the gray and white matter and central canal were drawn by planimetric methods. This procedure was performed on all consecutive sections. All drawn lines of segments were matched to each other using mentioned software. Finally, three-dimensional reconstruction of segments was obtained using 3D reconstruction module. Surface area, cross-sectional area and volume of the segments were calculated by Neurolucida explorer software. Obtained results from 3D models were given in tabular form. It is thought that obtained three-dimensional models possessed real measurements of the segments contribute to anatomy of region of interest, can be used as digital education materials and obtaining solid materials exporting three-dimensional models to 3D printers improve the quality of education and training in anatomy.

Keywords: 3D modeling, cervical segment, horse.

The anatomy, one of the oldest sciences, has evolved as much as the day-to-day evolution. The methods used in conjunction with anatomy, disintegration tools, dyeing methods, microscopes, photography and digital imaging systems have kept pace with this development. Anatomy knowledge has benefited from the revolutionary development of computers, automatic knowledge management and analysis capacity. A questionnaire study has shown the importance of applying computer science to anatomy science such as imaging, image processing, virtual reality, modeling and animation, artificial intelligence (Trelease 2002). Over the past two decades, 3D imaging techniques have made significant progress thanks to imaging, computer technologies, computer graphics and other related technological developments (Yamada 2006). Three-dimensional modeling of anatomical structures is indispensable for medical diagnosis, visualization and model-based treatment planning (Cebral and Löhner 2001). Although morphometric measurements of anatomical structures cannot be mechanically or optically in vivo, three-dimensional modeling of tomographic images is a preferred method, but requires verification of ex vivo tissue studies as the gold standard of in vivo imaging methods (Cebral and Löhner 2001, Chakravarty 2008). In order to confirm the data obtained by using in vivo imaging techniques, three-dimensional modeling of the structure of interest from serial histological sections is required (Chakravarty 2008). Imaging methods such as tomography and MRI with modern technology may be insufficient in the studies on morphometry of spinal cord belonging to domestic mammals, especially those other than laboratory animals.

The aim of this study is to model the relevant part of the histological sections obtained serially from the cervical part of the horse's spinal cord, which has an important place in the education and teaching of anatomy, and to analyze the morphometric data of the cervical division through the obtained models.

The study was carried out on histological sections obtained from cervical segments of a Thoroughbred horse from animals used in the research named "The Segmental Morphometric Properties of the Horse Cervical Spinal Cord: A Study of Cadaver" made at Selcuk University, Veterinary Faculty, Anatomy Department. The research was approved by the ethical committee of Faculty of Veterinary Medicine, Selcuk University (2011/16). Histologic section images scanned at 300 dpi using an office flatbed scanner were opened as an image stack in the stereo investigator (MBF Bioscience). First, the boundaries of the segmental white matter, gray matter, and central canal were marked using the planimetry method (Figure 1), keeping true to the actual measurements obtained from the measurement bar on the scanned images. This process was repeated in all successive sections. Drawings of the obtained segments were matched with the help of the program used (Figure 2). A grid image of the images of

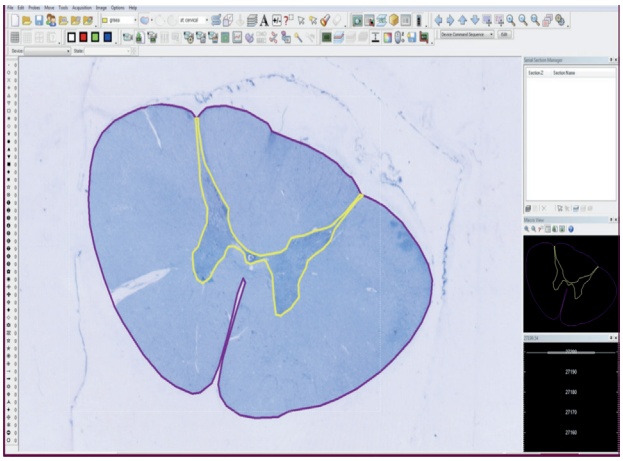

Figure 1. The boundaries of spinal cord, white matter, gray matter and central canal were determined by planimetry

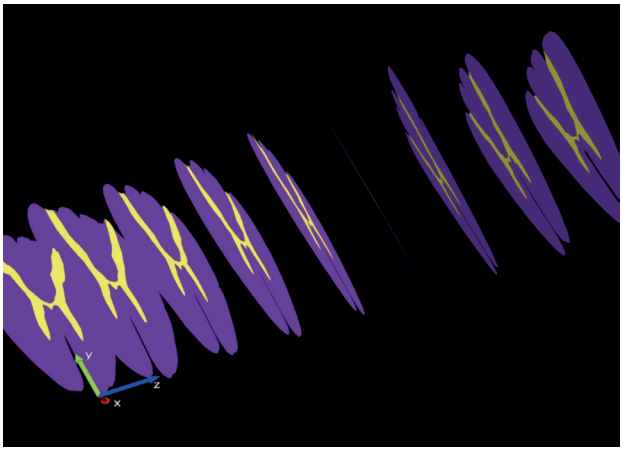

Figure 2. Segment sections made of solid coating.

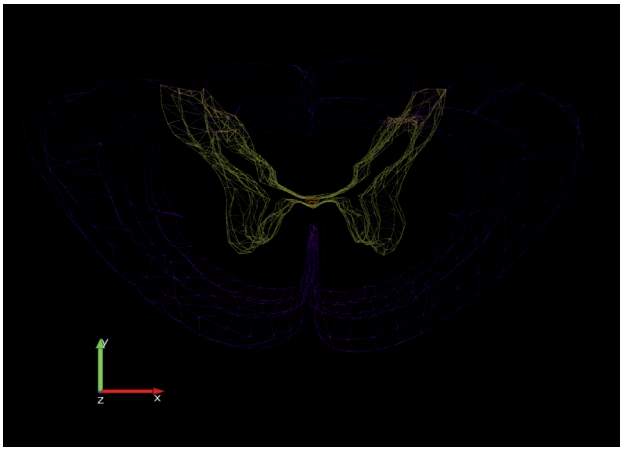

Figure 3. Grid view of gray matter.

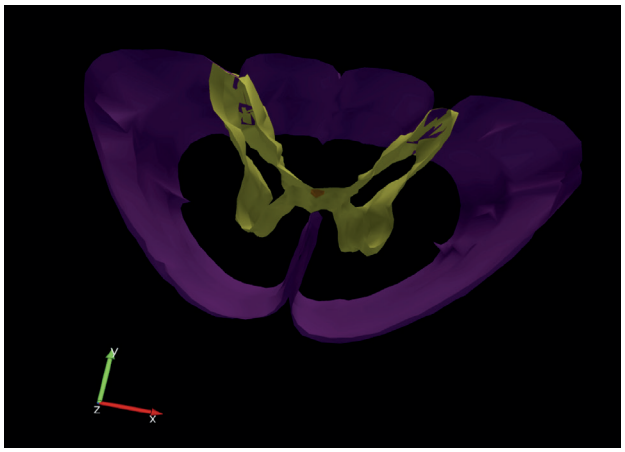

Figure 4. Surface coating of the spinal cord, white matter, gray matter and central canal.

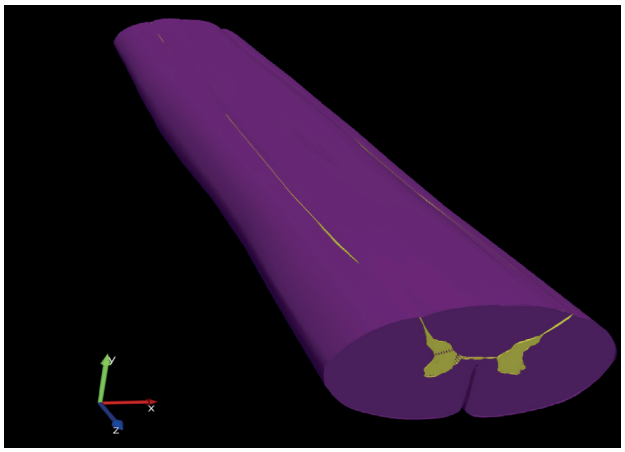

Figure 5. Three-dimensional segment view.

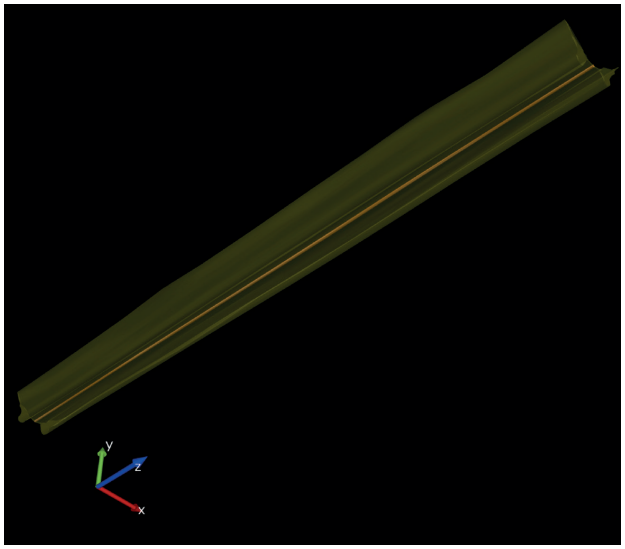

Figure 6. Semi-transparent view of gray matter and central canal, white matter was excluded.

each segment was obtained (Figure 3). Then the surface of the segment was covered with solid material (Figure 4). Following this operation, three-dimensional images of the segments and central canal were obtained via the 3d reconstruction module (Figures 5, 6, 7). Surface area, cross-sectional surface area and volume calculations of the drawings were done with the help of Neurolucida explorer (MBF Bioscience).

It is thought that obtained three-dimensional models possessed real measurements of the segments contribute to anatomy of region of interest, can be used as digital education materials and obtaining solid materials exporting three-dimensional models to 3d printers to improve the quality of education and training in anatomy.

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