3D Vector Reconstruction of the Axis from the Anatomical Sections of Korean Visible Human at the Laboratory of Clinical and Digital Anatomy of Paris Descartes University.

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Summary

Aim: Carry out a 3D vector reconstruction of the axis from anatomical sections of the "Korean Visible Human" for educational purposes.

Material and methods: The anatomical subject was a 33-year-old Korean man who died of leukemia. He was 164 cm tall and weighed 55 kg. This man donated his body to science.

Her body was frozen and cut into several anatomical sections after an MRI and CT scan. These anatomical sections were made using a special saw called a 0.2 mm thick cryo macrotome. Thus 8,100 cuts were obtained.

Only the sections numbered 820 to 900 were used for our study. A segmentation by manual contouring of the different parts of the axis was done using the software Winsurf version 3.5 on a laptop PC running Windows 7 equipped with an Ram of 8 gi gas.

Results: Our 3D vector model of the axis is easy to manipulate using the Acrobat 3DPDF interface. Each part of the axis accessible in a menu can be displayed, hidden or made transparent, and 3D labels are available as well as educational menus for learning anatomy.

Conclusion: This original work constitutes a remarkable educational tool for the anatomical study of the axis and can also be used as a 3D atlas for simulation purposes for training in therapeutic gestures.

Keywords: 3D Vector Modeling - Axis- Digital Anatomy - Korean Visible Human

1-Introduction

Training in human anatomy is essential at all stages of medical practice: clinical examination, interpretation of medical images and surgery are based on knowledge of the anatomy of the human body. The acquisition of these skills is first theoretical then practical with dissection. Unfortunately, the provision of subjects for this stage of learning by dissection remains problematic, in general in the countries of the South and in particular in Mali, sometimes letting certain professionals start their careers with little experience in this field. Sectioned images of the human body are very useful because of their high resolutions and natural colors compared to CT scans and magnetic resonance imaging **[1].** The images available include those of the Visible Human Project (VHP, male and female) conducted in the United States [1]; the Chinese human "Visible" (CVH, man and woman) **[2];** the Chinese virtual human (VCH, man and woman) **[3];** and the Korean "Visible" woman (VK; whole male body, male head, and female pelvis) **[4].**

The sectioned images of the VHP, CVH and VK males were used in several ways: for the creation of atlases**[5],** navigation software **[6,7]** and the virtual dissection software [8] and allowed access free and free to three-dimensional models in PDF atlas files [7,9]. In addition, cross-sectional images of VK have been used so that the radiology dose conversion coefficients are calculatedvirtually**[10].** However, the use of prepared female sectioned images has been limited for the following reasons:

- In VHP images, degeneration of the uterus and ovaries was observed because the subject was post-menopausal (59 years), and the lateral edges of the two arms could not be used due to the subject's overweight.

- The image quality was not optimal due to the limited performance of the digital camera and the personal computer used**[11,12].**

- In addition to this, gaps in the images appeared in the digital atlases.

In CVH and VCH images, small pixel size images (> 0.1 mm) and 24 bits color were made, but the colors of the living body could not be represented because a fixative had been injected into the body and a red dye was infused into the arteries**[13].** If there were high-quality sectional images of a whole male body, they would be very useful, like images of female bodies.

In this context, that we initiated this work which constitutes a part of our thesis of science relating to the 3D vector reconstruction of the ventral region of the neck from the anatomical sections of Korean Visible Human. (KVH)

This article deals with 3D vector reconstruction of the axis.

2. Materials and methods:

Our study was carried out in the DevelopmentResearch, Imaging and Anatomy Unit (URDIA) EA 4465 at the Laboratory of Clinical and Digital Anatomy of the University of Paris Descartes.

The anatomical sections of a 33-year-old Korean man who died of leukemia who donated his body were made in 2010 after an MRI and a CT scan. A cryo macrotome made it possible to cut 0.2 mm thick sections of the frozen body, i.e. 8,100 sections. **(Figure 1)**

Only the sections numbered 820 to 900 were used for our study **(Figures 2 and 3).**

A segmentation by manual contouring of the different parts of the axis was done using the software Winsurf version 3.5 on a laptop PC running Windows 7 with a Ram of 8 gigas **(Figure 4)**

3. Result

Figure 5: 3D vector reconstruction of the axis with Winsurf software: ventral view.

Joint process; Transversal process; Vertebral body ;

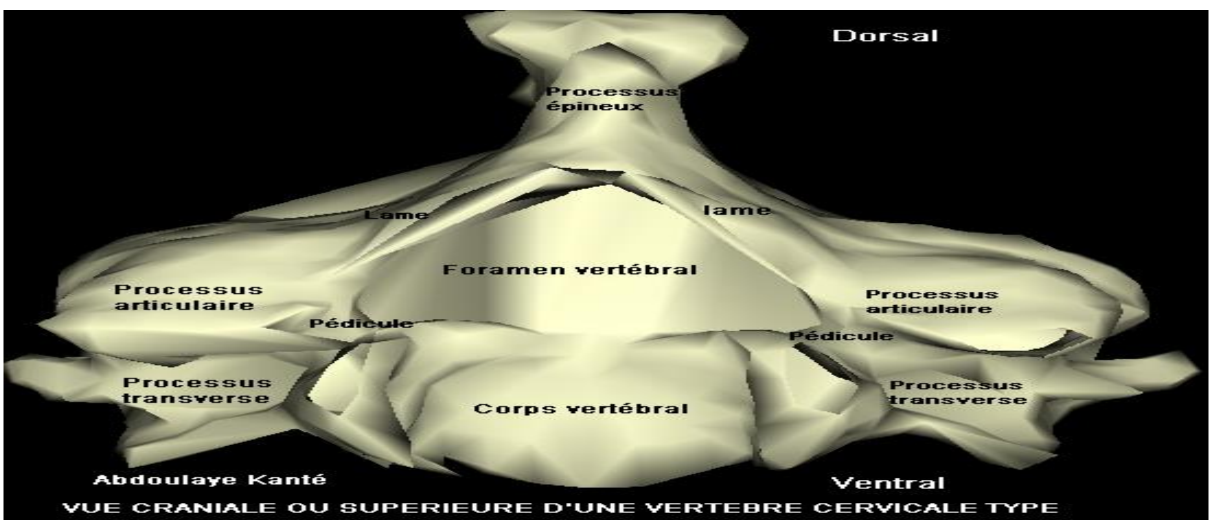

Figure 6: 3D vector reconstruction of the axis with Winsurf software: cranial or superior view

Joint process; Transversal process; Vertebral body; Thorny process; Pedicle; Blade; Vertebral foramen

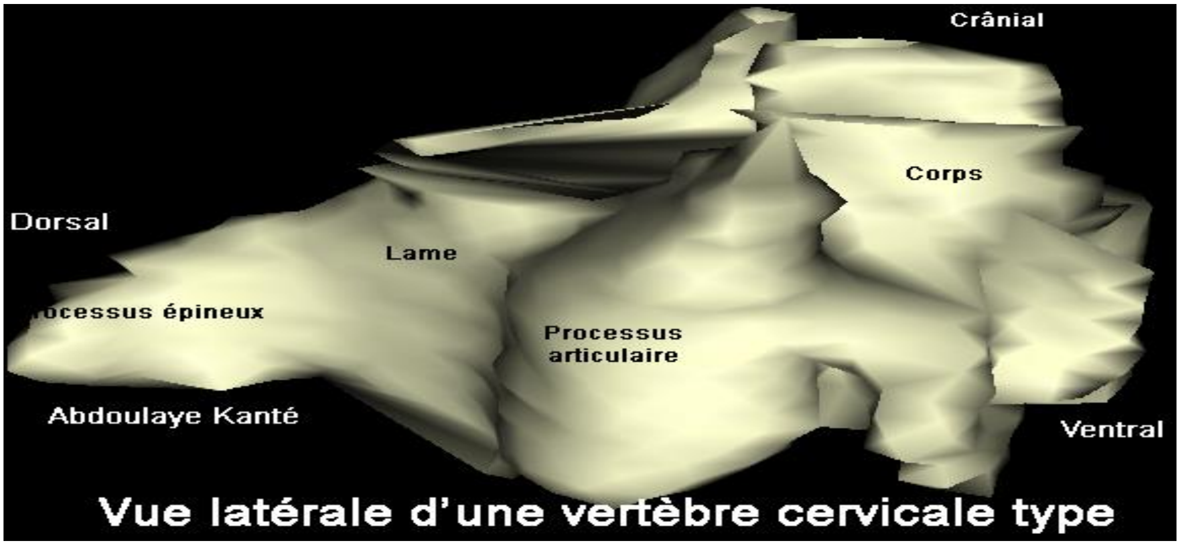

Figure 7: 3D vector reconstruction of the axis with Winsurf software: side view

Joint process; Transversal process; Vertebral body; Thorny process; Pedicle; Blade; Vertebral foramen

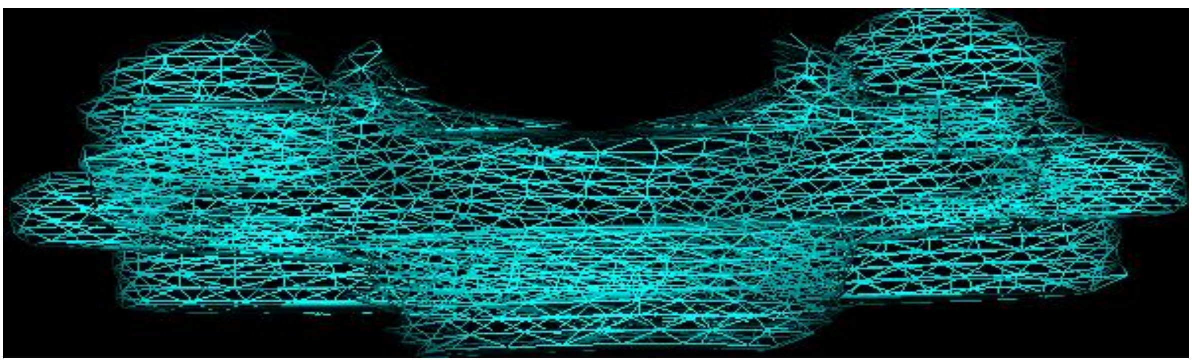

Figure 8: Wireframe representation of the axis with Winsurf software

4-Discussion

This article was made from the anatomical sections of Korean Visible Human in order to achieve in the best possible way, a dynamic and detailed 3D atlas of the axis.

Our work therefore consisted in recognizing the anatomical structures of the axis on these sections and in a more tedious work of contouring in order to obtain the most realistic models possible. Our methodology is quite similar to that of the Korean team, which used segmentation instead of manual contouring. **(Figures 9)**

The advantage of this work is mainly based on the fact that the entire contouring work and therefore the entire 3D vector reconstruction of the axis, was carried out from real sections of the human body. This results in a major increase in the precision and reliability inherent in the results presented above.

Indeed, reconstructions of the axis from digital processes such as CT scans can be somewhat disappointing in the sense that some structures are absent and others that are difficult to distinguish. In contrast to this process, this contouring work is based on a manual, analog segmentation process under our supervision and not that of an automaton, which reduces the risk of anatomical errors in reconstruction.

The second advantage is based on the fact that better precision as well as the possibility of individualization of the different parts of the axis favors a massive application in the university field thus participating in a better understanding by medical students and other fields. In addition, itis essential to underline that this application is not restricted to the university field but can also be the support of a "Surgical Training" thus allowing a continuous training of the surgeons and a fortiori an improvement of their aptitude in their practices daily.

Finally, itis clear that "Winsurf" and Acrobat 3D PDF are particularly easy to use software which is not the case with other 3D modeling and manual segmentation software. In addition, they offer fairly wide ranges of textures which further increase the realism that we can bring to our final work.

Although the "Winsurf" software made it possible to reproduce the typical cervical vertebra fairly faithfully, there are never the less some shortcomings.

The main disadvantage of this software is the time required to achieve the desired result. Indeed, this is a tedious contouring work of several months on several anatomical sections where sometimes only the section-by-section analysis was possible. To this are added the different objects that had to be created in order to be able to individualize the edges of the axis which increased the number of cuts to which it was necessary to return each time.

Unfortunately, there is no miracle cure allowing a reduction of this working time if itis not a great motivation and an unprecedented personal investment.

Conclusion: our 3D vector modeling of the axis is a remarkable educational tool for teaching the anatomy of the axis and can also be used as a 3D atlas for simulation purposes for training in therapeutic gestures.

Conflicts of interest:
The authors do not declare any conflict of interest concerning the publication.

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