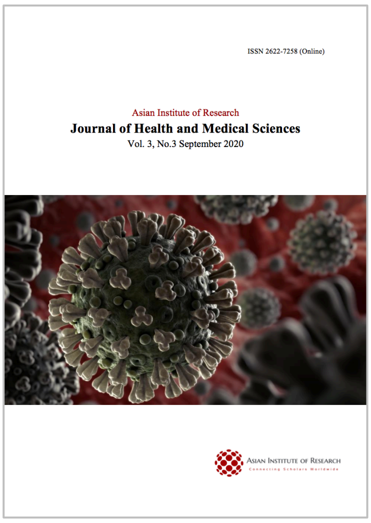

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3D Vector Reconstruction of the Brain from Anatomical Sections of Korean Visible Human at the Laboratory of Clinical and Digital Anatomy of Paris Descartes University

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Abstract
Aim: Carry out a 3D vector reconstruction of the brain 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. It measured 164 cm 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 0.2 mm thick cryomacrotome. Thus 8,100 cuts were obtained. Only the sections numbered 500 to 700 were used for our study. Manual contouring of the different parts of the brain was done using Winsurf version 3.5 software on a laptop PC running Windows 7 with an 8-gigabyte Ram. Results: Our 3D vector model of the brain is easily manipulated using the Acrobat 3DPDF interface. The different brain parts 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 brain reconstruction constitutes a remarkable educational tool for the anatomical study of the brain and can also be used as a 3D atlas for simulation purposes for training in therapeutic gestures.

Keywords: Three-Dimensional Anatomy, Korean Human Visible, Brain Modeling, Virtual Reality, 3D Reconstruction, Virtual Dissection, Surgical Simulation, Surgical Training

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 (Ackerman *1990)*. The images available include those from the Visible Human Project (VHP, male and female) conducted in the United States (Ackerman *1990)*; the Chinese human "Visible" (CVH, man and woman) (Cho Z. 2009); the Chinese virtual human (VCH, man and woman) (Cho, Calamate & al 2012.); and the Korean "Visible" woman (VK whole male body, male head, and female pelvis) (Chung, Shin, Brown P & al *2015*).

The sectioned images of the VHP, CVH and VK males were used in several ways: for the creation of atlases (Dai, Chung, Qu & al *2012*), navigation software (Kim, Choi, Jeong & al *2008*) ; (Park Chung, Shin & al *2013*) and the virtual dissection software (Park, Chung ,Hwang & al *2005*) and allowed access free and free to three-dimensional models in PDF atlas files (Park, Chung, Hwang & al *2005*). In addition, cross-sectional images of VK have been used so that the radiology dose conversion coefficients are calculated virtually (Park, Chung, Hwang & al *2006*). 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 (Park, Chung, Shin & al *2009*) ; (Quackenbush, Ratiu, Kerr & al 1996)
- 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 (Schiemann, Freudenberg, Pflesser & al *2000*). If there were high-quality sectional images of a whole male body, they would be very useful, like images of female bodies.
It is in this context that we initiated this work in order to reconstruct the brain from the anatomical sections of Korean Visible Human (KVH).

2. Materials and Methods

Our study was carried out in the Development Research, Imaging and Anatomy Unit (URDIA) EA 4465 in the Clinical and Digital Anatomy laboratory 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 CT scan. A cryomacrotome made it possible to make cuts of 0.2 mm thick on the frozen body, ie 8,100 cuts. (Figures 1)

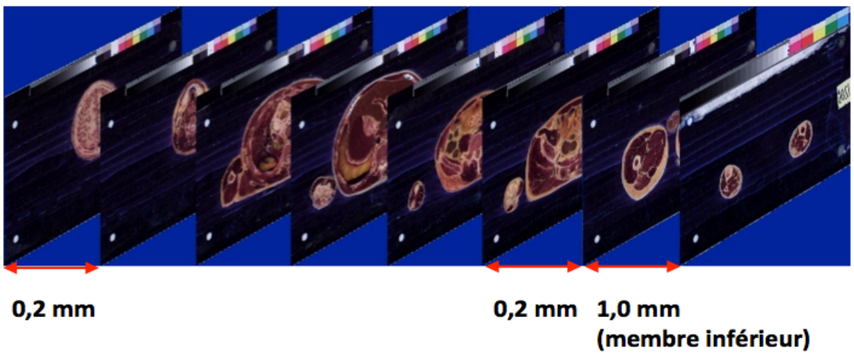

Figure 1: showing photographs of KVH anatomical sections

Only the sections numbered 500 to 700 were used for our study (Figure 2).

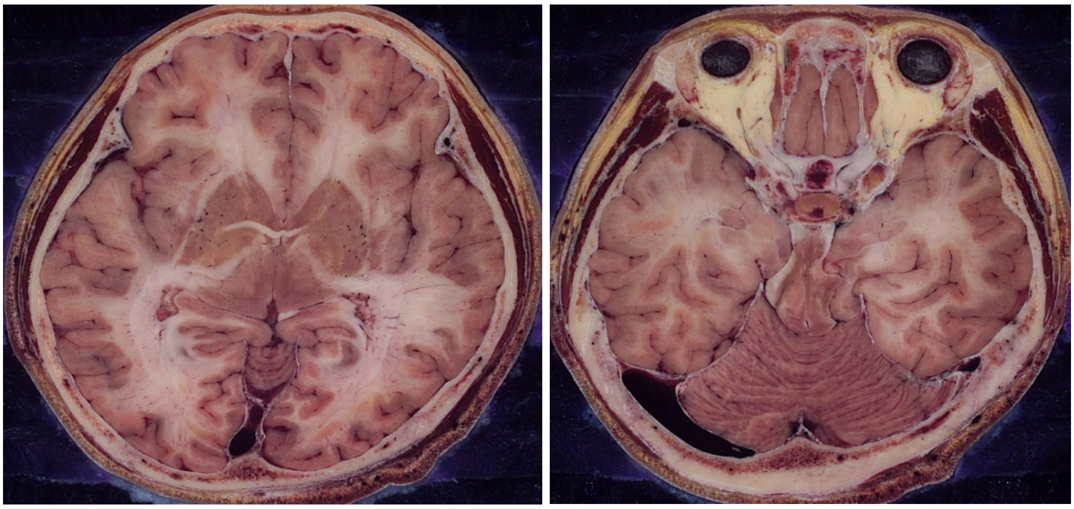

Figure 2 horizontal anatomical sections (2D) passing through the brain.

A segmentation by manual contouring of the different parts of the brain was done using the software Winsurf version 3.5 on a laptop PC running Windows 7 with an Ram of 8 gigas (Figure 3)

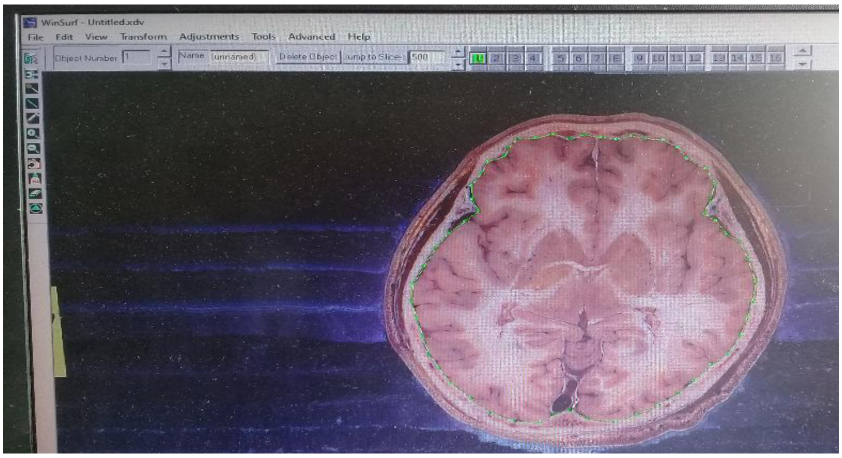

Figure 3: interface screen of the Winsurf® software (version 3.5) to draw the limits of the brain (green line and dots) on anatomical section number 500. This is done with the pen tool using the green channel.

3. Result

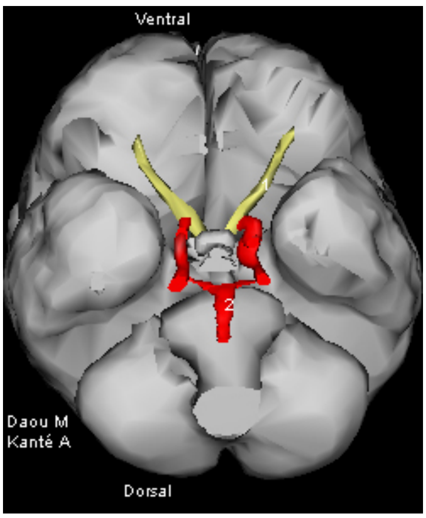

Figure 4 3D vector reconstruction of the brain showing the optic nerves (1) and the arterial circle of the brain (2) with Winsurf software caudal view

Figure 5 :3D vector reconstruction of the brain with Winsurf software : cranial view

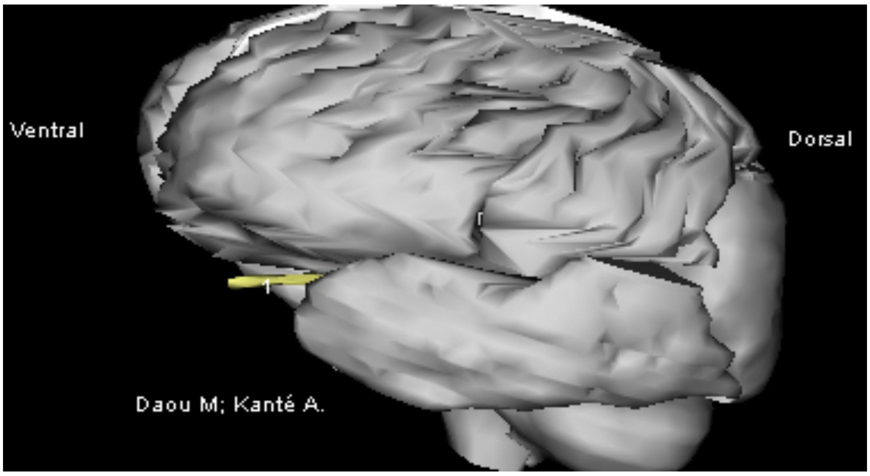

Figure 6 : D vector reconstruction of the brain showing the optic nerve (1) with Winsurf software : eft side view

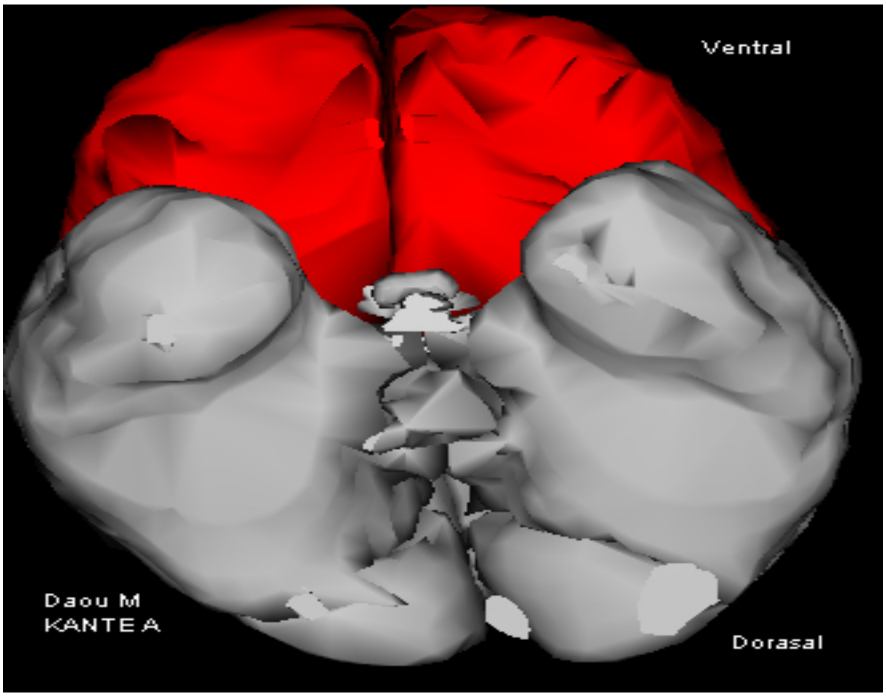

Figure 7 : D vector reconstruction of the brain showing the frontal lobes with Winsurf software : cudal view

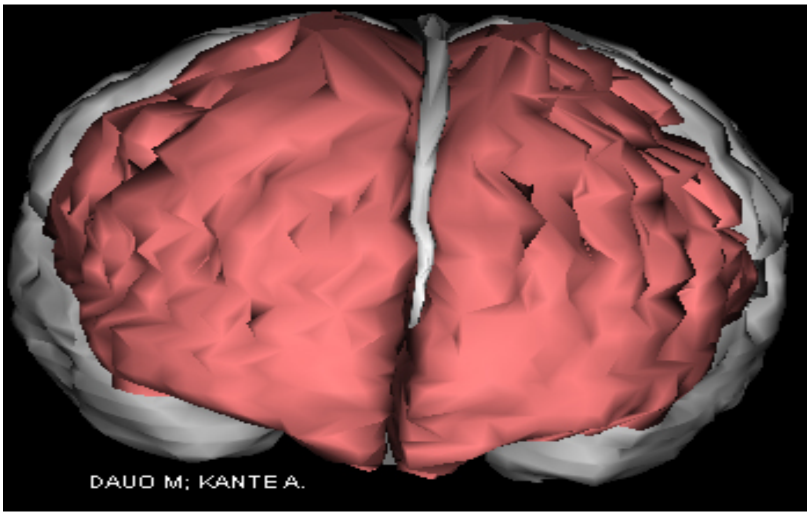

Figure 8 : 3 vector reconstruction of the brain showing the frontal lobes with Winsurf software : vntral view

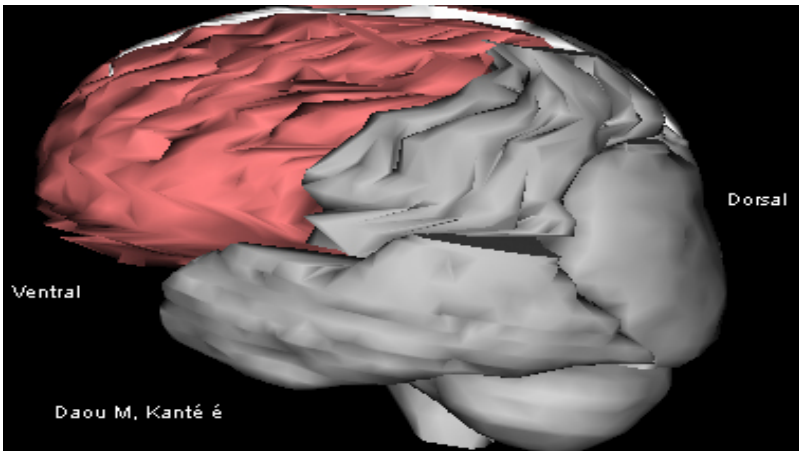

Figure 9 : D vector reconstruction of the brain showing the left frontal lobe with Winsurf software.

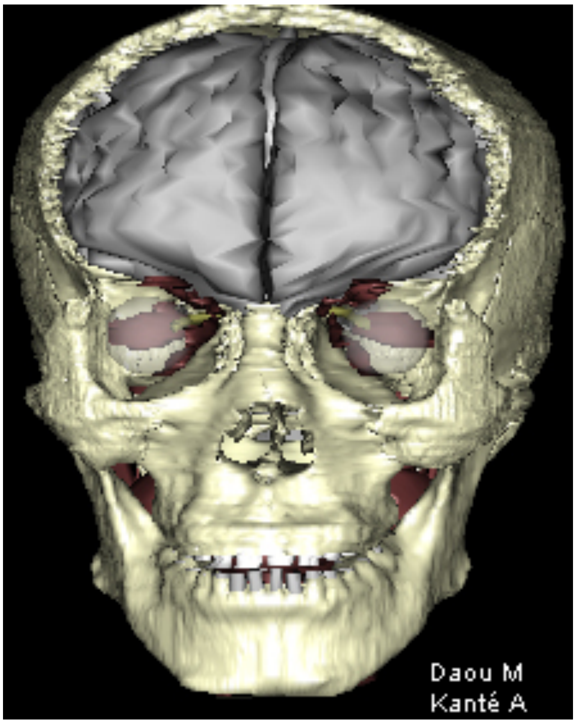

Figure 10 : D vector reconstruction of the brain showing the frontal lobes in the skull with Winsurf software.

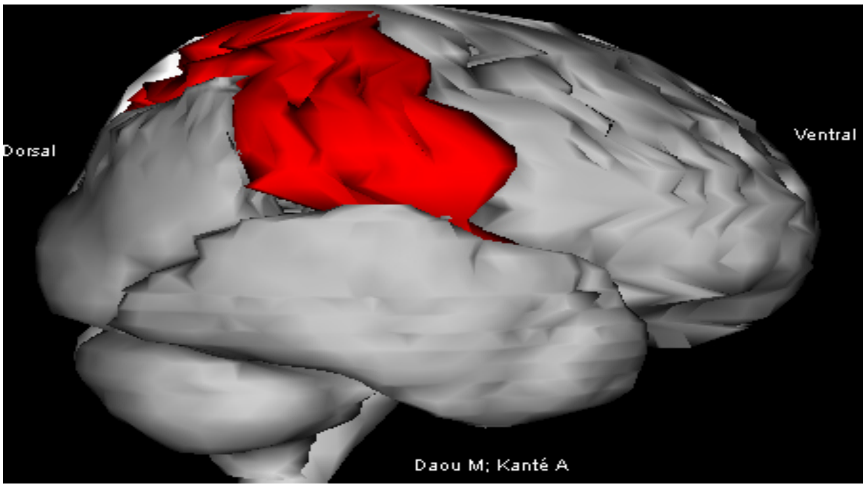

Figure 11 : 3 vector reconstruction of the brain showing the right parietal lobe with Winsurf software.

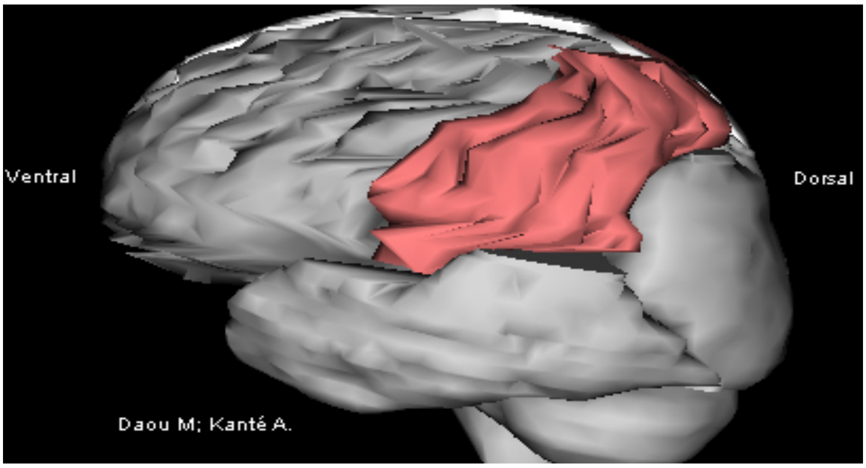

Figure 12 : 3Dvector reconstruction of the brain showing the left parietal lobe with Winsurf software.

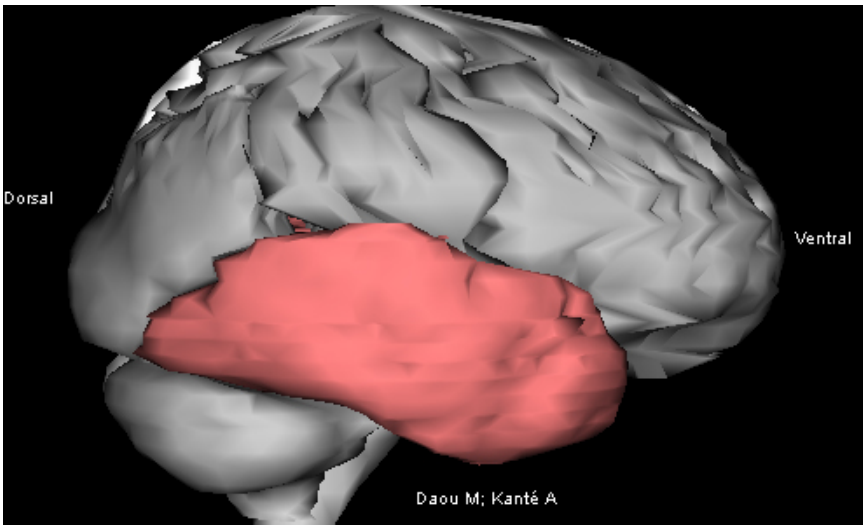

Figure 13 : 3Dvector reconstruction of the brain showing the right temporal lobe with Winsurf software.

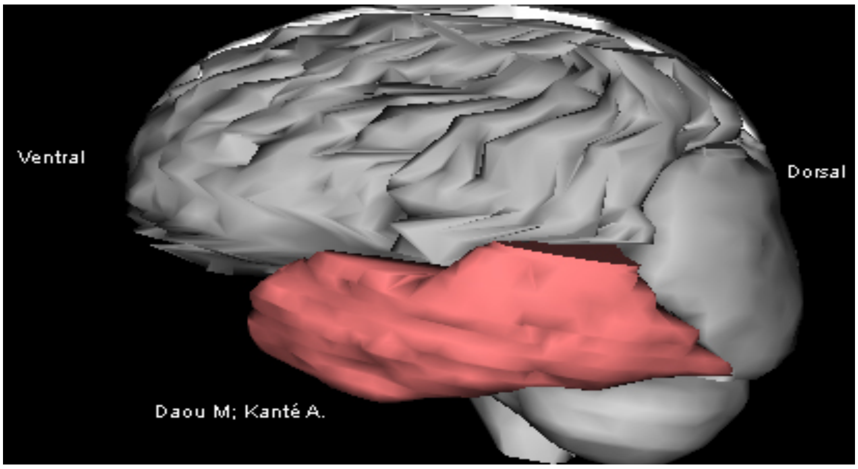

Figure 14 : 3Dvector reconstruction of the brain showing the left temporal lobe with Winsurf software.

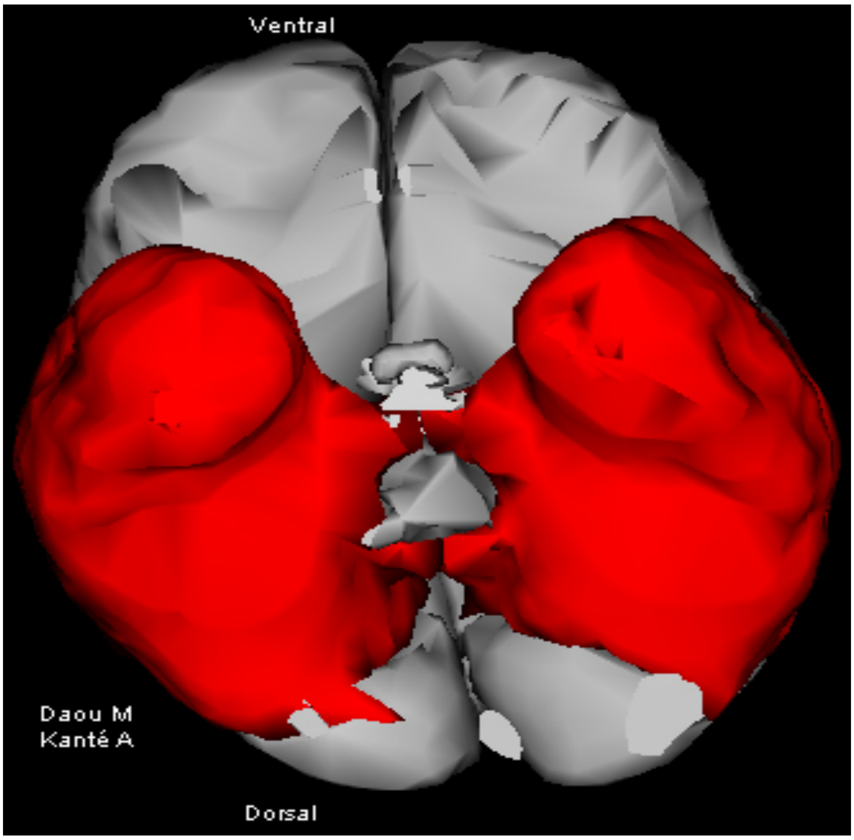

Figure 15 : 3Dvector reconstruction of the brain showing the temporal lobes with Winsurf software. Caudal view

Figure 16 : 3D vctor reconstruction of the brain showing the occipital lobes with Winsurf software.

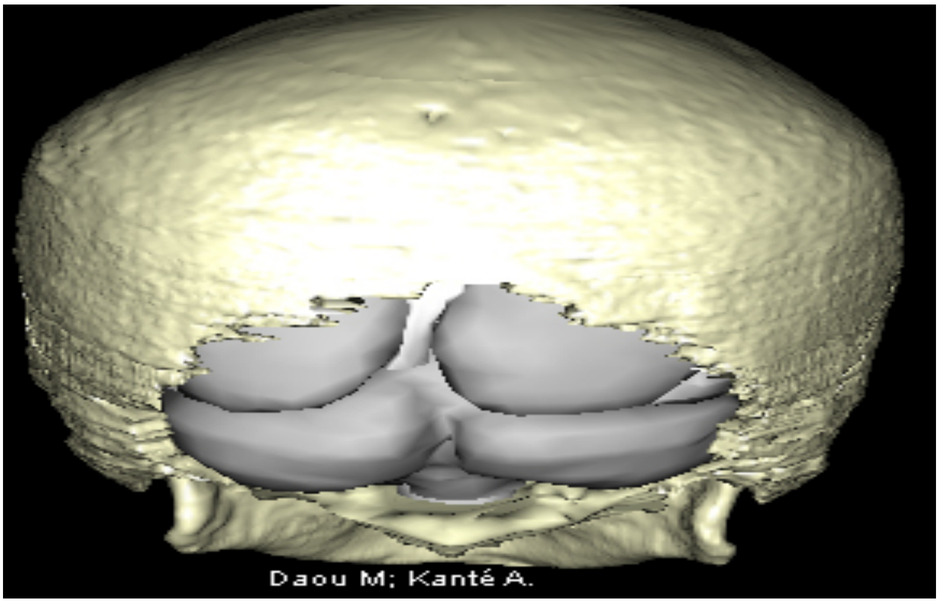

Figure 17 : 3D vctor reconstruction of the brain showing the occipital lobes in the skull with Winsurf software.

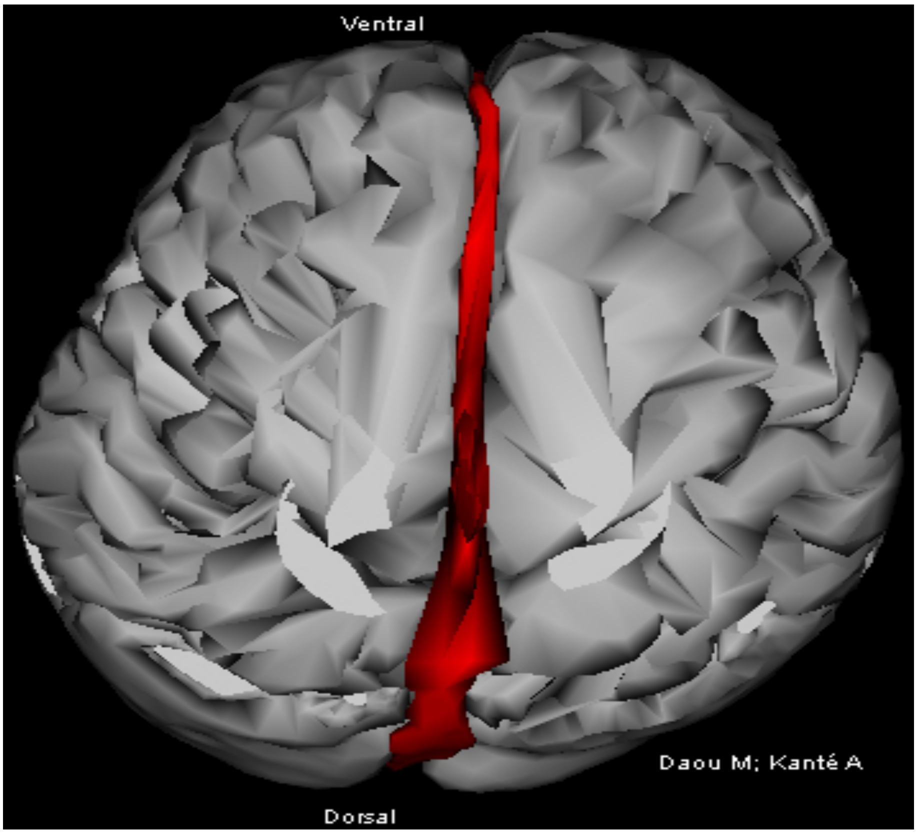

Figure 18 : 3D vetor reconstruction of the brain showing the brain scythe with Winsurf software.

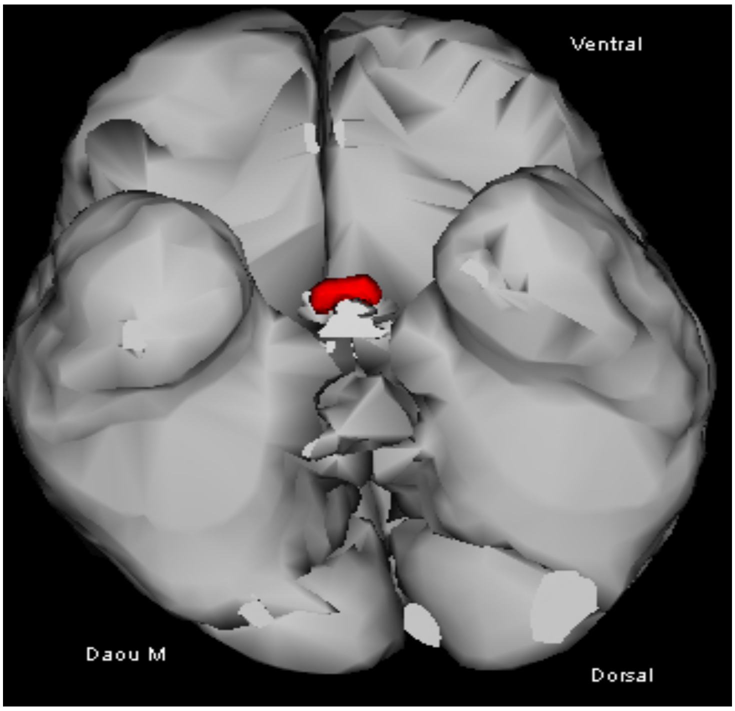

Figure 19 : 3D vetor reconstruction of the brain showing the pituitary gland with Winsurf software : cauda view

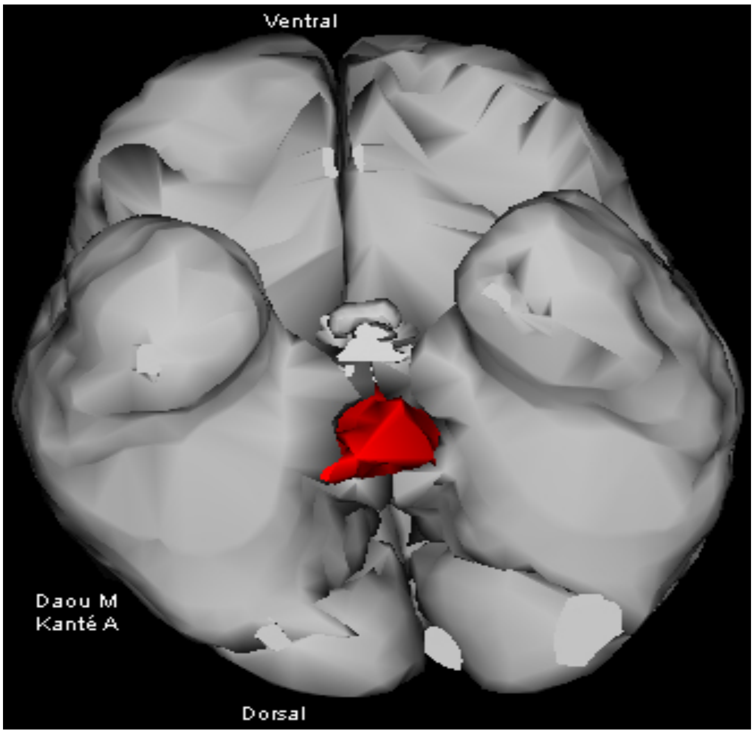

Figure 20 : 3D vecor reconstruction of the brain showing the thalamus e with Winsurf software : caudalview

4. Discussion

This article was made from anatomical sections of Korean Visible Human in order to achieve in the best possible way, a dynamic and detailed 3D atlas of the brain. Our work therefore, consisted, in recognizing the anatomical structures of the brain 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 21).

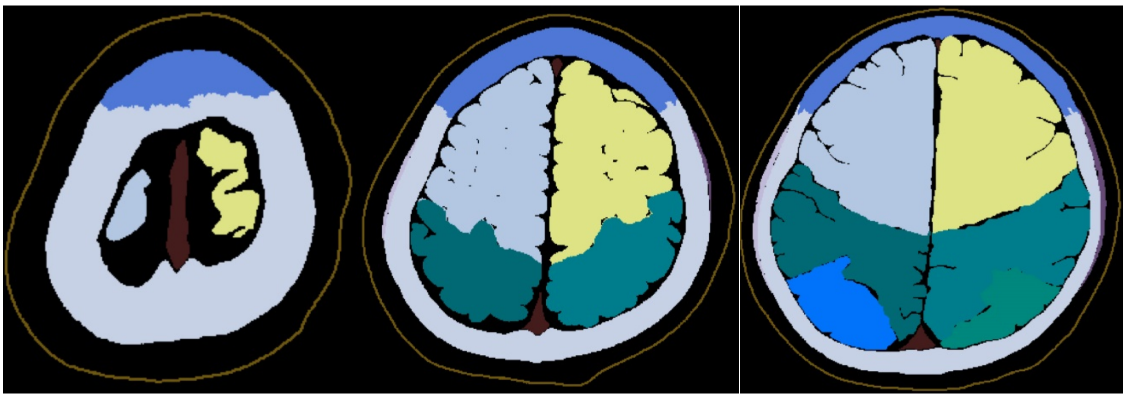
Figure 21 : segented sections used by the Korean team

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 brain, was carried out using 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 brain from digital procedures such as CT scans may prove to be somewhat disappointing in the sense that certain 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 brain promotes a massive application in the university field thus contributing to a better understanding by medical students and other fields. In addition, it is 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, it is 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 brain fairly faithfully, there are nevertheless 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 brain, 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 it is not a great motivation and an unprecedented personal investment.

Conclusion

Our 3D vector modeling of the brain is a remarkable educational tool for teaching the anatomy of the brain 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 of this document.

References

Ackerman M. J. The Visible Human project. A resource for education.*Acad Med.199 ;74()*:667-70.

Cho Z. H. 7.0 Tesla MRI Brain Atlas, In Vivo Atlas with Cryomacrotome Correlation. *Springer, New York.*2009.

Cho Z. H ; Caamate F ; ChiJG. 7.0 Tesla MRI brain white matter atlas.*Panmun, Seoul.*2012.

Chung BS ; Shn DS ; Brwn P ; Cho J ; Chng MS. Virtual dissection table including the Visible Korean images, complemented by free software of the same data. *Int J Morphol. 2015 ;33(2)*440-45.

Dai JX ; Chug MS ; Qu R;Yuan L; Liu SW ; Sin DS. The Visible Human Projects in Korea and China with improved images and diverses applications. *Surg.Radiol.Anat. 2012;34(6)*:527-34.

Kim CH ; Coi SH ; Jong JH ; Le C ; Chng MS ; HDR-Man. A whole-body voxel model based on high-resolution color slice images of a Korean adult male cadaver. *Phys Med Biol.2008;53(15)*:4093-106.

Park HS ; Chug MS ; ShinDS ; JungYW ; Park S. Accessible and informative sectioned images, color-coded images, and surface models of the ear. *Anat Rec.2013;296(8)*:1180-86.

Park JS ; Chung M ; Hwang SB; Lee YS ;Har DH ; ark HS. isible Korean Human:Improved serially sectioned images of the entire body. *IEEE Trans.Med.Imaging. 2005;24(3)*:352-60.

Park JS ; Chung MS ; Hwang SB ; Lee YS ; Har DH ; Park HS. Technical report on semiautomatic segmentation by using the Adobe Photoshop.*J Digit Imaging.2005;18(4)*:333 -43.

Park JS ; Chung MS ; Hwang SB ; Shin BS ; Park HS. Visible Korean Human : Its techniques and applications.*Clin Anat. 2006;19(3)*:216-24.

Park JS ; Chung MS ; Shin DS ; Har DH ; Cho Z.H ; Kim YB ; Han JY ; Chi J.G. Sectioned images of the cadaver head including the brain and correspondences with ultrahigh field 7.0 T MRIs.*Proc IEEE.2009;97(12)*:1988-96.

Quackenbush D ; Ratiu P ; Kerr,J. Segmentation of the Visible Human Data Sets.*The Visible Human Project Conference Proceedings.* October 1996:7-8.

SchiemannT ; Freudenberg J; Pflesser B; Pommert A; Priesmeyer K; Riemer M; Schubert R; Tiede U ; Höhne KH. Exploring the Visible Human using the VOXEL-MAN framework. *Comput Med Imaging Graph.2000;24(3)*:127-32.