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论著

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首例中国女性数字化可视人体数据集采集与可视化研究

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提 要:目的 建立中国女性数字化可视人体(Chinese digitized visible human female)。方法 选择经肉眼观察、CT和MRI检查无器质性病变的中等身材、青年女性人体标本1例,经外形测量、血管灌注后,用5%明胶包埋,置入-30 ℃冰库中冰冻1周,然后在-25 ℃低温实验室中用TK-6350型数控铣床(铣切精度为0.001 mm)从头至足逐层铣切。逐层用高清晰度数码相机摄影,完成人体模型数据获取,得到人体结构数据集。利用连续断层图像数据,在SGI图像工作站上,利用本课题组自主开发的三维重建软件包进行人体结构的三维重建和立体显示。结果 所选用标本为女性,22岁,身高1 620 mm,体质量54 kg,非器质性疾病死亡。CT扫描层厚:头颈部为1.0 mm,其他部位为2.0 mm。MRI扫描层厚头部为1.5 mm,其余部位为3.0 mm。连续横断面层厚:头部为0.25 mm,其他部位为0.5 mm,全身共计3 640个断面。数字化摄影分辨率为6 291 456(3 072×2 048)像素,每个断面图像文件大小为36 MB,整个数据集数据量为131.04 GB。结论 ①经文献检索和查新,仅见美国Colorado大学于1995年12月完成了1例女性人体标本的数据采集。本研究结果增添了新的一例女性可视化人体的数据资料,其研究结果同时在国际互联网站发布,网址为:http://www.chinesevisiblehuman.com/。②美国已报道的女性数字化可视人体在断面标本制作前,将人体标本裁为了4截,造成了其中的3段数据缺损;选用的标本为59岁的老年标本;图像分辨率为249万(2 048×1 216)像素。本研究报道的首例中国女性数字化可视人体为无器质性病变和缺损的中等身材22岁青年女性,为整个标本的连续断面,无节段性数据缺损,断面图像分辨率达629万(3 072×2 048)像素。

关键词:可视化人体;断面解剖;计算机三维重建;数字化
中图法分类号:R319;R322 文献标识码:A

Dataset collection and visualization for first visible human female in China

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Abstract: **Objective** To build the dataset of Chinese visible human female. **Methods** After undergoing macroscopical, CT and MRI examinations to exclude organic lesions, a young female cadaver of medium height was selected as the subject. After morphological measurement and vascular perfusion, the cadaver was embedded with 5% gelatin and cryopreserved in a -30 ℃ icehouse for 1 week. A digital milling machine TK-6350 (milling accuracy of 0.001 mm) was used to shave off slices of the body layer by layer from head to foot in a laboratory at -25 ℃. The successive cross-sections were photographed with a high-definition digital camera, and the pictures were put into a computer to establish a dataset of human body. By utilizing the image dataset derived from the successive cross-sections, 3D reconstruction and stereodisplay of human structure were finished with a SGI Workstation which was equipped with an independently self-developed software package for 3D reconstruction. **Results** The selected specimen, a 22-year-old female native of Chongqing, was 1 620 mm in height, 54 kg in weight and died of non-organic disease. CT scans were made in every 1.0 mm for head and neck and every 2.0 mm for rest parts, and the thickness for MRI scans was 1.5 mm for head and 3.0 mm for rest parts. For serial cross-sections, the thickness was 0.25 mm

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for head and 0.5 mm for rest parts. Thus, a total of 3640 slices were obtained, and the photo for every slice was saved as a 36 MB file in a resolution of 6 291 456 pixels (3 072× 2 048). Finally, the complete data files reached to 131.04 GB. **Conclusion** ① This is the first formally reported case of Chinese visible human female, suggesting that China becomes the second country owning visible human female dataset of her population. We set up a website for the purpose of exchanging ideas and information on this subject. So, the results are issued simultaneously on the Internet (http://www.chinesevisiblehuman.com). ② According to US Visible Human Project(VHP), the data of the 3 junctional parts of their female cadaver were absent because the body was cut into 4 segments. Taking the age of 59-year-old into account, the visible human female's body was not exactly perfect. The sections of 0.33 mm in thickness were saved to pictures at a resolution of 2 490 368 pixels (2 048×1 216). While, the first Chinese visible human female reported here is a young female without organic disease or lesion. No sectional datum is lost for being acquired from successive sections of the whole body. The resolution of cross-sectional image reaches to 6 291 456 pixels (3 072 ×2 048).

Key words: visible human; sectional anatomy; computerized 3D reconstruction; digitalization

由于数字化可视人体研究在医学、体育、影视、航天、军事等多个领域具有广泛的应用前景和潜在的经济价值,所以该领域的研究越来越受到科学界的重视和大众的关心[1]。首届数字化可视人体国际学术研讨会于2003年1月19~22日在重庆召开,中、美、韩三国进行数字化可视人体研究的学者报告了最新的研究进展、研讨了未来研究的发展方向和开发应用的重点领域等,对于该领域的研究起到了积极的推动作用[2]。本课题组继2002年8月完成了首例数字化可视人体之后[3],于2003年2月完成了1例女性数字化可视人体(Chinese visible human female)数据集的采集和可视化研究[4],现进一步报道如下。

1　材料和方法

选择经肉眼观察、CT和MRI检查无器质性病变的中等身材、青年女性人体标本1例,经外形测量、20%红色明胶动脉灌注后,用5%蓝色明胶包埋,置入-30 ℃冰库中冰冻1周,然后在-25 ℃低温实验室中用TK-6350型数控铣床(铣切精度为0.001 mm,数控系统为日本生产,铣刀为法国生产)从头至足逐层铣切。逐层用Canon高清晰度数码相机摄影,完成人体模型数据获取,得到人体结构数据集。利用连续断层图像数据,在SGI图像工作站上,利用本课题组自主开发的三维重建软件包进行人体结构的三维重建和立体显示。

2　结果

所选用标本为女性,22岁,身高1 620 mm,体质量54 kg,非器质性疾病死亡。CT扫描层厚:头颈部为1.0 mm,其他部位为2.0 mm,MRI扫描层厚头部为1.5 mm,其他部位为3.0 mm,连续横断面层厚:头部为0.25 mm,其他部位为0.5 mm,全身共计3 640个横断面,见图1~6。数字化摄影分辨率为6 291 456(3 072×2 048)像素,每个断面图像文件大小为36 MB,整个数据集数据量为131.04 GB。



图1　头部CT扫描图像(层厚1.0 mm)

Fig 1　CT image of the head (The thickness of the layer is 1.0 mm)

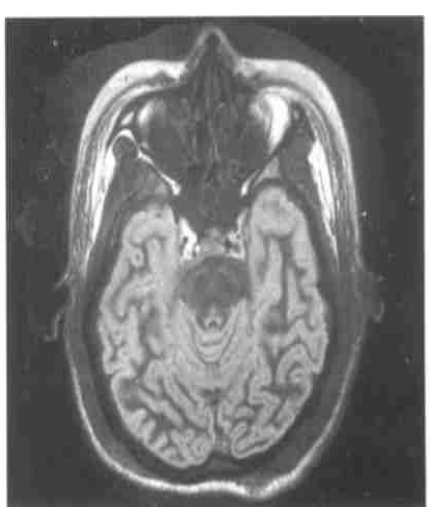


图2　头部MR扫描图像(层厚1.5 mm)

Fig 2　MRI of the head (The thickness of the layer is 1.5 mm)

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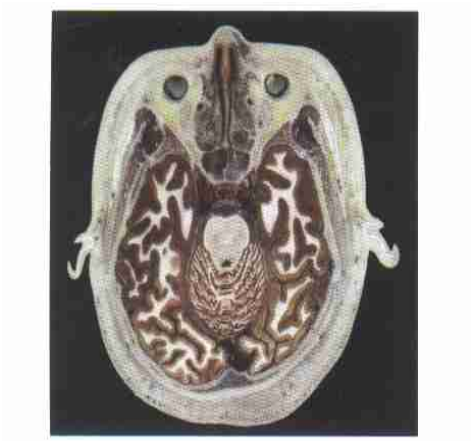


图3 头部断面图像(层厚0.25 mm)

Fig 3 Section image of the head (The thickness of the layer is 0.25 mm)

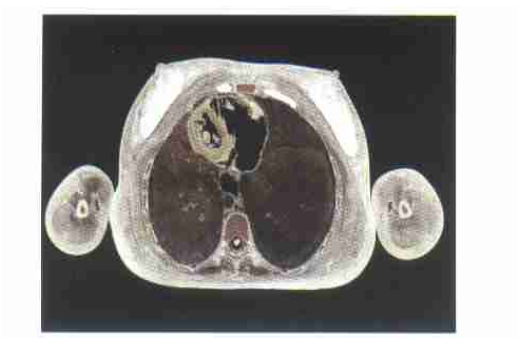


图4 胸部断面图像(层厚0.5 mm)

Fig 4 Section image of the thorax (The thickness of the layer is 0.5 mm)

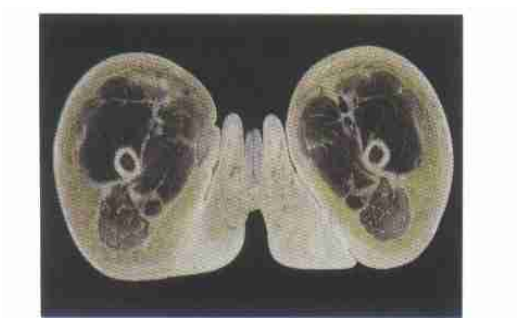


图5 会阴部断面图像(层厚0.5 mm)

Fig 5 Section image of the perineum (The thickness of the layer is 0.5 mm)



图6 足底断面图像(层厚0.5 mm)

Fig 6 Section image of the foot (The thickness of the layer is 0.5 mm)

3 讨论

1995年12月,美国Colorado大学医学院人体可视化仿真中心(The center for human simulation)在美国国立医学图书馆(NLM)的资助下,完成了世界第一例女性可视化人体数据集(Visible human female dataset),并向世界作了公布[5]。韩国的女性可视人体("Visible korean human female")计划2005年完成[6]。通过文献检索和成果查新,本研究报道的中国女性数字化可视人体(Chinese visible human female)数据集,为继美国之后的第二例女性数字化可视人体数据集完成的正式报道。其研究结果同时在国际互联网站发布,网址为:http://www.chinesevisiblehuman.com/。

美国已报道的女性可视化人体,同男性可视化人体一样,在断面标本制作前,将人体标本裁为了4截,造成了胸部、股部和小腿部共有3段数据缺损,因而标本不完整;断面摄影分辨率为249万(2 048×1 216)像素,每个断面未压缩数据为7.5 MB,整个数据集为39 GB;所用标本为59岁妇女,体形肥胖。本研究报道的数据集与VHP数据集相比较,有以下特点:①本数据集为整个人体标本的连续切片,无节段性数据缺损,而VHP则有3段数据缺损;②断面图像数字化摄影分辨率为6 291 456(3 072×2 048)像素,每个断面图像文件大小为36 MB,整个数据集数据量为131.04 GB,数码图像的分辨率(清晰度)比VHP高;③本研究进行了动脉灌注,使血管更加容易分辨;④由于在低温实验室中进行铣切,避免了牙齿、鼻甲、关节软骨等小结构从铣切表面脱落,使图像数据保持了更好的完整性;⑤所选用标本在年龄、身材和体形上都比较适中,具有更好的代表性。

参考文献:

[1] 张绍祥. 中国数字化可视人体研究进展[J]. 中国科学基金,2003,17(1):4-7.

[2] Zhang S X. Chinese visible human project. International workshop on visible human[J]. Jan. 19-22, 2003 Chongqing, China 10-13.

[3] 张绍祥,刘正津,谭立文,等. 首例中国数字化可视人体完成[J]. 第三军医大学学报,2002,24(10):1231-1232.

[4] 张绍祥,刘正津,谭立文,等. 首例中国女性数字化可视人体数据集完成[J]. 第三军医大学学报,2003,25(4):371.

[5] Spitzer V M, Whitlock D G. The visible human dataset: The anatomical platform for human simulation[J]. The Anatomical Record (New Anat), 1998, 253(2):49-57.

[6] Chung M S, Park H S. Another trial for making serially sectioned images (Visible Korean Human)[J]. International workshop on visible human, Jan 19-22, 2003 Chongqing, China 2-9.

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