Research on printing clinical teaching AIDS based on 3D printing technology

Yimao Fu,Yawen Ren,Yamin Zhang,Bo Wang
Gansu University of Chinese Medicine, Lanzhou 730000, China

Abstract: There are many problems in clinical teaching, such as limited vision, not careful observation, not intuitive learning and difficult to guarantee the effect. And 3D printing based on 3D digital image acquisition, 3D modeling can print realistic clinical teaching AIDS, and convenient customization, low cost, can effectively alleviate the contradiction of insufficient medical cadavers, assist clinical teaching.

Key words: 3D printing; 3D modeling; Clinical teaching AIDS

1 Introduction

In the current clinical teaching, due to the lack of medical cadavers, students can only watch the teacher's lecture, resulting in limited vision, careful observation, intuitive learning and other problems, teaching effect is difficult to be guaranteed. With the continuous development of science and technology, especially the progress of 3D printing technology, more choices are provided for clinical teaching. Teachers can use 3D printing technology to print teaching AIDS to alleviate the teaching difficulties caused by the shortage of medical corpse sources, so as to improve the quality of clinical teaching.

3D printing technology is a rapid prototyping technology, which is based on digital models, the use of powdery metal or plastic and other adhesive materials, through the way of layer by layer printing to construct objects. Many scholars are actively exploring and practicing the application of 3D technology in clinical teaching AIDS. The current research mainly focuses on exploring the characteristics of various organs of the human body, using 3D modeling technology to build anatomical models, making up for the deficiency of general standards and pathological standards, and assisting the theoretical and practical teaching of medical courses. However, due to the highly professional medical application field and high modeling requirements, the application range of 3D printing technology in clinical teaching is greatly limited, and further research and expansion are still needed.

2. Development and application of 3D printing technology

3D printing technology originated in the United States. In the 1980s began to study to meet the needs of scientific research and product design, since the 21st century, more and more researchers are committed to the research and promotion of 3D printing technology, so that its technology is constantly updated and iterated, and the application field is wide and mature industry.

The Chinese government attaches great importance to the development of 3D printing industry and takes it as one of the key projects of "Made in China 2025". The country is also making breakthroughs in 3D printing technology. 3D printing technology has brought great convenience to scientific research and people's lives. It can reduce the complexity of product manufacturing, improve the utilization rate and accuracy of raw materials, and realize the personalized needs of customers. It has been widely used in machinery manufacturing, cultural relic protection, product design, medical equipment, teaching demonstration and so on. In the field of education and teaching, 3D printing technology can simplify the processing process of teaching AIDS, and quickly realize the design, assembly, processing and other operations. Make intuitive teaching AIDS for teachers and students to facilitate the display of case organs, enrich the learning process, and mobilize the initiative and initiative of students to explore life. It can also allow learners to establish three-dimensional models to clarify pathological changes and anatomical parts, cultivate hands-on ability and enhance experience.

3. Ideas and technical routes of 3D printing clinical teaching AIDS

3.1 Design principles and objectives

The design principles should be oriented to restore integrity and authenticity, with accuracy and fidelity as the goal; Adhere to the convenience of researchers as the starting point, highlighting the sustainability and development of the design. Design principles and objectives run through the whole design process to ensure the correctness of the results.

3.2 Selection of medical organ model

Through the questionnaire analysis of medical students, it can be seen that the establishment of three-dimensional human anatomical entity models such as heart, liver, torso, skull and pelvis is of great help to their clinical learning and practice, and can more intuitively learn and understand the structure and characteristics of the human body.

3.3 Data Collection

3D digital image is the source of 3D printing information, and data acquisition is the basis of the establishment of 3D model, there are two commonly used data acquisition methods: indirect measurement and direct acquisition, indirect acquisition is through the 3D scanner to scan the acquisition object to extract data, high precision, fast efficiency, is the most commonly used data acquisition method. Direct acquisition is the data collector with the help of related medical instruments to directly extract some characteristic data of the acquisition object, the measurement method is direct but the accuracy is low, and the data collection is slow. The main technologies and equipment

for medical imaging equipment to acquire data include CT, MRI, CTA (CT angiography), 3D echocardiography, 3D laser scanning, etc. Enough DICOM data files of 2D medical images can be obtained through data acquisition of these technologies, and enough DICOM files are required for 3D modeling when processing data. This is because the more layers of the scan, the clearer the details of the scan, the more accurate the 3D modeling, but the number of layers also means that the processing of data will be slower.

4. Data Processing (3D Modeling)

4.1 Build models in software

There are many 3D modeling software, for example :3D-Doctor, 3DMAX, Blender, etc. 3DMAX software was chosen for this study because it is moderately difficult for medical students, suitable for beginners, and can work with DICOM files. DICOM files are extracted into 3D model images of human tissues and organs by the software, and then the data files are converted into STL format that can be recognized by 3D printers.

Before printing can use Materialise. Magics. V18.03 software model for fine processing, repair the STL file triangle crack, distortion and overlapping error. The structure of the actual model determines the complexity of image processing. It is generally necessary to segment and combine the original image, remove unnecessary structure, optimize the surface of the model, or design the corresponding mold, etc., to create the final three-dimensional model. Finally, the use of 3D printing technology according to the already designed 3D model to create a solid model, and according to the needs of the physical post-processing rendering.

4.2 3D printing of physical model

1) 3D printing technology classification and printing materials

Among the many existing 3D printing technologies, considering the application of medical organ models and the special requirements of materials, the current 3D printing technologies that can mainly be applied to medical organ models are inkjet printing, extrusion printing, light curing printing and laser melt sintering printing.

2) Classification of 3D printing methods

The 3D printing method can be divided into two kinds according to the final organ model, as shown in Table 1, and the model and material should be selected according to the specific needs of the two methods, as shown in Figure 1.

Table 1 Classification of 3D printing methods

Classification of methods	The difference between the two printing methods
Direct 3D printing	Directly use a variety of materials in a variety of colors to generate different structures, or use a single material monochrome printing, and then use processing for coloring rendering and other operations.
Indirect 3D printing	Manufacturing a variety of molds, using a variety of flexible, deformable “soft materials” in the mold to cast the final organ model

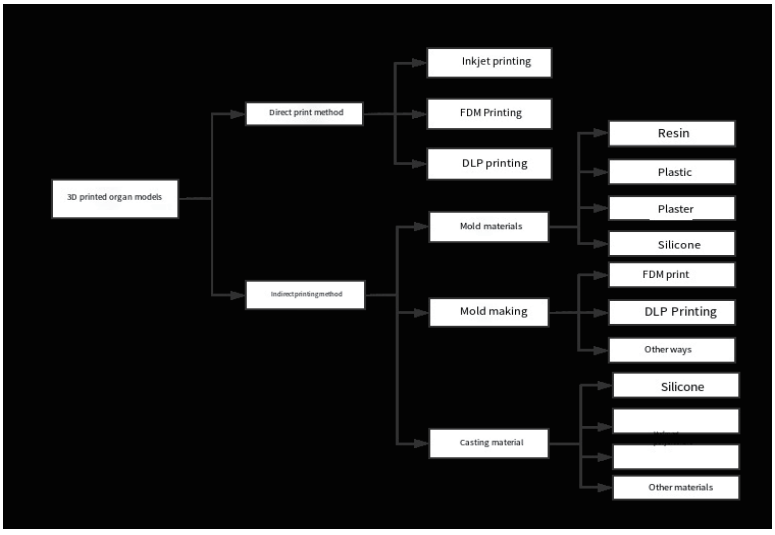

Figure 1 Method and material classification of 3D printing organ models

3) 3D model database of clinical teaching equipment

Clinical teaching equipment model database saves a large number of 3D organ models that have been designed, and exports the required models into STL text format when clinical teaching needs, and uses 3D printers to print out online.

5. Challenges and measures

5.1 Existing problems

1) The technology is not mature

In the modeling process of 3DS MAX, due to the complex software interface functions and unskilled use of tools, there will be some basic operation problems, such as: the 3D printed object model must be closed, and the model screen may not fit, the normal direction may change and other basic errors due to technical or operational problems in the modeling process. If you do not have excellent professional knowledge, you will blindly think that only the model can be printed, but the fact is that you also need professional knowledge and ability in engineering, model, aesthetic design and so on.

2) Long production cycle

Most of the 3D printed models require secondary processing, which will cause a huge waste of time cost. For example, in the pre-3D printing model, the high-quality image data requires the hospital to be equipped with high-resolution imaging equipment, which will increase the extra time cost and medical cost.

3) The imperfection of policy

At present, China's laws, regulations and safety regulations on 3D printing medical appliances and teaching AIDS are not perfect. Even with the cooperation of scientific research institutions, medical institutions, educational institutions, but the policy does not clearly regulate the privacy security and intellectual property rights ownership issues, which greatly restricts the collection of clinical 3D models, and limits the development of related teaching AIDS printing industry.

5.2 Specific Measures

1) Proficient in modeling technology

Proficiency in modeling software and various operational functions is a prerequisite for implementing 3D printing. In order to maintain the interest in modeling learning, it is necessary to learn, practice and think more, upgrade modeling equipment, master modeling thinking and skills, and improve imagination and operation ability.

2) Strengthen multi-department cooperation

Strengthen exchanges and cooperation among medical institutions, educational institutions and scientific research institutions, realize resource sharing, organize technical training, further explore and improve 3D printing technology, and guide the 3D printing of clinical teaching AIDS through clinical collection models.

3) Establish relevant laws and regulations

Establish a review system to standardize, guide and promote the application of 3D printing technology in the medical and health field through laws and regulations.

6. Summary

3D printing technology has made more prominent contributions in the field of clinical medicine and medical education research. For example, printed cell models are used in biomedical research, printed human organ models are used in pre-operation drills or bone replacement, and used as teaching AIDS in medical colleges to guide students' study and research. 3D printing technology can realize the characteristics of customized needs, provide personalized and precise medical services, and promote the transformation of the traditional medical model to the intelligent, efficient and professional model, so the future of 3D printing technology is bright.

References:

[1] Yi Da,Shi Chen,Hui Pan, Huijuan Zhu. Application of 3D printing technology in medical education [J]. Journal of Concord Medical Science,2014,5(02):234-237.

[2] Qing Li,Qing Wang. 3D printing: An emerging learning technology [J]. Journal of Distance Education,2013,31(04):29-35. (in Chinese)

[3] Dage Technology. Medical image 3 d printing is the basic process of how the [DB/OL]. (2018-2-26) [2023-6-3]. https://zhuanlan.zhihu.com/p/34033232.

[4] Xu Zhang,Ting Zhang. [J]. Chinese Medical Education Technology, 2019,34(02):191-194. (in Chinese) Zhang X, Zhang T, Zhang T.

[5] Yu Xiao,Liwen Tan,Mingyan Xiang,Tian Wang,Hong Wang,Nan Zhang,Shaoxiang Zhang. Preliminary study on 3D printing of high-precision organ model based on digital human body [J]. Journal of Third Military Medical University,2015,37(21):2147-2150.

[6] Canyou Wang,Qin Su. Impact of policy measures on the evolution of emerging technologies: A case study of 3D printing technology [J]. Science and Technology Progress and Countermeasures,2016,33(06):110-116. (in Chinese)

[7] Jinhua Gan,Huarui Men,Zhongman Zhang,Chaoya Hu, Hao Lei. Application status and prospect of 3D printing technology in medical related fields [J]. Modern Clinical Medicine, 2019,47(05):385-387+390. (in Chinese)

About the first author:

Fu Yimao, male, undergraduate of Gansu University of Traditional Chinese Medicine, majoring in Medical Information Engineering, carried out research on 3D printing under the guidance of teacher Ren Zhen.

*** Corresponding author:**

Ren Zhen (1979-), male, associate professor, master supervisor, mainly engaged in medical informatics and other related research.

This paper is a project of Innovation and Entrepreneurship Training Plan for College students of Gansu Province in 2022; Lanzhou Science and Technology Bureau Talent Innovation and Entrepreneurship special project (project number: 2014-2-33); Dunhuang Medical and Transformation Key Laboratory of Ministry of Education Open Fund Project (Project No. : DHYX14-001)