DOI: 10.23977/medsc.2022.030609
ISSN 2616-1907 Vol. 3 Num. 6

Research on Application of Plastic Surgery Based on 3d Digital Technology

Xinghua Wang

Zibo Vocational Institute, Zibo, Shandong, 255300, China
78119031@qq.com

Keywords: 3D, Digital technology, Plastic surgery

Abstract: With the continuous emergence of 3D printing, artificial intelligence (AI), virtual reality (VR), 5G and other technologies, the connotation of digitalization has become richer. Digital technology is developing rapidly in the medical field, which makes diagnosis and treatment more intuitive, accurate, safe and effective. Digital technology is changing with each passing day, and 3D printing technology is one of the research focuses in clinical application. In this paper, the 3D digital technology is used to reconstruct the image of the plastic surgery area, import the computer and apply the corresponding software to analyze the measurement data, so as to reduce the error caused by traditional experience judgment. The experimental data showed that the implants after digital three-dimensional shaping fitted the complex physiological and anatomical morphology of craniofacial bone to the greatest extent, especially the defects of frontal bone, orbital bone and zygomatic bone.

1. Introduction

Digital technology equipment can be used for plastic surgery to obtain more accurate preoperative information, and can be used for computer assisted surgery and impression repair, as well as personalized design and production of the pedestal, with significant value[1]. Before plastic surgery, computer aided design software is used for preoperative planning, which can simulate the placement process of implants and explore the implantation direction[2]. These information parameters are converted into STL file format and made into digital guide plates, which can be used as information carriers to guide planting ideas[3]. When designing digital guide plate, CAD software shall be used to integrate soft and hard tissues, prostheses and other information. When making the digital guide plate, CAM should be used to restore the actual template as much as possible to improve the accuracy of the template[4]. Computer aided design technology makes the design process personalized, quantitative and digital, and overcomes the shortcomings of previous design only based on experience. It also enables patients to have a better understanding of the prognosis in advance, facilitates communication between doctors and patients, and reduces unnecessary medical disputes.

In recent years, in the medical field, the state has introduced the “smart medical” policy to vigorously promote the update and development of digital technology in the medical field[5]. Aesthetic surgery has both surgical and aesthetic attributes, so aesthetic analysis of appearance is particularly important[6]. With the increasingly powerful computer image processing technology, cosmetic surgeons at home and abroad have conducted a lot of research on the introduction of computer display and analysis[7]. In 2016, Min L et al. used 3D intraoperative navigation to assist in delayed reconstruction of complex orbitozygomatic fractures, combined with preoperative design and intraoperative navigation planning, to improve the accuracy of surgery and shorten the operation time[8]. In the field of head and neck reconstruction, Group T et al. established a three-dimensional mirror template with the help of a three-dimensional navigation system to perform microsurgery on patients with severe mandibular defects and deformities, which improved the accuracy of surgery[9].

2. Digital Technology Concept

2.1 Concept

Digital technology refers to the technology of using 0 and 1 digital codes to store, transmit, control and express information through computers, optical cables, wireless networks, satellites and other equipment[10]. As a way of information processing, digital technology has the characteristics of large amount of storage information, less storage space, fast transmission speed, less information loss, and convenient information query (Figure 1). With the increasing precision of mechanical engineering technology, related digital technologies are more and more widely used in plastic surgery[11]. The representative computer aided design and manufacturing, reverse engineering and finite element analysis technology can measure and analyze the shape of various parts of the human body, design and simulate surgery, prefabricate prostheses, and analyze mechanics. It is the most important component of computer assisted plastic surgery at present[12]. Digital medical technology is one of the comprehensive modern medical technologies, which is based on the combination of computer technology, information network technology, precision design and manufacturing technology and medical imaging and anatomy. It has realized the conversion from planar 2D images to 3D data, making it possible to simulate surgery, 3D visualization anatomy, 3D diagnosis and analysis, rapid prototyping of models, surgical navigation, telemedicine and robotic surgery[13]. Three-dimensional reconstruction technology is the foundation of digital technology, which converts two-dimensional plain CT data into three-dimensional images through computer software processing. Through three-dimensional images, doctors can accurately locate the position and size of the lesion and understand the relationship between the lesion and surrounding tissues.

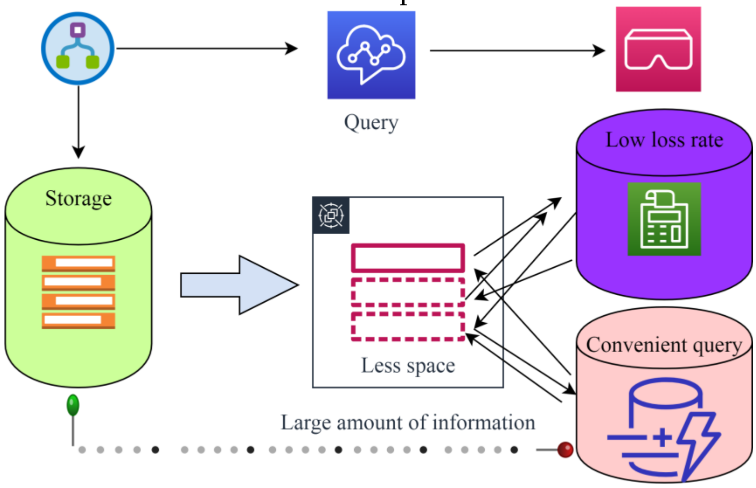

Figure 1: Characteristics of Digital Technology

2.2 Computer-Aided Technology and Digital Plastic Surgery

Digital technology includes: 3D reconstruction technology, computer-aided design and manufacturing technology, computer-aided surgical simulation system, computer-aided navigation system, robot arm, etc. Digital plastic surgery is to introduce computer graphics processing technology, auxiliary design and manufacturing technology, finite element analysis technology, reverse engineering technology, rapid tooling technology, biomaterial technology and other high-tech technologies into the field of plastic surgery. Based on human anatomy and medical imaging, it can achieve predictable, high-precision, rapid craniofacial repair and remodeling. For example, for facial plastic surgery, digital surgical design and simulation system can be used for preoperative design, measurement, intraoperative navigation, prosthetic auxiliary design and transplantation simulation. It is a process of human-computer interaction and doctor-patient communication to simulate and design personalized three-dimensional implants on computer-aided design system. Designers can directly observe the products conceived in their minds through computer screens, and patients and their families can participate in the design and put forward opinions and suggestions. The simulation effect can be observed from various angles, and can be compared with the contralateral normal anatomical structure, so that the patient can have a relative understanding of the expected appearance effect.

3. Application of 3D Printing Technology

3D printing is to convert the source imaging files obtained from clinical imaging examination into 3D image files after post-processing. The 3D molding machine prints layer by layer, and finally converts the virtual data into a physical model, which can replace different anatomical structures according to the different colors and properties of raw materials. At present, different 3D printing machines have different principles, mainly including fused deposition molding, selective laser sintering, light curing rapid prototyping (SLA), layered solid manufacturing and multi-point injection modeling. Imaging technology has developed in a more detailed direction, which can obtain higher resolution anatomical images, and also can post process the original images to obtain three-dimensional images. It is highly displayed from multiple perspectives to promote the development of all aspects of medical diagnosis and treatment. In clinical surgery, the 3D printing technology can be used to obtain the equal scale simulation model of the surgical site, so that the operator can have a clearer and more intuitive understanding of the morphology and structure of the tissues and organs of the surgical target site, with a stronger sense of reality. At the same time, the surgeons can rotate and cut the image arbitrarily on the software according to their own needs, observe the structure from all angles and simulate the operation. If the osteotomy line is designed, the prosthesis placement is simulated and the surgical effect is predicted, the postoperative surgical effect can be evaluated quantitatively.

In the field of plastic surgery, 3D printing technology is often used in preoperative simulation, medical education, clinical application and prosthesis making of maxillofacial plastic surgery. 3D printing technology has many advantages in related applications of plastic surgery, such as precise operation, precise positioning, individualized surgical scheme design, and the ability to transform complex problems into intuitive and simple ones. Throughout its development history, it can be roughly divided into three stages. Firstly, the advantages of three-dimensional imaging and simulation reconstruction are used to quickly and accurately manufacture a fully simulated biological model of three-dimensional structure, so as to complete the formulation of complex surgical plans and the manufacture of personalized prostheses. Then, combined with the research results of regenerative medicine, stem cells and tissue engineering, “bio-printing” is carried out under limited conditions to simulate the external structure of organs and tissues, and at the same time, some physiological functions are restored and reconstructed. Finally, we entered the stage of “organ printing”, successfully printed bionic tissues and organs, and completely solved the limitations of autologous or allograft transplantation. 3D printing technology plays a model role in increasing the rationality and accuracy of operation, reducing the blindness of operation, the rate of accidental injury, and reducing harmful exposure and postoperative complications in clinical surgery. Its shortcomings are also an important direction that needs continuous improvement in the future.

3.1 Experiment

A total of 100 patients with complex craniofacial bone repair surgery were treated in this experiment. They were randomly divided into a 3D simulation group (preoperative 3D digital technology to simulate craniofacial bone reduction, surgical approaches and other operations) and a control group (conventional surgical treatment), with 50 patients in each group. The operation time, bleeding volume, incision length, intraoperative fluoroscopy time, anatomical reduction rate, hospital stay, healing time and surgical complications were compared between the two groups. SPSS 19.0 software was used for data processing. Measurement data was expressed in (x ± s), t-test was used, and counting data was expressed in χ 2(%). The difference is statistically significant if $P < 0.05$.

Table 1: General Data Of Two Groups of Patients (X ± s)

Group	Age	Gender (male/female)	Affected side (left/right)	Complication
3D simulation group (n=50)	40.5±6.9	26/24	22/28	10
Control group (n=50)	39.5±7.2	28/22	19/31	21
T value	0.1035	0.2069	0.1222	0.2605
P value	0.1508	0.1327	0.2321	0.2024

According to the experimental data in Table 1 above, the implants after digital three-dimensional shaping fitted the complex physiological and anatomical morphology of craniofacial bone to the greatest extent, especially the defects of frontal bone, orbital bone and zygomatic bone. In addition, there is no need of cutting during the operation, which avoids the damage of the stress structure of the implant. It reduces the operation time and the difficulty of the operation, with reliable fixation, no floating and concave, reduces the surgical injury, improves the safety of the operation, improves the success rate of the operation, and reduces the complications of the operation.

It can be seen from the data of surgical recovery effect of patients in Figure 2 that the personalized titanium mesh made by the experimental group with computer-aided design technology has a good fit with the craniofacial bone, especially the plastic and aesthetic effect of craniofacial bone defects and deformities involving forehead, upper orbital margin and zygoma. After repair, the appearance of the original defect and deformity is satisfactory, the appearance is symmetrical and complete, and the shape is satisfactory, which fully meets the aesthetic requirements of the craniofacial physiological morphology, meets the patients' requirements for appearance, and improves the patients' quality of life.

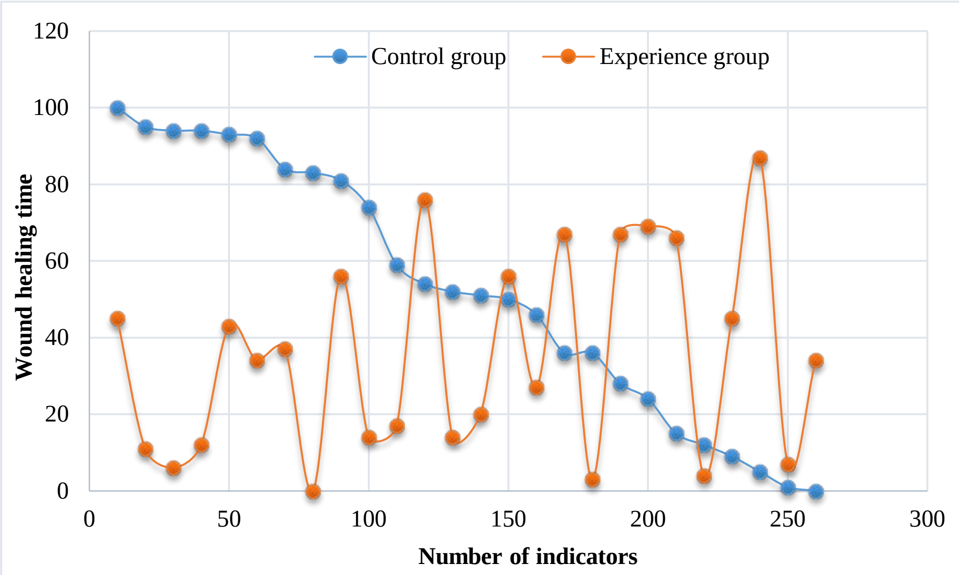

Figure 2: Comparison of Surgical Effects between the Two Groups

4. Conclusions

The application of digital technology in plastic surgery can make the surgical planning more intuitive, significantly improve the surgical accuracy, save the operation time and reduce the surgical complications. The personalized three-dimensional implants produced by computer aided design and manufacturing technology have reached the requirements of physiological and anatomical structures to the greatest extent, restored the patient's appearance to the greatest extent, obtained good cosmetic effects, and achieved the perfect combination of science and aesthetics. In the long run, the application of 3D printing technology in the medical field has a broad prospect, but long-term planning and cooperation in many aspects are required. At present, there is no large-scale research and randomized controlled trial to verify its value, and to promote the technology to practical clinical application in a larger range. As a key research discipline in the field of 3D printing, plastic surgery has been developed and deepened more and more research, such as vascularization, cell manipulation and tissue viability or transfer. In the future, it is very hopeful that these research results will be widely used in clinical practice, bringing disruptive challenges and opportunities to the development of plastic surgery.

References

[1] Zheng B, Li Y, Zhang G. Digital image-guided surgery to breast reconstruction [J]. Chinese Journal of Plastic Surgery, no.2, pp.5, 2017.
[2] Dai L. The 3D Digital Technology of Fashion Design [J]. Science and Technology, no. 9, pp .3, 2018.
[3] Dini B, Hutagalung M R, Kusuma D P, et al. Varying features of indonesian deutromelayu female bodies and 3D digital model of attractive bodies [J]. Engineering Sciences, no. 11, pp. 2, 2021.
[4] Pandey S, Dinesh K, Chittoria R K, et al. The role of 3D printing technology in plastic surgery [J]. Science and Education Publishing Co. Ltd, no.12, pp.3, 2020.
[5] Shibata T, Shiraki Y, Kamei M. Clinical Utility of Stereoscopic 3D Displays in Heads-up Surgery [J]. SID International Symposium: Digest of Technology Papers, no.3, pp.2, 2019.
[6] Hanson A J. Visualizing Quaternions: Series in Interactive 3D Technology [J]. International Journal of Science and Technology, no.11, pp.2, 2020.
[7] Zuffo M K, Mouton C, Slusallek P, et al. Proceedings of the 15th International Conference on Web 3D Technology [J]. Web 3d Technology, no.3, pp.2, 2019.
[8] Min L, Wu J, Yu X, et al. 3D printing technology for RF and THz antennas [J]. Antennas & Propagation, no.4, pp.1,

2018.
[9] Group T. Mitsui Chemicals, IBM Japan Look to Visualize Plastic Circulation Using Digital Technology. [J]. The Catalyst Review Newsletter, vol. 36, no. 5, pp. 3, 2018.
[10] Jauniaux E, Mccarthy C, Coombe H, et al. Ensuring proper standards in digital technology for surgery in low resource settings[J]. BMJ, vol. 33, no.2, pp.8, 2019.
[11] Zu-Bing L. Application of digital technology in maxillofacial trauma surgery [J]. Journal of Plastic Surgery, vol. 34, no. 7, pp.1, 2022.
[12] Takano M. The new trend of digital technology and application to the field of Oral and Maxillofacial Surgery [J]. Japanese Journal of Oral and Maxillofacial Surgery, no.8, pp.11, 2017.
[13] John, Pallanch. 3D and the Next Dimension for Facial Plastic Surgery [J]. Facial Plastic Surgery Clinics of North America, no.9, pp.15, 2016.