

Application of three-dimensional reconstruction in stomatology

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Abstract: Three-dimensional reconstruction (3D) in computer vision, is the process of three-dimensional view information from single or multiple views. In medicine, 3D reconstruction techniques are mainly based on MSCT, magnetic resonance imaging and other output medical digital image communication protocol (DICOM) format files. As a new digital medical technology, 3D reconstruction technology has been widely used in the field of stomatology, using 3D software, we can freely rotate, segment and view the CT scan results from many different angles, so that we can get more clear skull contrast and more information, data in CT scan results can also be processed so that reference markers can be clearly displayed for better diagnosis and treatment^[1]. It has the unique preoperation design advantage, reduces the operation time, enhances the operation accuracy.

Keywords: Three-dimensional reconstruction (3D), stomatology

1. The application of three-dimensional reconstruction in oral clinical teaching

Stomatology requires the stomatologist to have good comprehensive quality and good clinical skills. It is a comprehensive, practical and practical subject. The development of digitalization brings new teaching mode, not only confined to the scope of textbooks, but also new technology brings new possibilities to traditional education. The concrete three-dimensional model brings the direct-viewing understanding from different angles and levels, which makes learning to fully understand the anatomical structure and treatment process of tooth invagination the key and difficult point in children's stomatology, it is difficult to classify and treat the special and complicated anatomic structures^[2]. At present, the experimental courses of pre-clinical root canal therapy in stomatology school can use natural extracted teeth, transparent root canal resin blocks and plastic simulated pulp teeth as teaching models^[3]. By 3D printing technology, the dental model can be reconstructed more intuitively and comprehensively to guide the students to do root canal training before clinical practice, but the cost is higher than the traditional method. The muscles of the maxillofacial region are attached to the different shapes of the jaws, and the nerves are closely distributed and convoluted with the ducts of the arteries, veins and salivary glands, the salivary glands in the maxillofacial region, and the hidden maxillofacial space, the three-dimensional model can hide some tissues to make the deep structure appear, and truly reflect the structural relationship of each muscle, blood vessel, salivary gland and so on, it is convenient for students to understand and study. The development of three-dimensional classroom has brought a new model which is simple, effective and easy to implement. Compared with the traditional model, students can learn more easily, promote the development of basic medical education in our country^[4]. Su Xiaoxia et al integrated the application of 3D Skeletal Atlas APP digital projection and cephalometric software as teaching methods in the practical course of orthodontic cephalometry, and analyzed its application effect, digital integration teaching method is more in line with the logic of learning to improve the effectiveness of orthodontic practice teaching^[5].

2. Application of 3D reconstruction in oral surgery

Reported that the incidence of disease abroad is about 0.6% ~ 3.6%, domestic about 1.6%^[6]. In a variety of adverse factors or congenital factors, the process of the embryo can not be fused with each other caused by maxillofacial deformities. As one of the most common causes, nasal obstruction associated with cleft lip and palate often leads to misshapen deformities and^[7] 3-d reconstruction of the oropharynx airway after segmentation using CT 2-d data thresholds is considered one of the gold

standards for reflecting nasal morphology; A three-dimensional model developed by Cao Sicong et al showed the characteristics of nasal deformities in patients with cleft lip and palate from a spatial perspective^[8] and Tetsuya Takahashi et al analyzed by airway reconstruction, anatomical differences in pharyngeal airway volume have also been found in patients with cleft lip and palate^[9]. The influence of cleft lip and palate is a kind of three-dimensional influence, even after surgical treatment, still need to follow-up with a series of orthodontic-related treatment, patients often because of the younger, its measurement and analysis will bring inconvenience, the analysis of three-dimensional reconstruction can better evaluate the characteristics of maxillary and mandibular changes compared with the traditional two-dimensional analysis, and the established model can be used to make the preoperative operation plan, the operation simulation and the palatal guard fabrication^[10]. It can also be used in a series of orthodontic-related treatment, which brings great challenge to the treatment of some tumors because of the complex structure and organization of maxilla, maxilla and maxillofacial region, and the crisscrossing of blood vessels and nerves^[11].

The mandible is one of the main bone tissues in the maxillofacial region. Osteomyelitis, tumor and trauma of the mandible may lead to the destruction and defect of the mandible, which may lead to the influence of speech, eating, beauty and temporomandibular diseases, greatly affects the patient's physical and mental health^[12]. The defect of mandible and scar of soft tissue after the operation of huge mandibular cyst provide a new idea for the secondary treatment of mandible, all these have brought great difficulty to the restoration of occlusal and the development of 3D reconstruction technology. According to Peng Xin et al, virtual surgery after three-dimensional reconstruction reduces the difficulty of the operation, and patients' satisfaction with the postoperative occlusion and appearance increases, which increases the difficulty of secondary repair of mandibular defects^[13], the digital guide plate design combined with 3D printing technology can guide accurately and help fibula flap to repair missing mandible to establish stable occlusion, use the bite plate to fix the bite. Recently, there are more and more 3D models for reconstruction surgery. The use of 3D reconstruction technology to simulate post-3d printing design has also become a new option for fabricating prostheses, Masayuki et al designed and fabricated 3D titanium mesh plates using 3D reconstruction techniques that successfully preserved the shape and function of the maxilla, using a pre-curved 3D titanium mesh and a tunnel skin flap to make surgery easier and simpler, surgical accuracy and safety have been greatly improved^[14].

3. Application of three-dimensional reconstruction in oral medicine

In the treatment of calcified root canals, it may destroy too much tooth tissue or cause complications such as lateral perforation and deviation of root canals, and the success rate is low, although the microscope, ultrasound, cone-beam CT and other equipment used in conjunction. Xu Qiong et al. 15 used the latest micro-ultrasound and other techniques to treat 47 calcified root canals. The successful rate of recanalization of calcified root canals was 78.7%, and there was room for further improvement. On the other hand, Zehnder et al and Connert et al^[16] successfully dredged the root canals of all single teeth and the relatively narrow mandibular incisors with three-dimensional printed guide plates in vitro. In clinical application, KRAS^[17] and Connert^[18] successfully cured the calcification of the root canal of one maxillary anterior tooth and achieved the root canal treatment of bilateral mandibular incisors by three-dimensional printing technology. In addition, tooth invagination may result from hypoplasia of the tooth, which may result from over-curling of the enamel layer or local over-hyperplasia. Grooves in the alveolar bone affect the periodontal tissue, from the root canal system to the apical foramina, and the spaces created by these grooves will serve as important junctions between the pulp and the periapical tissue^[19]. Given the complexity of tooth invagination, Zubizareta et al.^[20] proposed a new three-dimensional printed guide to effectively deal with this condition and achieved good results in root canal therapy of one maxillary lateral incisor; The loss caused by pulp necrosis and periapical lesions was greatly reduced. Mena-alvarez et al.^[21] used a guide plate technique to precisely implant a central maxillary incisor with a chair-side veneer restoration. In addition, they also used 3D printing technology, the affected teeth were replicated, in order to better achieve clinical treatment^[22]. This technique not only makes the implant implantation more safe and accurate, but also provides a new idea for the root canal treatment of teeth with abnormal shape and position. The 3d-printed guide plate has become the preferred technique for apical surgery, which can effectively improve the effect of root canal therapy and can effectively reduce the possibility of treatment failure, in particular, 3D printing can improve treatment outcomes in patients with more severe anatomical variations. By using modern microscopy, not only can you protect the healthy bones around you, but you can also reduce the damage to your teeth, which can greatly reduce the risk of apical surgery, and its success rate is as high as 89%^[23]. With the popularity of non-surgical root canal retreatment, the number of patients undergoing apical surgery has decreased

significantly, but the complexity of the operation has also increased. Especially when the operation scope is close to the important anatomic structures such as the inferior alveolar nerve, maxillary sinus and adjacent root, it is still difficult to precisely locate the lesion and remove the bone. A 3d-printed guide plate can accurately localize the position and depth of the bone and can guide apical resection at specific levels and angles^[24]. It can not only help doctors deal with complex conditions, but also improve their surgical skills to achieve more accurate, rapid and simple apical surgery.

With the development of technology, autologous tooth transplantation has made great progress in the treatment of missing teeth in young patients. It can not only complete the operation quickly and effectively, but also has lower cost. However, the success rate of autogenous tooth transplantation is still influenced by many factors, including the time in vitro, the degree of periodontal ligament damage and the matching of alveolar fossa. Adopting advanced technology can effectively reduce the destruction of periodontal ligament, shorten the time of the donor teeth in vitro, improve the success rate of transplantation, and can accurately control the direction and angle of implantation according to the patient's dental condition, so as to achieve the best therapeutic effect.

4. The application of three-dimensional reconstruction in prosthodontics

Implant has been the preferred treatment method in the treatment of missing teeth, but the procedure is complicated in the treatment of edentulous jaw, implant is the preferred method of treatment, but the procedure of treatment is complex, and the three key factors, temporomandibular joint and teeth, play a vital role in the process of occlusal reconstruction, their harmonization contributes to the establishment of long-term stable occlusal relationships that could otherwise lead to severe consequences such as pain, muscle hypertrophy, joint snapping, and biological or mechanical complications of the prostheses^[25]. In the process of implant restoration of missing teeth, implant becomes the difficult problem of traditional whole-mouth implant fixed restoration, which can be solved by digital technology. Prior to implant surgery, we can use digital technology to collect patients' jaws, mucosa, and radiological diagnostic models in order to work out the optimal surgical plan in a visual environment, we will also provide accurate guidance panels for implant surgery, and support with digital devices, depending on the patient's condition, in order to better record and analyze the patient's mandibular position, neuromuscular and temporomandibular joint changes, so as to achieve the effective combination of temporary and permanent prosthesis. In this way, the restoration can obtain better active recovery effect^[26]. All these changes can make implant reconstruction more accurate and personalized. The key to planting success lies in the rational design of planting location, in which biomechanical design can not be ignored^[27,28]. The masticatory action is a dynamic process, which has a certain procedure and repeatability. The force applied on the denture is different from the static loading of the point contact, thus more realistic simulation of the actual chewing process. Li Ying^[29], et al, in order to study the effect of the position of the implant on the implant and the stress of the bone around the implant in patients with mandibular edentulous, used the method of dynamic loading, in order to provide clinical reference for implant.

With the development of all-ceramic restoration materials, the clinical application of computer-aided design and single-layer structure all-ceramic restorations is becoming more and more extensive, by incorporating aesthetic and occlusal information into the design and fabrication of all-ceramic prostheses, the final temporary prostheses can be effectively replicated and transferred, thus enabling efficient retrofitting of the original structures^[31].

In order to ensure the best therapeutic effect, it is very important to establish a perfect occlusion relationship between the upper and lower jaws in the cases of complete occlusal reconstruction such as severe dentition attrition^[30]. Therefore, in the process of occlusal design, it is necessary to carry out a comprehensive examination and analysis in order to establish a reliable benchmark, and use occlusal pad, diagnostic facing, temporary crown and other techniques, this benchmark is further evaluated, validated, adjusted, and adjusted to achieve better treatment results. Through multi-step redesigns and precise manipulation, we were able to find the optimal repair plan that best meets the patient's needs. In this process, we need to choose and use the temporary prosthesis such as occlusal pad, diagnosis, temporary crown according to the order from non-invasive, minimally invasive to invasive, from reversible to irreversible, to meet the needs of patients^[31].

5. Conclusion

As a new digital medical technology, 3D reconstruction has been widely used in the field of

stomatology. Three-dimensional reconstruction has been widely used in the field of stomatology. 3-D reconstruction can be called the key ^[32,33]to connect 2-d space and 3D. The rapid development of digital medicine has brought new concepts to modern medicine, as well as brand-new ways of medical research. It is easy to reconstruct three-dimensional models from two-dimensional image data, increasing the research samples, improve the accuracy of research, and no longer bound to traditional research methods ^[34]. With the development of digital medical treatment and 3D reconstruction, more accurate models and simulated operations can be realized, which not only bring new ideas to solve the problems of difficult cases in oral clinic, but also bring new ideas to solve the problems, at the same time, it also brings a new way for oral teaching. For the real precision oral medicine will bring a qualitative leap, can better solve the pain of patients, to promote a new model of oral medicine research!

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