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Review of Craniofacial Plastic Correction Method Based on Computer Aided Technology

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Abstract*:* With the development of plastic surgery techniques, computer aided approach has become a significant method in medical plastic surgery. In order to solve effects on surgical results made by the surface of a wound in craniofacial cosmetic surgery, accurate preoperative preparation is usually required for the surgery. This paper summarizes the application of computer aided technology in craniofacial surgery and illustrates the future development trend, thereby further improves basic research and diagnostic level of plastic surgery.

Keywords Craniofacial, Plastic Surgery, Computer Aided Technology

INTRODUCTION

Craniofacial cosmetic surgery mainly refers to surgeries that can change the shape of face, such as high cheekbones reduction surgery, mandibular angle hypertrophy surgery (change square face into oval face), chin horizontal osteotomy transplantation surgery (correct small chin), etc. These surgeries own accurate operations, which require excellent surgical instruments. Furthermore, surgeon must possess artistic aesthetics like sculptors and the first-class surgical techniques (Lin, *et. al.*, 2015). When people start attempting these surgeries, there is a limitation in instruments and experiences. In order to better expose surgical areas, directly cutting from faciocervical skin is usually needed to reduce the difficulty, however there are many deficiencies of this method. With the improvement of surgical instruments and the development of computer aided technology, the above three common feature-modified surgeries can be completed merely by computer aided technology, of which the surgical risks are greatly reduced, and surgical results are promoted simultaneously (Rodby, *et. al.*, 2014). The paper analyzes and studies cases aided by computers to make market evaluation and prospects for surgeries through computer simulation and application.

APPLICATION OF COMPUTER AIDED TECHNOLOGY IN CRANIOFACIAL SURGERY

Repair surgery of craniofacial deformity includes the correction of cephalofacial deformity caused by innate and acquired factors. Whether the surgery will success depend on surgical operations (Hassfeld, *et. al.*, 2001). Moreover, it also depends on accurate surgical projects to a large extent. Traditional surgery will simulate the surgical osteotomy trajectory on plaster models, which will be a huge limit to the complex craniofacial deformity surgery with requirements of high precision. Therefore, some scholars begin to apply CASS to conduct preoperative design of craniofacial surgery (Ewers, *et. al.*, 2005). Some scholars have collected 12 patients with craniofacial deformity to produce a three-dimensional craniofacial model for them. Furthermore, two surgical simulations are made: conduct simulative surgery and traditional surgery with the assistance of CASS (Hanasono, *et. al.*, 2013). After the surgery, it is better to make a statistical evaluation from correction level of the whole cranilfacial bone correction and corrections of maxilla, underjaw and chin. It turns out that surgical results achieved by the application of CASS are obviously better than traditional methods, and surgeon can better correct partial deformity with the application of CASS and recover symmetry of the lower jawbone. With the auxiliary of intra-operative navigator, MaliS and others have conducted precise osteotomy and prosthesis implantation to patients with temporomandibular joint stiffness, and completed total temporomandibular joint replacement, which have achieved effective results.

Application in craniofacial tumors

Digital technology has significant assistance in the evaluation, excision and postoperative repair of craniofacial tumors. Some scholars will take three-dimensional digital stereo photogrammetric technology to evaluate the facial development situation of children with aggressive fibromatosis who has been received the mandibular condyle segmental resection in two years. Then consider that three-dimensional digital stereo photogrammetry is a non-invasive method in monitoring facial growth, which is objective and quantitative. LU bbers has made a preoperative virtual planning of a patient who

has a huge frontal and temporal bone osteoblastoma, and he adopts image technology and navigation system to remove the lesion. Meanwhile, he takes advantage of autologous skull according to the uninjured side to reconstruct the affected side and achieves effective results, which provides a new method for the complex craniofacial tumor surgery (Gil, et. al., 2015). In recent years, many domestic scholars has applied digital technology to craniofacial tumor and obtain ideal effects. Some scholars would like to conduct three-dimensional reconstruction of preoperative craniofacial bone to 14 patients who have zygomatico maxillary fibrous dysplasia of bone, they take image technology to precisely mark the cone mass needed to be removed (Dreiseidler, *et. al.*, 2012). In addition, intra-operative navigation system is taken to direct the removal of diseased bone, and the maximum difference between post-operative outcome of each patient and the pre-estimated value is less than 2mm. Besides, digital technology is also applied to the field of reconstruction of the skull defect. It turns out that digital 3D skull forming technology has been applied to the first stage of cranioplasty, which can promote the accuracy of skull shaping, reduce post-operative complications after cranioplasty and shorten operation time (Antony, *et. al.*, 2012).

Application in craniofacial trauma

Orbital zygomatic fracture has taken a great proportion in craniofacial trauma. The greatest difficulty of orbital reconstruction lies in the fact that the surrounding structure of orbit is complicated with rich meurovascular, so that it is difficult to recover orbital bony outline before the disease and extraocular muscle functions. Although traditional surgery is effective, there will be apparent defects on patients (Cima, *et. al.*, 1996). Some foreign scholars combine pre-operative surgical simulation with intra-operative navigator, and repair and reconstruct unilateral orbital deformity caused by trauma, which has high precision in anatomic reduction. However, secondary deformity caused by the limit of soft tissue cannot be completely overcome. Results suggest that pre-operative surgical simulation and intra-operative navigator can provide helpful guidance for complex orbital wall repair (Long, *et. al.*, 2013). Studies of domestic scholars has indicated that computer aided technology SNNS is beneficial to promote the resetting precision of craniofacial old fracture. Some scholars adopt image technology to make 3D craniofacial model for patients with orbital zygomatic fracture, and conduct anatomical shaping of titanium mesh on the model, of which the accuracy of orbital wall repair is higher than the predicted titanium mesh. In addition, SLA model is also widely used in skull defect repair. Some scholars take optical 3D imaging and rapid proto-typing technology to make prosthesis transplantation to large defect on craniofacial that the ration has passed the center line, and convince that it is available to take virtual transplantation in repairing large facial defect that maintains ocular structure.

Simulation of influence of bone translocation on soft tissue

Predicting 3D changes of soft tissue in cosmetic surgery is a difficult and key issue. Bone block is rigid, and the relocation of bone can be completed through direct linear transformation and point or line transition (Anon, 1998). Compared with bony structure, the simulation of soft tissue is complex, which is not only decided by movement quantity and direction of bone block, but shall consider some other factors: whether the combination of soft tissue and bone is the solid synostosis; whether the thickness of soft tissue and soft tissue of the moving bone surface can move; tension effect of the surface of soft tissue; thickness and type of soft tissue of adjacent area of the operation; and whether existence of scars and other soft tissue deformities will change predicting outcomes, etc.

Integrated locomotion simulation and biomechanical simulation

Plastic surgery shall not only consider aesthetic components, but consider whether physiology after face-lifting can be influenced. Especially how to accurately conduct repair surgery in an ideal location and reach good biomechanical environment in repair surgery of maxillofacial bone defect and orthodontics, which are the urgent problems of the clinic (Wagner, *et. al.*, 2003). Therefore, Integrated locomotion simulation and biomechanical simulation shall be included in the plastic surgery simulation to help clinicians conduct analytic and comparative study to performance and quality of prosthesis from multiple perspectives, which will make the repair achieve optimum results from aesthetics and physiology to provide a extremely valuable method of evaluation and design assistance for modern clinical surgery.

The establishment of knowledge base of plastic experts

The current grid deformation scale is still determined artificially by experts according to the measured characteristic data. Because of the differences in doctors' personal experience and the subjectivity of plastic surgery implementation process, cosmetic results will be diversified. Establishing characteristic value of plastic parts and expert knowledge database related to cosmetic results is one of the important factors to ensure effects of plastic quality.

Application in fields apart from craniofacial surgery

Some scholars will take 3D stereo photogrammetry or 3D software to conduct the evaluation of soft tissue of craniofacial before and after the operation, as well as changes of soft tissue and objective evaluation of orthognathic surgical recurrence. Some scholars apply volume and surface area of 3D

computed tomography data to analyze the size of the coronoid process that can be accurately evaluated, which provides assistance of clinical diagnosis and therapy for coronoid process hyperplasia.

RESEARCH PROSPECT

The most important difference between plastic and aesthetic surgery and other clinical departments lies in the fact that patients of plastic and aesthetic surgery are those who have appearance defect or appearance and function defects. Plastic and aesthetic surgery therapy shall not only restore and maintain functions, but more importantly achieve appearance beautification. Therefore, the important content of plastic and aesthetic surgery digitization is to make digital quantitative diagnosis of patients' appearance defects (Hallermann, et. al., 2006). We get digital photos of patients through positioning camera techniques, and adopt computer image measurement and analysis technology to conduct image analysis of photos of patients. In terms of aesthetic standard studied and summarized by us about different nationalities, genders and ages, we take computer system to carry on aesthetic evaluation and realize digital diagnosis of appearance defects. Furthermore, we take the analysis report to state distance between each part of patients and aesthetic standard, the difference between angles and radians in details to realize quantitative diagnosis of appearance defects and guide clinicians to achieve quantitative surgical design. Meanwhile, as a result of the development of quantitative diagnosis system of appearance defect, we can realize quantitative evaluation of surgical results. By comparing aesthetic grade changes of patient's appearance before and after the operation and quantitative way to evaluate surgical results, no unified evaluation criteria of the plastic and aesthetic surgery in the past has been solved.

Plastic and aesthetic surgery not only includes aesthetic improvement of patients' appearance and facial profile, but aesthetic improvements of skin, especially adopting the laser, surgery and other techniques to cure pigmented skin, which is one of the important parts of plastic and aesthetic surgery. Because there is no digital analysis system in the past, clinicians can only evaluate the state and size of pigment by eyes and rulers, which is a lack of science and accuracy (Movahed, et. al., 2013). By computer image analysis technology, we have established a quantitative analysis system of pigment, including the measurement of disease degree and size of pigment to provide clinical diagnosis with scientific basis for therapeutic evaluation. Furthermore, it can also be used in guiding clinical charges, especially that the analysis results can direct clinical choice of laser.

Patients of plastic and aesthetic surgery are different from patients of other clinical departments. The outstanding feature of patients in other departments see a doctor as a result of diseases, while patients of plastic and aesthetic surgery see a doctor not for diseases. Psychology of plastic and aesthetic surgery patients is very complicated, which will easily lead to medical disputes. We have combined psychological measurement technique and by computer technique to realize digitization of psychology measurement and analysis. By analysis of psychology to pursue beauty to find out mental problems in patients, and make a timely and reasonable solution to reduce possibilities of medical disputes. Besides, with the development of plastic techniques, personalized cosmetic surgery is required in plastic surgeries. Personalization includes personalization of patients' appearance and mental traits, which require that cosmetic surgery doctors must understand personality of patients when conducting surgical planning. Our psychological quantitative assessment system of pursuing beauty can realize the fact to help surgical planning become more suitable for psychological characteristics of patients, and make them easier to accept themselves after the surgery, which will bring out the best of plastic and aesthetic surgery.

Along with the improvement of material and culture living standard, requirement for service quality is becoming higher and higher. Improving doctors' service awareness and strengthening physician-patient communication is not only needed to steady and expand patient groups, but are the key to reducing medical disputes and constructing harmonious medical services simultaneously. However, the fact is that clinicians are busy, and usually they have no time to communicate with patients, or they may forget to conduct timely reminder and follow-up visit. In response to these circumstances, we have adopted a way of SMS through modern digital communication technology to realize digitization, automation and intelligence of doctor-patient communication, which greatly reduces the doctors' work load, improve doctor-patient communication efficiency and realize communication anytime and anywhere.

REFERENCES

Anon, J. B. (1998). Computer‐aided endoscopic sinus surgery. The Laryngoscope, 108(7), 949-961.

Antony, A. K., & Cohen, M. N. (2012). Reply: The New Age of Three-Dimensional Virtual Surgical Planning in Reconstructive Plastic Surgery. Plastic and Reconstructive Surgery, 130(1), 194-195.

Cima, L. G., & Cima, M. J. (1996). U.S. Patent No. 5,490,962. Washington, DC: U.S. Patent and Trademark Office.

Dreiseidler, T., Tandon, D., Kreppel, M., Neugebauer, J., Mischkowski, R. A., Zinser, M. J., & Zöller, J. E. (2012). CBCT device dependency on the transfer accuracy from computer‐aided implantology procedures. Clinical oral implants research, 23(9), 1089-1097.

Ewers, R., Schicho, K., Undt, G., Wanschitz, F., Truppe, M., Seemann, R., & Wagner, A. (2005). Basic research

and 12 years of clinical experience in computer-assisted navigation technology: a review. International journal of oral and maxillofacial surgery, 34(1), 1-8.

Gil, R. S., Roig, A. M., Obispo, C. A., Morla, A., Pagès, C. M., & Perez, J. L. (2015). Surgical planning and microvascular reconstruction of the mandible with a fibular flap using computer-aided design, rapid prototype modelling, and precontoured titanium reconstruction plates: a prospective study. British Journal of Oral and Maxillofacial Surgery, 53(1), 49-53.

Hallermann, W., Olsen, S., Bardyn, T., Taghizadeh, F., Banic, A., & Iizuka, T. (2006). A new method for computer-aided operation planning for extensive mandibular reconstruction. Plastic and reconstructive surgery, 117(7), 2431-2437.

Hanasono, M. M., & Chang, D. W. (2013). Discussion: jaw in a day: total maxillofacial reconstruction using digital technology. Plastic and reconstructive surgery, 131(6), 1392-1393.

Hassfeld, S., & Mühling, J. (2001). Computer assisted oral and maxillofacial surgery–a review and an assessment of technology. International journal of oral and maxillofacial surgery, 30(1), 2-13.

Lin, H. H., Chang, H. W., & Lo, L. J. (2015). Development of customized positioning guides using computer-aided design and manufacturing technology for orthognathic surgery. International journal of computer assisted radiology and surgery, 1-13.

Long, S. A., Stern, C. S., Napier, Z., Mandel, B., Soltanian, H. T., Bentz, M. L., ... & Hazen, A. (2013). Educational Efficacy of a Procedural Surgical Simulator in Plastic Surgery: A Phase I Multicenter Study. Plastic and Reconstructive Surgery, 132(4S-1), 13.

Movahed, R., Teschke, M., & Wolford, L. M. (2013). Protocol for concomitant temporomandibular joint custom-fitted total joint reconstruction and orthognathic surgery utilizing computer-assisted surgical simulation. Journal of Oral and Maxillofacial Surgery, 71(12), 2123-2129.Petzold, R., Zeilhofer, H. F., & Kalender, W. A. (1999). Rapid prototyping technology in medicine—basics and applications. Computerized Medical Imaging and Graphics, 23(5), 277-284.

Rodby, K. A., Turin, S., Jacobs, R. J., Cruz, J. F., Hassid, V. J., Kolokythas, A., & Antony, A. K. (2014). Advances in oncologic head and neck reconstruction: systematic review and future considerations of virtual surgical planning and computer aided design/computer aided modeling. Journal of Plastic, Reconstructive & Aesthetic Surgery, 67(9), 1171-1185.

Wagner, A., Wanschitz, F., Birkfellner, W., Zauza, K., Klug, C., Schicho, K., ... & Ewers, R. (2003). Computer‐aided placement of endosseous oral implants in patients after ablative tumour surgery: assessment of accuracy. Clinical oral implants research, 14(3), 340-348.