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Development and Research on the Orthopedic 3D Image Computer Aided Diagnosis and Treatment System

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Abstract. Objective: Development of orthopedic 3D image computer aided diagnosis system can provide the help in the diagnosis of the orthopedic diseases. Methods: 150 patients from January 2014 to January 2016 were chosen as study samples. According to CT scan and X-ray image data, we got 3D reconstruction to the injured parts for the patients with fractures, and conducted evaluation according to the clinical data. Results: Comparing the examination result of the patients with fractures with the computer three-dimensional reconstruction, P>0.05, the difference is not of statistical significance. Conclusion: Orthopedic 3D image computer aided diagnosis system can help to reconstruct 3D images of damaged fracture parts, which is a very helpful diagnos and treatment asistant method for bone injuries, and will have very broad clinical application prospect.

Keywords: Orthopedic, 3D Image, Computer Aided Diagnosis

Introduction

The development of medical imaging was very rapid over the past decades. As the functions of CT, MRI and other imaging equipment are more and more powerful, the obtained patient data are more accurate, the reconstructed 3D model accuracy is improved constantly with less and less gap with the reality, using the computer model to simulate the anaplasty and design program gradually becomes an important auxiliary means before the actual surgery. Of course, there are many limitations for the simulation surgery, there are also certain gaps between the simulation result and actual operation results, and the main reason is that the doctor's operation still relies on the subjective experience and feeling due to the limitation of surgical approach and the failure to see the operation side and other factors in the actual operation. Moreover, the computer model can also be established for the muscle and other soft tissues. The muscular atrophy after the operation and other nonlinear changes can not be simulated, and this is the drawback of current simulation operation[1]. However, along with the rapid improvement of computer graphics processing speed and the improvement of corresponding software processing ability and the computer aided design, the development of rapid prototyping technology realizes the tangible flyover from 2D image to 3D object[2], thus providing the important basis for the clinician to diagnose the disease, position the lesion point and determine the operation program, and improving the operation safety and quality obviously.

With the goal to develop and perfect 3D imaging computer aided diagnosis system in the orthopedics department, the improvement of the application of the system on the actual diagnosis and treatment effect is analyzed via the real diagnosis and treatment in the research.

Material and method

Main equipment and material:

Main experimental equipment:

Dell PRECISIONT5400I station (Intel (R), Xeon (R), Microsoft Windows XP Professional Edition 2002 Service Pack 3); Spiral CT: Biograph16HR type, Germany's Siemens; Mmics10.0:Belgium Materialise Company; Geomagic8.0: US Raindrop Company; AFS Laser Rapid Molding Machine: Beijing Longyuan Company.

Experimental method:

The computer aided design is used to establish the fracture model and simulate the operation fracture reduction model. After the patients were hospitalized, x-ray inspection and spiral CT scanning were operated, the thickness of the scanning layer was 1mm. The intertrochanteric fracture outline and CT fault information were fully understood before the operation, the hip CT scanning fault data was imported to Mimics 10.0 via Dicom3.0 format. The technology (Thresholding) was selected with the threshold firstly, the reconstruction organizational structure was selected by the operator according to different density of reconstruction organization, the threshold value range of the organization can be obtained automatically in the software[3]. After the threshold value range was accepted, the original cover of the organization can be obtained. In the experiment, thresholding=200 (housefieldscale) was selected, the editmask- erase option was started to manually erase acetabular bone layer by layer to facilitate further extracting the proximal femur[4]. 3D region growing technology was used, the structural region at the proximal femur to be reconstructed was selected, further the new cover can be obtained. The pixel set of mask shall be established at the proximal femur, 3D frommask shall be calculated to establish the intertrochanteric fracture model and export with STL format. Similarly, the fracture proximal and distal fracture model shall be established, reposition shall be started under CEF/Simulation unit of mimics to make the anatomical reduction at the fracture end, Boolean shall be conducted to merge the fracture model into new STL file.

Research object:

150 patients with intertrochanteric fracture treated by the orthopedic department in Jinan Qianfoshan Hospital from January 1, 2014 to January 1, 2016 were selected, their ages were ranged from 18-55 years old with the average age of 40 years old, 64 cases had the fall damage, 37 cases had the car accident, 29 cases had the falling injury, and 20 cases had the training damage, 98 males and 52 females were included. The patients complying with the standard were divided into groups alternately according to the hospitalization sequence, the conventional operation and computer aided operation were operated for 75 cases respectively; In the computer aided group, the patients conducted the tibial tubercle traction, spiral CT scanning before the operation and computer aided design-rapid modeling technology to establish the fraction model for the observation in the operation, the computer designed the nail placement template conforming with the greater trochanter and printed and took to the operating room for uperization to be used in the operation; In the conventional group, the patients only conducted the tibia tubercle traction, they were all anesthetized under the epidural continuously, and lay on the back at the closed reduction under the surveillance of C-arm machine.

Results

The fracture model printed with the application of computer aided design-rapid modeling technology was totally consistent with that in the operation, thus reflecting the basic condition of the lesion accurately and visually. All patients completed the surgery as scheduled, the operation process

was smooth, their operation duration, blood loss and radiation frequency in operation and statistics analysis were recorded as shown in Tab.1; All patient's one-time nail placing success rates in the operation were recorded as shown in Tab.2, hip joint positive side X-ray was re-examined after the operation. The follow-up was made for all patients via outpatient appointment for radiography and clinical examination combined with the phone and questionnaire. 12-month follow-up was made for 30 patients after the operation, no one lost the follow-up, the coxa vara deformity and limb shortening deformity did not occur among two groups of patients.

Tab.1 Result of operation duration、blood loss、radiation frequency in operation between two methods (n=15, Meana±SD)

Observation index	N	Operation duration	Blood loss	Radiation frequency
Conventional group	75	55.67±10.04	136±18.23	45±1.95
Computer group	75	43.96±9.23	113±9.84	27±1.00
t		-3.258	-5.529	-10.759
P		0.003	0.001	0.001

Tab.2 The successful rate of one-time nail placement between two methods

Group	One-time nail-placement success	One-time nail-placement failure	Total	Effective rate（%）
Computer aided group	64	11	75	85.3
Conventional operation group	36	39	75	48.0
Total	100	50	150	66.67

The fracture model printed with the application of computer aided design-rapid modeling technology was totally consistent with that in the operation, thus reflecting the basic condition of the lesion accurately and visually. All patients completed the surgery as scheduled, the operation process was smooth. In the computer aided group, the average operation duration was (43.96±9.23)rain, the blood loss was (113±9.84)ml; In the conventional operation group, the operation duration was (55.67±10.04)rain, and the blood loss was (136±18.23)ml, the radiation frequency in the operation was (45±1.95) times, and that in the computer aided operation group was(27±1.00) times, and the gap between two groups was of significant differences (P<0.05); The one-time nail placement success rate in the computer aided group was 85%, and that in the conventional operation group was 48%. The application of template to guide the nail placement improved the one-time nail placement success rate by 1.77 times, and the hip joint positive side X-ray effect was well in the postoperative re-examination.

Conclusion

Orthopedic 3D image computer aided diagnosis system improves the safety of operation, shortens the operation time and blood loss in the surgery. In the postoperative X-ray re-examination, the fracture reset, internal fixation and the patient's recovery are well with the application of Harris hip score, the coxa vara deformity and limb shortening deformity do not exist, thus significantly improving the effectiveness of the operation and reaching the preoperative expected effect. Compared with the shortcomings of traditional surgery such as totally depending on the human experience, insufficient accuracy, larger trauma, doctor and patient's repeated X-ray irradiation in the operation, the application of Orthopedic 3D image computer aided diagnosis system on the operation

is safe and accurate. The preoperative collected image can be used repeated in the operation[5], thus reducing the radioactive damage for the doctor and patient in the operation. Using the computer's high-speed processing and controlling ability on the digital medical image can provide the technical support for the orthopedist via the virtual operation environment, and make the operation become a more invasive, safe and accurate new technology.

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