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The Dynamic Visualization Application of 3ds Max in Organ Deceleration Injury

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Abstract *Objective* The dynamic visualization process of chest organs in the event of deceleration injury is to be constructed based on the PC in order to directly observe and und\erstand the injury process and mechanism of chest viscera in traffic deceleration injury.

Methods Firstly, combined with chest organ anatomy as well as the structure of spatial location and the abutting relationship, it constructed the main models of the chest organs and bones in the software of 3D Studio Max (version 2010) through the modeling method of edit mesh, mesh smoothing, UVW map and FFD, etc., to complete the 3D reconstruction and display of chest main organs. Secondly, based on the chest and abdomen high strength landing experimental conclusions, it completed the chest viscera injury process design through 3ds Max animation design principle and FFD software deformation technology.

Results Using 33ds Max technology, (1) it has well reconstructed the main organ morphology and structure of the chest; (2) it can do arbitrary scaling, rotating and mobile display in the three-dimensional space; (3) the dynamic visualization is very close to the experimental process of thoracic deceleration injury; (4) it can do display and observation from different perspectives on injury process.

Conclusions The 3D models reconstructed according to the real organ anatomy characteristics, are of strong sense of reality. Through the 3ds Max model visualization dynamic process, it can conveniently observe and understand the thoracic organ damage process and mechanism in the deceleration injury. It solves the visual problem and visual adjustment problems, to achieve a good simulation of three-dimensional effect.

Keywords: Forensic science; Traffic medicine; 3D studio max; Deceleration injury; Dynamics; Visualization; Organ; Model.

1 Introduction

As a major threat to human security, Road Traffic Trauma (RTT) causes about 1.2 million deaths each year in road traffic injury around the world according to statistics. [1] The thoracoabdominal viscera deceleration injury is common and is an important type in RRT injury. In recent years, the organ of deceleration injury has been widely reported in clinical reports [2] and experimental studies [3], but it is rare studied of the process reproduction for organ deceleration injury by the dynamic visualization technology.

3D Studio Max 2010 (Autodesk, USA) is a solution for 3D modeling, animation and rendering especially to the visual design, game, movie and TV.As the world's most widely used 3D animation software currently, it is to meet the new requirements of advanced design and visualization.

In this paper, this software is used for the main functional structure modeling on the chest and abdomen, and then, for the dynamic visualization of the chest viscera deceleration injury by its animation design function, to reproduce the effect of three-dimensional simulation process.

It has set up a visual multimedia platform for a more intuitive display and understanding of the deceleration injury process and mechanism on the internal organs.

2 Materials and Methods

2.1 The reconstruction of three-dimensional model

The precision of model and scene is key and foundation to the three-dimensional visualization simulation. Different from the reconstruction method which is processed in the 3D medical image software based on continuous sectional two-dimensional images [4], it reconstructed major thoracic and abdominal organs (skeletal, cardiac, lung, diaphragm, liver, stomach and kidney, etc.) with the help of 3ds max 2010 add graphite modeling tools, combining the organ anatomy characteristics and mutual relationship.

The model belongs to the low dimensional model, and its precision is

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lower to the digital model, but it can also meet the requirements of the visualization effect of three-dimensional simulation.

First of all, the scene was set in advance; to build the project folder and collect items required documents and materials. The system unit was set to mm, and the display unit was set to M.

Secondly, it created the basic body in view of corresponding viscera. At the same time, it loaded image files of organs in the viewport as model reference patterns.The basic body was converted to editable mesh, and then it adjusted and modified the five levels of vertices, edges, faces, polygons and elements of the editable mesh. Table 1 shows the structure modeling methods of each organ.

Finally, the model was optimized by adding mesh smoothing, FFD and other modifications. The performance of the texture model details was increased by adding textures, models of diffuse color, transparency, high light and other material parameters for the three-dimensional model.

2.2 The reproduction of injury process

The jnjury process dynamic visualization is the focus of this paper. The organ deceleration injury mechanisms and process has been found by us research group through early basic experiments [5]. In real life, the human thorax injury includes the acceleration injury and deceleration injury. The main factors of organ injury are not caused by the extrusion between organs and the thoracic-abdominal wall, but due to the compression collision of organs and the thoracic-abdominal wall by inertia continued movement, for the sudden deceleration of chest and abdomen in resistance to the deceleration movement.

In order to truly simulate the dynamic injury process in the organ deceleration injury, the basic visual scene was set up. On the basis of the human perspective modeling in the early stage, it used floodlight to set lighting. At the same time, a free camera was created in view. 3ds Max has two modes for creating key frames as Auto Key and Set Key. It can simply drag the time slider and parameter adjustment to run the Auto Key mode. This article created the dynamic simulation process of organ deceleration injury mainly through the Auto Key mode.

First of all, click [Auto Key] to activate the function in the 3Dmax view window. At the same time, open [Time Configuration] and set the frame rate as PLA with time length of 600 frames.

Secondly, this study focuses on the performance of chest viscera deceleration injury process, namely the main reproducing cardiopulmonary during deceleration injuries. Therefore, it is just an assisted reproduction process for the diaphragm, the abdominal cavity and the organ. It represents a perspective view of the moving human body model which suddenly encounters an obstacle from 0 to 200 frames, to simulate the formation of deceleration injury. In this process, the various organs of the human body in the perspective model are treated as a grouped object for keyframe settings. It represents a continued forward movement for the chest cardiopulmonary due to inertia in the case of a sudden body stop from 201 to 380 frames, which wounded directly colliding with the front side of the chest wall until its own inertia compression deformation reaching the maximum amplitude. In this process, there is no squeeze injury process for the back side of the chest wall to the heart and lungs, and this is the focus of the reproduction process in this article. From 381 to 550 frames, it represents the recovery process of the cardiopulmonary after the maximum compressed. In this process, there is a self deformation recovery process for the biological material properties of the cardiopulmonary. There is no dynamic settings from 551 to 600 frames.

Since it has very complex grid throughout the dynamic changing process for various organs, the Rigid Body Simulation method can not produce the real deformation of organs. Therefore, it can edit parameters of keyframes for each organ by the use of the FFD software modifications, to control the FFD crystal to achieve the overall deformation of the organ. Again, drag the time slider to various key points to adjust the camera view, and the view shows Smooth + High Light, in order to complete the dynamic setting of the camera view. Finally, set the rendering properties when the entire dynamic process in the camera view is ideally simulated, and output to AVI video files for the entire dynamic process. The entire rendering process may take a long time to complete.

3 Results

3.1 Three-dimensional model results

It reconstructed the morphology and structure of the major organs of the chest by 3ds Max, and the details of some of various organs were also well performed with a strong sense of reality. It reconstructed the spatial location of the vital organs of the chest and abdomen and adjacent relationship by arbitrarily scaling, rotating and moving in three-dimensional space. The reconstruction structure can be used alone or in combination to show injury process not only from a different perspective for display and observation, but also be able to adjust to the different perspectives.

Figure 1 to Figure 8 are perspective models of the body generated by 3ds Max as the diaphragm model, the lung model, the heart model, the liver model, the stomach model, the bone model and the kidney model.

3.2 The dynamic simulation results

In this paper, it reconstructed the dynamic process of the deceleration injury through automatic keyframing settings. The simulation results well reproduced the dynamic process of organ deceleration injury. The dynamic visualization is very closed with the chest deceleration injury experiments. It especially visually

Table 1. The structure modeling methods for organs.

	Heart	Lung	Diaphragm	Liver	Stomach	Kidneys	Abdominal aorta
Basic Objects	plane	rectangular	plane	line	sylinder	sphere	line
Modifier	Mesh Editing UVW Map	Mesh	FFD Meshsmooth	Loft FFD	FFD Noise	FFD Meshsmooth	Loft Mesh Editing

reproduced organs in the process of deceleration injury due to the direct collision of organs and chest wall because of the inertia, rather than the squeezing of the chest wall of the organs.

Figure 9 to Figure 15 are some key frames in the simulation process.


Fig. 1 The perspective model of human body.

4 Discussion

Chest trauma is the second cause of death in traffic injuries. In real life, the human chest injury includes the acceleration injury and the deceleration injury. From the pre basic experimental study, we found that, the traditional injury assessment based on the chest compression has great limitations. In order to simulate the dynamic process for chest organs in deceleration injuries more realistically, we carried out human injuries dynamic visualization technology, which has been demonstrated of great significance for the basic research of human injury.


Fig.2 The model of diaphragm muscle.

The reconstruction of the three-dimensional model of the human organs is the premise and basis of the 3D simulation of human injury. The morphology of human organs is very specific, and it is difficult for the three-dimensional reconstruction.

The group of Zhang Shaoxiang[4] (Third Military Medical University, China) has complete the three-dimensional reconstruction and visualization of the structure of various organs on the PC, concentrating various organs tomographic images based on the first digitized visible human data of China, by data partitioning,

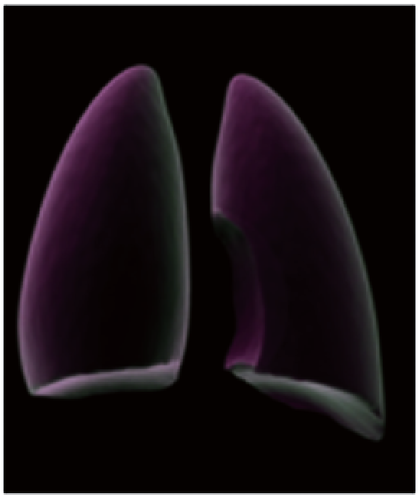
Fig.3 The model of lung.

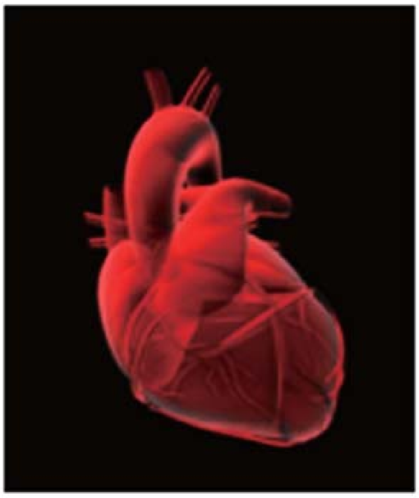
Fig.4 The model of heart.


Fig.5 The model of liver.


Fig.6 The model of stomach.


Fig.7 The model of bones.

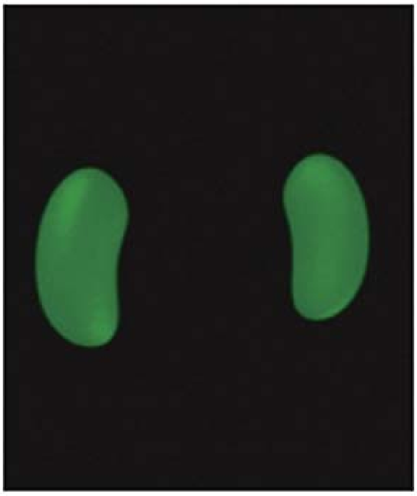
Fig.8 The model of kineys.

alignment reconstruction and three-dimensional display, to ensure a high accuracy of their models.

In this study, it is mainly through modeling capabilities of 3D Studio Max 2010 (Autodesk, USA) to complete the human organs three-dimensional reconstruction. And then, it combined materials and lighting features with software to complete the details of the performance of each structure. Although the accuracy of the model does not reach the accuracy of the digitized remodeling, it is also able to truly achieve the three-dimensional structure of the organ.

3ds max is for three-dimensional modeling, rendering and dynamic simulation and production softeware developed by Autodesk and based on the PC system. Its applications can be found reported [6, 7] in medical simulation.

With the rapid development of computer technology, medical image processing technology and information technology, and through the concerted efforts of clinicians and engineers and technicians, the accuracy of the three-dimensional modeling of human organs will be getting higher and higher, and simulation results will also be increasingly more authentic.

At the same time, 3D organs of simulation and visualization, built based on digitized visible human dataset, can be saved as max format file, if they can be combined with 3ds max software, both will be the basis of human injury research and have a broad application prospect.

Fig. 9 The 100 frame.

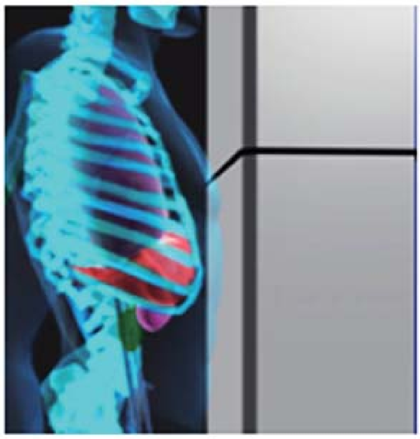

Fig. 10 The 200 frame.

Fig. 11 The 300 frame.

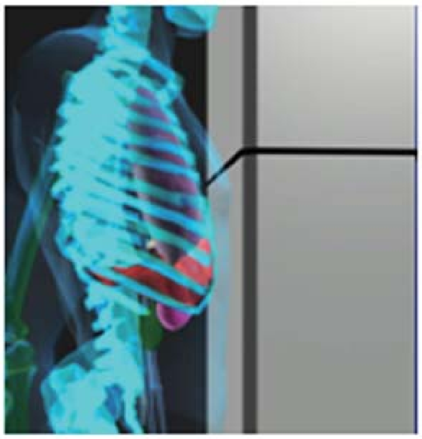

Fig. 12 The 380 frame.

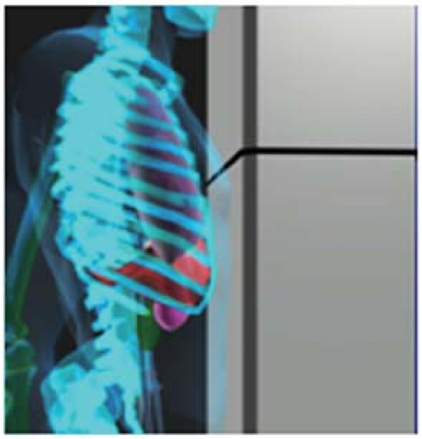

Fig. 13 The 450 frame.

Fig. 14 The 500 frame.

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Fig. 15 The 550 frame.