

A 3D system for training in endoscopic repair of subcondylar fractures of the mandible

Hueto J.A.<sup>1</sup>, Díaz J.<sup>2</sup>, Monclús E.<sup>3</sup>, Navazo I.<sup>2</sup>, Vázquez P.P.<sup>4</sup>, Raspall G.<sup>1</sup>

<sup>1</sup> Hospital Vall d'Hebron, Oral and Maxillofacial Surgery, Barcelona, SPAIN

<sup>2</sup> Universitat Politècnica de Barcelona, Departament de Llenguatges i Sistemes Informàtics, Barcelona, SPAIN

<sup>3</sup> CSIC, Institute of Robotics and Industrial Informatics, Barcelona, SPAIN

<sup>4</sup> Universitat Politècnica de Catalunya, LSI, Barcelona, SPAIN

Keywords Surgical training, Endoscopic simulation, Volume visualization

#### Introduction

Conventional treatment of the subcondylar fractures of the mandible is challenging because of the medial and anterior displacement of the condylar fragment and the limited surgical field. Proximity of facial nerve, carotid artery branches, parotid gland, and ear canal are risk factors to open surgical procedures. In these fractures a proper reduction and osteosynthesis are always difficult, even if using open procedures.

The recent endoscopic approach allows a perfect control and vision of the fragments, and it also permits an anatomic reduction and plating of the fracture avoiding risks associated to the open surgery.

Surgical training for these endoscopic procedures is difficult, especially in those cases in which surgeons are not familiar with endoscopic interventions and they still don't have skills to work while looking at the screen. Simulators are friendly and risk free systems to train surgeons to operate with endoscopes.

#### Methods

We have studied and determined the main features that a system for training of endoscopically assisted intraoral treatment of subcondylar fractures should have. We have developed a prototype system that focuses on training the surgeon in precise endoscopic examination and tools manipulation. In order to do this, we have created a virtual 3D model of a fractured mandible from the CT data of a real patient. Images were segmented semi-automatically and the noise generated by the capture process has been eliminated. We have opted by a hybrid model of surface and volume that eases the movement of structures and realistic volume renderings. The system allows simulating an interactive inspection of the fracture with a straight or a 30 degrees telescope, by rendering onto screen a similar image to the generated by a real telescope. Jointly with the model we may also visualize some surgical tools. The system incorporates additional functionalities that help the medical doctor understanding the relationship between the different structures and facilitate the training for endoscopic examination. As an example, it allows modifying the transfer function that enhances the rendering of the different structures and placing an additional virtual camera that offers a global view that better shows the depth. Displacement of the virtual model fragments may also be modified to simulate different fracture cases.

#### Results

Thus far, results suggest that our application has great potential for endoscopic surgical training. Navigation, visualization, shading, and interaction techniques require the system to have a modern graphics card such as Nvidia GeForce FX 8600 or superior in a commodity PC.

#### Conclusions

We have studied the specifications that a training system must fulfil in order to perform intraoral treatment of mandibular fracture training. We have designed and implemented some of them and the validity of the system is being currently analyzed. We are also working on the improvement of the interface and its adaptation to the clinical practice, particularly the interaction and navigation techniques. Future improvements of this prototype would include haptic devices to simulate the whole procedure with the fragment reduction and plating.