1. Introduction

Laryngoscopy is a procedure carried out by anaesthetists, in which the tongue of a patient is compressed and displaced to one side of the mouth using a rigid blade. A tube is subsequently inserted into the larynx to feed a mixture of oxygen and anaesthetic gas to the lungs. Sometimes this procedure can be difficult and even life threatening, and there is therefore a need for training anaesthetists to respond rapidly and correctly to a wide variety of circumstances occurring during laryngoscopy. Currently, plastic models of the head are used for this purpose, and these have many disadvantages. They are not realistic, they offer no variation, they do not attempt to simulate difficult airways, and there is no way of assessing the quality of the trainee. A computer based training system in which anaesthetists interact with simulated tissues is an attractive alternative [2]. We have approached the problem by developing a realistic computer model of the behaviour of the upper airways during laryngoscopy [1]. The model focuses on simulating tongue behaviour during the insertion of the laryngoscope blade through a three-dimensional finite element representation. We start from MR scans and X-ray films, extract the details that characterise the subject, and then incorporate these in a model to investigate how the tongue tissue behaves in response to the insertion of the blade, when it is subjected to a variety of loading conditions [3, 4, 5]. The mechanical properties of the tongue are complex. When deformed, there is a phase, in which the blood is squeezed out of it, followed by a compression phase. In particular, we have simulated the mechanical behaviour of the tongue from simple linear elastic to complex non-linear viscoelastic. The results show that, within a specific set of tongue material parameters, the simulated outcome can be successfully related to the experimental laryngoscopic studies. These biomechanical models and simulation prototypes proved capable of representing realistic information about the complex mechanisms involved and are being used to construct a computer based training system.
2. Implementation Status

The initial implementation was based on a commercial, general-purpose structural analysis software. An open system solution is being implemented and is currently on its final stages of development. Further research is underway to integrate these solutions with Web-based technologies. Users of such a system would, at different locations, set the model parameters and run the simulations on a remote machine, while visualising and interpreting the results on a low cost local machine to compute the deformations in real time and improve the visual realism of the images.

3. Expected Benefits

Performing simulated laryngoscopy offers the following advantages: there is more time to formulate effective strategies for expected and unexpected difficult laryngoscopy; current and new laryngoscope blade designs can be evaluated; a useful and safe environment can be provided for training anaesthetists, residents and medical students giving experience in both simulation and actual images; many different clinical cases can be analysed, recorded and assessed with greater flexibility and in a shorter time; a scientific basis for further hypothesis testing can be established. In addition, this virtual environment may be used to train anaesthetists by helping them to predict the outcome of the procedure.

References


