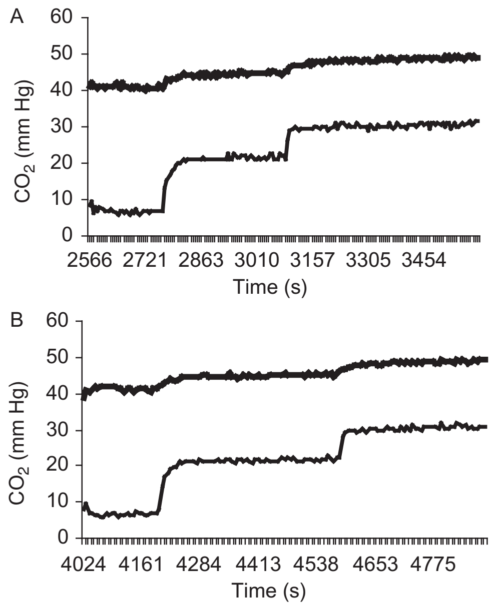

Fig 3 Typical first and second traces in one subject with 10 min rest between. (A) The upper trace shows the end tidal $P\text{CO}_2$ and (B) the lower, the inspired $P\text{CO}_2$.

a filtered mixture of oxygen, carbon dioxide, and nitrogen in concentrations determined by a blender and breathing out through a large tube acting as an alveolar gas reservoir followed by a one-way expiratory valve in parallel with a loaded inspiratory valve. Ventilation was monitored using a pneumotachograph in the expiratory limb. The inspired and expired $P\text{CO}_2$ was measured at the mouth. Once the subject was familiar with the breathing system they were introduced to an electronic breathlessness score. A light was moved between seven verbal scores from 0=no breathlessness to 7=extreme breathlessness.[2] Scores were measured every 30 s throughout the study. Measures were recorded for two $P\text{CO}_2$ levels after an initial trial run. The breathlessness scores were similar at the same $P\text{CO}_2$ but significantly different between the two $P\text{CO}_2$ levels (P<0.01 [Mann–Whitney U-test]). In this small group of subjects (Fig. 3) the stability of the breathing system and the repeatability of the scores at the different $P\text{CO}_2$ levels indicate that the method may be applicable to testing in patients.

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Keywords: carbon dioxide; partial pressure, end-tidal; respiration, breathlessness

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A shape model of the human mandible

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We have developed a shape model of the human mandible in which the main modes of variation can be visualized in three dimensions and studied. The model is controlled by a small number of parameters. It will be of use in obtaining a better understanding of the geometry of the mandible and the shape factors that contribute to difficult intubation. We hope to combine the model with our earlier work on finite element modelling of the tongue,[1] to produce a full model of the human upper airway, which can be incorporated in computer simulations for medical education, training and pre-operative prediction of difficult laryngoscopy.

CT scans of 10 dry human mandible specimens were used to build the model. The images were segmented by hand to remove imaging artifacts and to eliminate the internal air spaces. One of the 10 sets was then selected as a base, and the other nine were registered to it.[2] The registration process deforms an image set so that it matches the base set. The correspondence between each surface point of the image set and the base image set can then be found. The surface geometry of the base image set was found by first using the marching cubes algorithm, which provides a fine triangulation of the surface. The set of triangles produced by this method was then decimated using standard techniques to find a small set of triangles that represents the geometry accurately. Each coordinate of each vertex of this set was taken as a variable and principal component analysis was used to find the main modes of variation in the set. The principal components can be used to reconstruct any mandible shape that is a linear combination of the others.

The largest mode of variation in the data sets was a result of the different sizes of the specimens. However, shape changes, such as elongation, could also be observed. Some smaller modes of variation were caused by the shape, position, or absence of teeth. The work clearly demonstrates the potential of shape models to encode the geometry of the human mandible in a quantitative form suitable for use in accurate simulation of the human airway. However, the results are preliminary and further work is being undertaken on a number of aspects. These include increasing the sample size, which will increase the degree to which the model can represent the whole population and segmenting the teeth from the image sets to prevent their masking more interesting modes of variation. In the long term we plan to investigate whether there are simple external measurements that can be used to determine the mandible shape with reasonable accuracy without the need for scanning a patient.

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Keywords: model, mandible

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Use of a multi-scenario questionnaire to investigate management option considerations by anaesthetists for difficult airway/difficult laryngoscopy

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Anaesthetists are concerned about anaesthetized patients with a difficult airway. For difficult laryngoscopy, perhaps what matters most is whether the larynx can be visualized. Unambiguous communication can be a problem when patients have had problems with either. A scenario questionnaire was designed to explore how