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Anatomical analysis to establish the optimal positioning of an osteotomy for genioglossal advancement: a trial in cadavers

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Abstract

Genioglossal advancement, which is one of the treatments for obstructive sleep apnoea, can be effective only if it contains enough genial tubercle for an osteotomy. The aim of this study was to establish the position of the genial tubercle and of the optimal osteotomy during genioglossal advancement. Twenty-four adult cadavers with intact bony mandibular structures were included. Five variables were measured: the width and height of the genial tubercle (GTW); the distance from its inferior border to the inferior border of the mandible (IGT-IBM); the distance from the superior border of the genial tubercle to the inferior border of the mandible (SGT-IBM); and the width of the intermental foramen (IMFW). The following mean (SD) (range) measurements were obtained: GTW 7.38 (1.43) (4.5–10.0); GTH 7.94 (1.45) (5.0–10.0); IGT-IBM 7.96 (2.29) (4.0–12.0); SGT-IBM 15.90 (2.29) (12.0–20.0); and IMFW 56.65 (6.44) (43.0–67.0) mm. Of the 24 cadavers, 22 showed evidence of optimal positioning when the osteotomy was placed 2 mm higher than the SGT-IBM measured on the inner table. This suggests that an optimal osteotomy, which includes the genial tubercle, may be possible in most patients when the osteotomy is positioned 2 mm higher at the SGT-IBM.

Keywords: Genial tubercle; Genioglossus muscle; Genioglossal advancement; Mandible; Osteotomy; Obstructive sleep apnea; Cadaver

Introduction

Genioglossal advancement is a popular procedure for the treatment of the level of the tongue base in obstructive sleep apnoea,[1] and it is based on a mandibular osteotomy that brings the genioglossus muscle forward and prevents posterior collapse during sleep.[2] Its effectiveness has been validated repeatedly, although the degree of success has varied. It has recently undergone several modifications, each of which has attempted to minimise morbidity while improving the incorporation and advancement of the genioglossus muscle.[3,4] Adequate advancement of the genial tubercle is most important to maximise the surgical effect.[1–6] Positioning of the osteotomy is important for this, but we do not know of enough studies to provide a precise understanding of optimal positioning.

There have been efforts to establish the location of the genial tubercle using cephalometry,[5,6] but it is difficult because of the limited images. According to our recent research using 3-dimensional computed tomography (CT), the location varies from case to case.[7] It has also been proved that genioglossal advancement may not work for some patients because of anatomical or structural limitations.[7] Previous studies have shown that there is no difference in the width of the genial tubercle depending on the angle or curva-

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ture of the mandible, but the position along the same height as the upper margin may differ from the outer table to the inner table.[5,6] However, 3-dimensional CT can be used to measure the position or size of the genial tubercle only on the inner table of the mandible.[7] The results of previous imaging studies using 3-dimensional CT, therefore, have some limitations when applied to actual operations, because an osteotomy is made assuming the position of the genial tubercle, based on the outer table of the mandible during genioglossal advancement. There might therefore be visible differences in the operative field that could help establish the optimal positioning of the osteotomy on the outer table.[5,6,8]

The aim of this study was to establish the positions of the genial tubercle and the mental foramen in cadavers, together with the optimal position for osteotomy in relation to the outer table, using the measurements of the genial tubercle on the inner table.

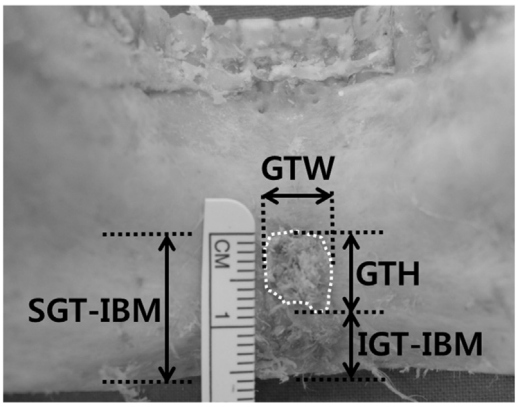

Fig. 1. The abridged general view of anatomical measurements (back view). GTW = width of genial tubercle; GTH = height of genial tubercle; IGT-IMB = distance from the inferior border of the genial tubercle to the inferior border of the mandible; and SGT-IMB = distance from the superior border of the genial tubercle to the inferior border of the mandible.

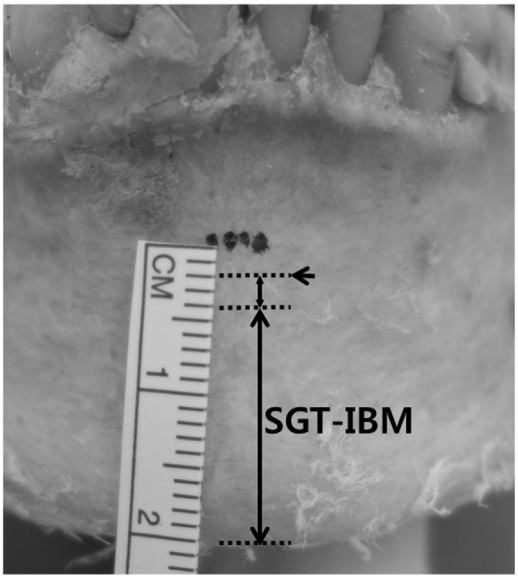

Fig. 2. The abridged general view of anatomical measurements (front view). Drilling site = a hole was drilled in the outer table of the mandible 2 mm higher than the SGT-IBM of the inner table SGT-IMB = distance from the superior border of the genial tubercle to the inferior border of the mandible.

Material and methods

Cadaver study

Twenty-four formalin-fixed adult human skulls with intact bony mandibular structures were selected for the study. All subjects had donated their bodies for scientific research to the Department of Anatomy at a tertiary university hospital. The inclusion criteria were as follows: age 18 years or over; intact bony mandible; no obvious facial asymmetry, history of facial trauma, or congenital craniofacial anomaly; and no previous operation on the anterior mandible. The skulls were identified by sex and dentition.

The cadaver was dissected to expose the mandible using a gingivobuccal incision around the mandible and posteriorly to expose the genial tubercle. All soft tissues were removed from the anterior and posterior aspects of the mandible. A single investigator (SYJ) then measured five variables using calipers, including the following: width of GT (GTW); height of GT (GTH); distance from the inferior border of the GT to the inferior border of the mandible (IGT-IBM); distance from the superior border of the GT to the inferior border of the mandible (SGT-IBM); and the width of the intermental foramen (IMFW) (Figs. 1 and 2).[7] To reduce errors of measurement, all measurements were repeated on two separate occasions at two weekly intervals, and the mean values were recorded.

While we were taking measurements, we decided to display the measured value SGT-IBM from the inner table to the outer table, and then implement superior horizontal osteotomies at 0, 2, and 4 mm superior to that point (Fig. 2B). The osteotomy that is used in clinical operations was omitted for convenience, and drilling with a 1.5 mm cutting burr was used instead. Drilling was done vertically to the anterior surface of the mandible. During drilling, the drill was supported by a thick steel guide to maintain its insertion angle and vertical direction. After the drilling was complete, inclusion of the genial tubercle within the drilling site was established, and marked on the cadavers. According to the drilling results, when the drill did not pass through the genial tubercle the advancement was considered a success; when it did, it was considered a failure (Fig. 3).

The study was approved by our institutional review board. Before death all donors had signed formal agreements to consent to the use of their bodies for research, so no other form of consent was required.

Statistical analyses

All calculations were made with the aid of IBM SPSS Statistics for Windows (version 20.0, IBM Corp). An intraclass

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