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Papercraft temporal bone in the first step of anatomy education

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ABSTRACT

Objective: (1) To compare temporal bone anatomy comprehension taught to speech therapy students with or without a papercraft model. (2) To explore the effect of papercraft simulation on the understanding of surgical approaches in first-year residents.

Methods: (1) One-hundred and ten speech therapy students were divided into three classes. The first class was taught with a lecture only. The students in the second class were given a lecture and a papercraft modeling task without instruction. The third class modeled a papercraft with instruction after the lecture. The students were tested on their understanding of temporal bone anatomy. (2) A questionnaire on the understanding of surgical approaches was completed by 10 residents before and after the papercraft modeling. The papercraft models were cut with scissors to simulate surgical approaches.

Results: (1) The average scores were 4.4/8 for the first class, 4.3/8 for the second class, and 6.3/8 for the third class. The third class had significantly better results than the other classes ($p < 0.01$, Kruskal–Wallis test). (2) The average scores before and after the papercraft modeling and cutting were 2.6/7 and 4.9/7, respectively. The numerical rating scale score significantly improved ($p < 0.01$, Wilcoxon signed-rank test).

Conclusion: The instruction of the anatomy using a papercraft temporal bone model is effective in the first step of learning temporal bone anatomy and surgical approaches.

1. Introduction

Understanding temporal bone anatomy is crucial for otolaryngologists, as well as for every medical staff member involved in the treatment of an individual with hearing loss. However, the three-dimensional anatomy of the temporal bone is complicated and teaching with slides and textbooks is insufficient. Temporal bone dissection using a human cadaver is the gold standard educational program; however, human cadavers are limited and not available for all medical staff members who want to understand the temporal bone anatomy [1]. Recently, high quality artificial temporal bones have been attained [2,3]; however, artificial temporal bones remain expensive and require facilities that have a microscope and drilling system. Computer simulation is becoming realistic [4,5]. However, even with the improvements, computer simulation is not intuitive. In addition, it requires a haptic device, which makes it inadequate for use with lecturing in a large classroom. These high-quality teaching materials are designed primarily for medical doctors and residents; very few materials are available for medical students and paramedical staff members, including speech pathologists.

In 2011, Araki and his colleagues reported the effectiveness of a 3D paper model for learning paranasal sinus anatomy [6]. In this study, we developed a papercraft temporal bone

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model and explored its effectiveness in mastering temporal bone anatomy and surgical approaches.

2. Papercraft temporal bone

The papercraft temporal bone is composed of four pieces of paper (Fig. 1A), and it forms a double-shelled box (Fig. 1B and C). The outer shell represents a temporal bone. The inner shell is further divided into lateral and medial compartments. The lateral compartment is the external auditory canal, and the medial compartment is the tympanic cavity. The inner shell has an opening between the attic and the tympanic cavity. A thin box is set at the floor of the outer shell to make the floor of the attic and the mastoid shallower than that of the tympanic cavity. The ossicles are attached to the oval window and the tendon of the tensor tympanic muscle. The ossicles, the facial nerve, and the eminence of the lateral semicircular canal, among other structures, are arranged in a simple rectangular fashion to facilitate understanding. After completion of the papercraft modeling, simulating the surgical approach including posterior tympanotomy (Fig. 1D), transcanal atticotomy (Fig. 1E), and canal wall-down mastoidectomy (Fig. 1F) is possible by cutting part of the shell with scissors.

The template of the papercraft temporal bone is accessible on the internet (http://temporalboneanatomy.blogspot.jp/).

3. Materials and methods

Two experiments were conducted to show the effectiveness of using a papercraft temporal bone for teaching temporal bone anatomy and the surgical approach. In total, 120 participants (110 in experiment 1 and 10 in experiment 2) were included.

3.1. Experiment 1

An examination was conducted of 110 students attending a speech therapy school (Kyoto College of Medical Health). There were 67 females and 43 males, ranging from 22 to 46 years of age (mean 28.3 years). The students were divided into three groups. The average ages of the three groups were similar (28.1, 28.5, and 28. 3 years old respectively, $p = 0.97$, one-way analysis of variance test). The proportion of males was comparative high in group 1 but the difference was not significant (18 females and 17 males in group 1, 23 females and 15 males in group 2, and 26 females and 11 males in group 3, $p = 0.20$, chi square test). The first group was taught by lecture only. In this group, the students received lectures using conventional slides and 3D slides with an anaglyph and were able to touch and view an artificial temporal bone. The second group received a lecture and modeled a papercraft temporal bone without instruction. The third group received a lecture, followed by instruction in modeling the papercraft; the anatomical landmarks and their relationships were taught using the papercraft model. In the second and third group, the lecture was done with conventional slides. The length of the lecture for each class was identical. Subsequently, all students underwent an examination on basic temporal bone anatomy. The examination is composed of eight questions using the following format: the malleus is (anterior/posterior) to the incus, the oval window is (anterior/superior/posterior/inferior) to the round window, and so on. Two questions are about the ossicles; two questions are about the inner ear; three questions are about the facial nerve; one question is about the Eustachian tube; and one question concerns the relationship among the stapes, facial nerve, and lateral semicircular canal.

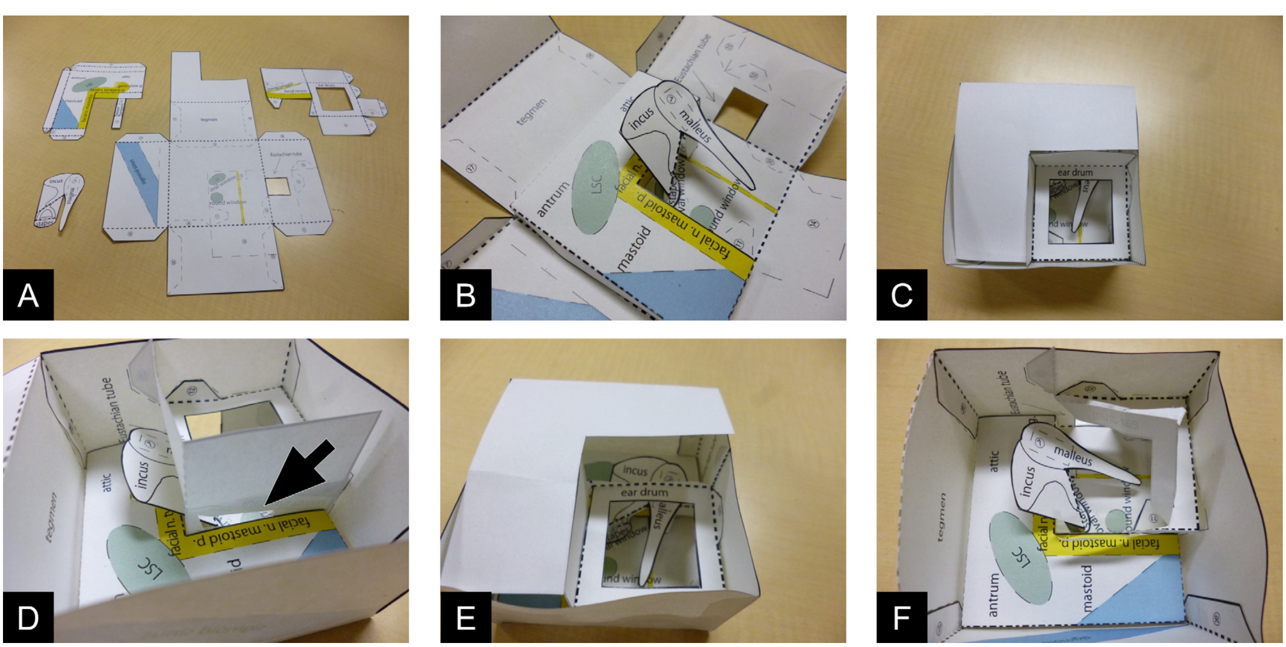

Fig. 1. The model is composed of four pieces (A). The ossicles, the facial nerve, the eminence of the lateral semicircular canal, etc. are arranged in a rectangular fashion (B). After the completion of a right ear papercraft model (C). Posterior tympanotomy (arrow) (D), transcanal atticotomy (E), and canal wall-down mastoidectomy (F) can be simulated by using scissors.