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# Head motion may help mouth opening in children

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ABSTRACT

Concomitant head and mandibular movement during jaw function is well known in adults; however, its importance in children has not been studied. The brain attains 85–90% of its adult weight at 5 years of age, though the maximum rate of condylar growth is attained at approximately 14 years of age. These findings suggest that the coordination of the head and mandible may differ between children and adults. This study investigated head and mandibular movements of 19 children with complete primary dentition (average age: 5 years 5 months) and compared their functional integration of jaw and head movements to those of 16 female adults (average age: 20 years 3 months) with permanent dentition. Although the mandibular opening distance was significantly greater in the adults, the magnitude of concomitant head motion was greater in children. The results suggest that head extension in children helps increase the magnitude of mouth opening more than in adult women.



## 1. Introduction

Concomitant head movements during various kinds of human activities have been studied for the last three decades. Some studies focused on whole body movements such as walking,[1–3] hopping[2–5] and running.[5] These reports clearly established that head and trunk movements are coordinated during these tasks. Coordination of head and mandibular movements has also been reported during tooth tapping,[6–9] opening or open–close movements[8,10–15] and masticatory movement.[16,17] These articles also suggested a close functional integration between the temporomandibular and the cranio-cervical motor systems during mandibular movement, probably controlled by a common central nervous network.[7] Development of this coordination has not been investigated, and no articles have looked for these coordination patterns in young children.

The postural capacity of children to control balance with their leg muscles is not attained before 4–5 years of independent walking, *i.e.*, at about 5–6 years of age.[18] By 7 years of age, the adult muscle-activation pattern is complete,[19] whilst head control and head–trunk coordination,[20] integration of body parameters[1,21] and development of anticipatory postural adjustments[1,22] require at least 8 years of walking experience. Given this slow development, coordinated head and mandibular movements of young children might be expected to differ from those of adults.

The aim of the present study was to look for differences in the integration of mandibular and head movements in children with primary dentition and in adults with permanent dentition. The tested null hypotheses were (1) that the magnitude of head motion in children during the habitual open–close motion, which is one of the simplest mandibular movements, is the

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same with that of adults, and (2) that concomitant mandibular and head motions are not established in children.

## 2. Materials and methods

### 2.1. Human subjects and measured movements

Nineteen children (10 girls and 9 boys) with healthy primary dentition were selected for the study. Their ages ranged from 4 to 7 years (average: 5 years and 5 months). They had no dental caries, or only slightly restored teeth. The occlusion of all subjects was normal (less than 1 mm deviation of midline, proper overjet and overbite, no transversal and vertical malocclusion), and none had a history of orthodontic treatment. Temporomandibular joints were without pain or clicking, and the masticatory muscles were without pain in all subjects. Both condyles were able to move smoothly, and no subjects had a history of temporomandibular dysfunctions.

The aim of this study was to investigate head and mandibular movements of normal children with primary dentition. For comparison, we needed a control group that most investigators could agree had normal head and mandibular movements. Because mandibular movements tend to be larger in adult males than adult female females,[23] we considered adult females to be a better control group to compare with children. Sixteen healthy dentate female subjects with permanent dentition, aged between 19 and 24 years (average: 20 years and 3 months), participated in this study.

The objectives, procedures, methods, benefits and disadvantages of the experiment were explained in detail to each subject or his or her parents. Prior to entering the study, informed consent (which was reviewed and approved by the Ethics Committee of the Faculty of Dental Science, Kyushu University) was obtained from each subject or their parents if the subjects were children.

The subjects were seated upright, without restriction of the head, and with the Frankfort Horizontal plane parallel to the floor at the start of the experiment. Before the tests began, each subject was instructed to open and close his or her mouth smoothly. Starting from the intercuspal position, each open–close motion was recorded using the optoelectric system described below. Open–close movements were recorded 3–5 times for each subject, resulting in 87 and 88 movements from the children and adults, respectively.

### 2.2. Recording head and mandibular motion

Head and mandibular motion was recorded using an optoelectronic analysis system with six degrees-of-freedom (TRI-MET, Tokyo-Shizaisha, Tokyo, Japan) at a sampling frequency of 100 Hz. The TRI-MET is a light, non-contact measuring device that allows precise three-dimensional tracking without obstructing occlusion and functional movements. The accuracy of this optoelectronic instrument in bench tests is better than 0.19 mm. This value represents the distortion within the range of 200 mm × 200 mm × 200 mm from the centre of the measuring fields.[24]

The medial tip of the left lower primary central incisor in the children and left lower permanent central incisor in the adults were used as reference points on the mandible. The medial tip of the maxillary left upper incisor was used as the reference point for head movement.[25]

To compare head and mandibular movements, head movement was recorded relative to the TRI-MET camera's reference frame (*i.e.*, earth reference) (Fig. 1) and the mandibular movements were measured both relative to the subject's head and the earth reference. The coordinate system for mandibular movement relative to the head was the Frankfort Horizontal plane (*i.e.*, auriculo-orbital plane), defined by using right and left porion and left orbitale as the *x*–*y* plane. The lateral axis was defined as a line passing through porion of both sides, and the posterior–anterior axis was defined as a perpendicular line passing through the medial tip of the maxillary left incisor. Because the subjects were seated upright with the Frankfort Horizontal plane parallel to the floor, mandibular position relative to the head and the earth reference should be close at the start of mouth opening.

### 2.3. Data preparation and measurements

A computer programme automatically identified the frame numbers (*i.e.*, time) for (1) the beginning of mouth opening from the intercuspal position, (2) the beginning of closing, and finally (3) the end of closing near the intercuspal position. At each frame, the maximum head vertical distance of maxillary movement from the intercuspal position at the earth reference (head distance, HD; Fig. 2B), the maximum head rotation angle from the intercuspal position relative to the earth reference (head rotation angle, HRA; Fig. 2C), the maximum mandibular vertical distance from the intercuspal position

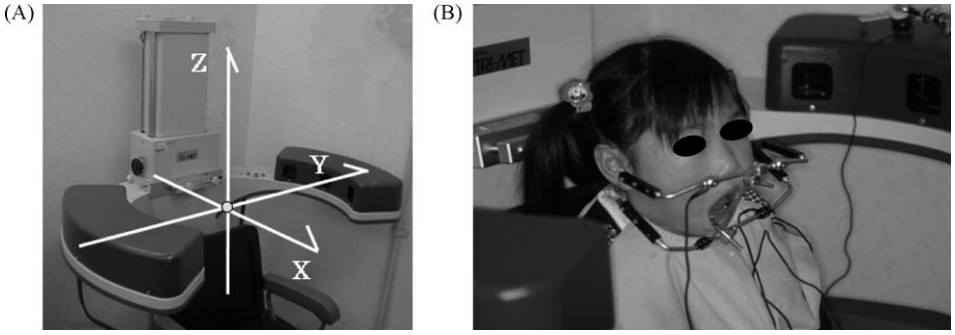


**Fig. 1 – Coordinate system of the TRI-MET. (A) TRI-MET measurement system and each superimposed axis. (B) Measurement of a child's habitual mouth opening motion.**