

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

ScienceDirect

journal homepage: <http://www.elsevier.com/locate/aob>

## Stage I intraoral food transport: Effects of food consistency and initial bolus size

Shinya Mikushi<sup>a,b,\*</sup>, Sosuke Seki<sup>a,c</sup>, Martin B. Brodsky<sup>a</sup>, Koichiro Matsuo<sup>d</sup>, Jeffrey B. Palmer<sup>a,e</sup>

<sup>a</sup>Department of Physical Medicine and Rehabilitation Medicine, Johns Hopkins University, 600 North Wolfe Street, Phipps 160, Baltimore, MD 21287, USA

<sup>b</sup>Department of Gerodontology Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo, Tokyo 113-8549, Japan

<sup>c</sup>Department of Rehabilitation Medicine Kawasaki Medical School, 97 Matsushima, Kurashiki, Okayama 701-0192, Japan

<sup>d</sup>Department of Dentistry, Fujita Health University, 1-98 Dengakugakubo, Kutsukake, Toyoake, Aich 470-1192, Japan

<sup>e</sup>Department of Otolaryngology-Head and Neck Surgery and Center for Functional Anatomy and Evolution, Johns Hopkins University, 600 N. Wolfe St., Phipps 160, Baltimore, MD 21287 USA

### ARTICLE INFO

#### Article history:

Received 1 October 2013

Received in revised form

18 December 2013

Accepted 2 January 2014

#### Keywords:

Mastication

Deglutition

Oral cavity

Tongue

Fluoroscopy

### ABSTRACT

**Objective:** We examined the temporospatial characteristics of stage I oral food transport, in which a piece of solid food is moved from the anterior oral cavity to the postcanine region for chewing. Anteroposterior transport is accomplished by carrying food posteriorly on the surface of the tongue, in contrast to the squeeze-back mechanism of stage II transport from the oral cavity to the pharynx.

**Design:** There were two experiments (Exp1 and Exp2): In Exp1, Twelve healthy young adults ate 2 g, 4 g, 6 g, 8 g 12 g initial bolus sizes of banana and cookie; in Exp2, fourteen similar subjects ate 6 g of banana and cookie with and without radiopaque tongue surface makers. Motions were recorded with videofluorography in lateral projection.

**Results:** Stage I transport duration was longer for cookie than banana ( $P \leq .025$ ), but there were no significant durational differences among initial bolus sizes. With cookie, tongue pullback was more frequent for small (2 g and 4 g) than large (12 g) bolus sizes ( $P \leq .048$ ). With banana, however, the frequency of pullback was independent of initial bolus size. Kinematic analysis of tongue pullback revealed that the lower jaw opened as the tongue and hyoid bone moved both posteriorly and inferiorly; the magnitude of these displacements did not vary significantly between banana and cookie.

**Conclusions:** We conclude that stage I transport is a complex behaviour involving posterior and inferior displacement of the tongue, jaw and hyoid bone. Its frequency of occurrence is related to initial bolus size and consistency, but the magnitude of displacement is relatively constant.

© 2014 Elsevier Ltd. All rights reserved.

\* Corresponding author at: Department of Gerodontology Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo, Tokyo 113-8549, Japan. Tel.: +81 3 5803 5561; fax: +81 3 5803 5561.

E-mail address: [sirokori5@yahoo.co.jp](mailto:sirokori5@yahoo.co.jp) (S. Mikushi).

0003-9969/\$ – see front matter © 2014 Elsevier Ltd. All rights reserved.

<http://dx.doi.org/10.1016/j.archoralbio.2014.01.002>

## 1. Introduction

Human swallowing is traditionally divided into sequential oral preparatory, oral propulsive, pharyngeal, and oesophageal stages.<sup>1</sup> Development of this model was based on observations of liquid barium swallows, but it does not fully reflect the sequence of events in eating solid food. Several investigators have used cine- or video-fluoroscopy to examine mastication and oral food transport in non-human mammals eating solid food.<sup>2–7</sup> These reports led to the development of the “Process model of Feeding” by Hiimeae and colleagues.<sup>8</sup>

The Process model describes two distinct processes of anteroposterior oral food transport. In stage I transport, an ingested and/or incised piece of solid food is moved from the anterior oral cavity to the post-canine region for mastication. In stage II transport, triturated (fully reduced) food is squeezed posteriorly between the tongue and palate and thus propelled from the oral cavity to the pharynx for swallowing.

The present study addresses the mechanism of stage I transport. Prior studies suggested that stage I transport includes two sequential behaviours. Firstly, food is carried posteriorly as it sits on the superior surface of the tongue; we call this mechanism “tongue pullback” to differentiate from the “squeeze-back” mechanism of stage II transport. Secondly, the tongue rotates and deposits the food bolus on the occlusal surfaces of the postcanine teeth in preparation for chewing.<sup>11</sup> Stage I transport has been studied with foods of differing physical consistencies.<sup>8,12,13</sup> Okada et al.<sup>14</sup> reported that the duration of transport was closely bound to the texture recognition process in subjects eating rice sticks. Tongue pullback was noted in all subjects.

In the present study, we examine the frequency and duration of stage I transport in relation to bolus size and consistency and analyse the kinematics of stage I transport in healthy adult volunteers.

## 2. Material and method

### 2.1. Data collection

Healthy asymptomatic young adults were recruited to determine patterns of normal movement during eating and swallowing with videofluorography. This study consisted of two experiments; both protocols were approved by the Institutional Review Board. All participants gave oral and written informed consent. Participants had normal dentition with class I occlusion. No participant had a history of major medical problems, dysphagia, or gastroesophageal reflux disease. Each participant demonstrated normal oral and pharyngeal swallowing of liquid barium (barium/water, 50%, w/v ratio) on videofluorography (VFG) in the lateral and anteroposterior projections. We use the term VFG to emphasise that these were not clinical videofluoroscopic swallowing study protocols. The experiments were performed sequentially; data collection for experiment 1 were completed prior to experiment 2. Different subjects were included in the two experiments to avoid excessive radiation exposure.

Participants were instructed to eat the foods in their usual manner while seated comfortably in a chair. Subjects were instructed to minimise head movements; this was facilitated by placing a firm headrest in gentle contact with the occiput.

### 2.2. Experiment 1

There were 12 participants in experiment 1 including 7 males (age  $24.1 \pm 2.3$  years [mean  $\pm$  SD], range 22–29) and 5 females (age  $22.4 \pm 1.1$  years, range 21–24). Each participant ate 2 g, 4 g, 6 g, 8 g and 12 g samples of banana and cookie (shortbread fingers; Carr’s of Carlisle, Carlisle, UK). These foods were selected to provide a soft food (banana) and a hard food (cookie). Food samples were presented in random order with respect to both bolus size and consistency. Foods were lightly coated with barium sulphate powder and placed in the participant’s anterior oral cavity by the examiner.

### 2.3. Experiment 2

There were 14 different participants in experiment 2 including 5 males (age of  $22.4 \pm 4.5$  years, range 19–30) and 9 females (age  $21.6 \pm 4.1$  years, range 18–31). Radiopaque markers (small lead discs of 4 mm diameter and 0.4 mm thickness) were glued to the buccal (lateral) surfaces of the right upper and lower canines and right upper first molars with dental cement (Ketac, ESPE-Premier Sales Corp., Norristown, PA); these served as reference points for kinematic analysis (see Data Reduction). Two additional radiopaque markers were glued to the dorsal surface of tongue. The tongue markers were placed in the midline: an anterior tongue marker (ATM) as close to the tongue tip as possible and a posterior marker (PTM) as far posterior as possible without eliciting the gag reflex. The distance between the tongue markers thus varied slightly among subjects but averaged about 2 cm. To prevent injury of soft tissue, the tongue markers and dental cement were gently removed after the experiment using dental instruments. The dental cement did not adhere so tightly to the mucosa as to cause tissue injury by its nature.

Each participant ingested 6 g of banana and 6 g of cookie with and without tongue markers for a total of four trials each. Foods were lightly coated with barium sulphate paste (Varibar; E-Z-EM Inc. NY USA) and placed in the anterior oral cavity by the examiner. No barium was used in the trials with tongue markers as barium occluded the markers on fluoroscopy. Positioning and instructions were as described for experiment 1.

### 2.4. Data reduction

Each VFG recording included the complete feeding sequence from ingestion through the completion of the terminal swallow. VFG was performed in the lateral projection at 30 frames per second and archived on a digital video recorder. A time stamp was simultaneously recorded and overlaid on each video frame. Recordings were converted to digital video files (.avi) for kinematic analysis.

We examined movement of the lower jaw (LCM), tongue markers and hyoid bone and the barium bolus (when present) during stage I transport using the slow-motion and stop-frame

Download English Version:

<https://daneshyari.com/en/article/3120940>

Download Persian Version:

<https://daneshyari.com/article/3120940>

[Daneshyari.com](https://daneshyari.com)