

Original Paper

# Taste and Temperature in Swallowing Transit Time after Stroke

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## Key Words

Stroke · Sour taste · Cold temperature · Deglutition, pharyngeal phase · Videofluoroscopy

## Abstract

**Background:** Oropharyngeal dysphagia is common in individuals after stroke. Taste and temperature are used in dysphagia rehabilitation. The influence of stimuli, such as taste and temperature, on swallowing biomechanics has been investigated in both healthy individuals and in individuals with neurological disease. However, some questions still remain unanswered, such as how the sequence of offered stimuli influences the pharyngeal response. The goal of the present study was to determine the influence of the sequence of stimuli, sour taste and cold temperature, on pharyngeal transit time during deglutition in individuals after stroke. **Methods:** The study included 60 individuals with unilateral ischemic stroke, 29 males and 31 females, aged 41–88 years (mean age: 66.2 years) examined 0–50 days after ictus (median: 6 days), with mild to moderate oropharyngeal dysphagia. Exclusion criteria were hemorrhagic stroke patients, patients with decreased level of consciousness, and clinically unstable patients, as confirmed by medical evaluation. The individuals were divided into two groups of 30 individuals each. Group 1 received a nonrandomized sequence of stimuli (i.e. natural, cold, sour, and sour-cold) and group 2 received a randomized sequence of stimuli. A videofluoroscopic swallowing study was performed to analyze the pharyngeal transit time. Four different stimuli (natural,

cold, sour, and sour-cold) were offered. The images were digitalized and specific software was used to measure the pharyngeal transit time. Since the values did not present regular distribution and uniform variances, nonparametric tests were performed. **Results:** Individuals in group 1 presented a significantly shorter pharyngeal transit time with the sour-cold stimulus than with the other stimuli. Individuals in group 2 did not show a significant difference in pharyngeal transit time between stimuli. **Conclusions:** The results showed that the sequence of offered stimuli influences the pharyngeal transit time in a different way in individuals after stroke and suggest that, when the sour-cold stimulus is offered in a randomized sequence, it can influence the response to the other stimuli in stroke patients. Hence, the sour-cold stimulus could be used as a therapeutic aid in dysphagic stroke patients.

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## Introduction

Oropharyngeal dysphagia is a common manifestation in individuals after stroke [1]. The traditional therapy of dysphagic individuals involves sour taste and cold temperature [2].

Many studies have investigated the influence of taste and temperature on swallowing, showing changes in the oral and pharyngeal phases when individuals swallow boluses of different taste and temperature [2–7]. Cold temperature reduces the time of the pharyngeal phase in individuals with oropharyngeal dysphagia [8]. Cold and hot temperatures differ from the intraoral mucosal temperature. Such stimuli may increase subject awareness of the bolus, modifying the pharyngeal response [9]. However, some studies did not find changes in the oral or pharyngeal phases with boluses of different taste and temperature [10–12].

Sensory input is crucial to the initiation and modulation of swallowing and promotes changes in neuronal circuits. Damage to sensory information due to oral anesthesia reduces both the sensory feedback and the cortical control of swallowing [13]. Therefore, sensory stimuli, such as taste and temperature, may cause changes in swallowing. The hypothesis has been raised that sour taste and cold temperature can influence the bolus pharyngeal transit time, determined by the order of stimulus offering. The aim of the present study was to determine the influence of the sequence of stimuli, i.e. sour taste and cold temperature, on pharyngeal transit time in deglutition of individuals after stroke.

## Methods

### *Study Population*

The study population consisted of 60 individuals, right-handed adults with unilateral ischemic stroke, 29 males and 31 females aged 41–88 years (mean age: 66.2 years), investigated 0–50 days after the ictus (median: 6 days) and with mild to moderate oropharyngeal dysphagia. The individuals were divided into two groups of 30 individuals each. Group 1 (G1) received nonrandomized sequences of stimuli and group 2 (G2) received a randomized sequence of stimuli.

The study protocol was approved by the Research Ethics Committee, School of Medicine, State University of São Paulo, UNESP, Botucatu, SP, Brazil. All patients or their legal representatives in the study protocol were aware of the test and gave free and informed consent to participate in the study.

Exclusion criteria were hemorrhagic stroke patients, patients with decreased level of consciousness, and clinically unstable patients, as confirmed by medical evaluation. All individuals were submitted to neuroimaging examination to confirm the laterality of brain lesions.

### Method

A videofluoroscopic swallowing study was performed to analyze pharyngeal transit time. During the test, the patients remained seated and the images were taken from a lateral position, the upper and lower borders of the frame formed by the oral cavity and the esophagus, respectively, with the lips in frontal view, the pharyngeal wall at the back, the nasopharynx in upper view, and the cervical esophagus at the bottom [14–16].

The equipment consisted of a Prestilix seriographer, model 1600X (GE; 1,000 mA, 130 kV), operated by remote control. The images were transmitted to a Sony video monitor (model PVM-95E). The tests were recorded on video tape using an SVHS Panasonic VCR (model AG7400). A microphone was coupled to the video to enable audio recording.

Each subject was observed during swallowing of a 5-ml paste bolus given by spoon with a total of four different stimuli (natural, cold, sour, and sour-cold). G1 received nonrandomized sequences of stimuli (natural, cold, sour, and sour-cold) and G2 received a randomized sequence of stimuli. For videofluoroscopy, we used a consistent paste since we considered it safest for all patients in this group [16].

The paste bolus preparation was made with a 4-gram measure of Thick and Easy thickener from Hormel Health Labs (USA), marketed in Brazil by Fresenius Kabi Brasil Ltda., consisting of a mix of carbohydrates and minerals, containing 360 kcal/100 g, added to water and lemon flavor diet juice (pH 2.84).

Room temperature (22°C) and cold (8°C) were used, measured with a digital thermometer (model 07-402) from Nuclear Associates (Carle Place, N.Y., USA). The food temperature was checked before the beginning of the tests.

The exams originally recorded on VHS tapes were digitalized with an acquisition rate of 29.97 frames per second, allowing a resolution of approximately 33 ms. Specific software [17] was used to analyze the time in ms, permitting frame-by-frame analysis of the exams in slow motion or at conventional speed.

A frame-by-frame analysis of the test was performed. The beginning and end of the bolus passage through the pharyngeal phase were marked in order to establish the duration of the phase by counting the frames. The beginning of the pharyngeal phase of swallowing was considered to be at the moment when the food bolus reached the posterior part of the nasal spine, located at the end portion of the hard palate, at the beginning of the soft palate. The end of the pharyngeal phase of swallowing was considered as the moment when the bolus passed the upper esophageal sphincter [18].

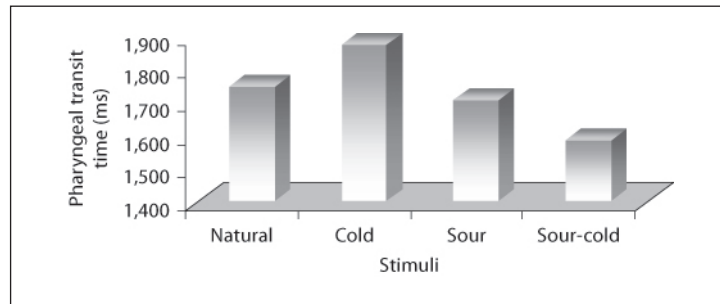
The test analysis was evaluated by two speech and language pathologists, with the same time of specialization in oropharyngeal dysphagia and with 10 years of experience in videofluoroscopy.

Since the values did not present regular distribution and uniform variances, nonparametric tests were performed. Interobserver comparison was performed using the Wilcoxon test. Since there was no statistically significant difference in the results found by the evaluators, an average between them was used in the subsequent analyses. The Friedman test was used to compare stimuli. The level of significance was set at 5%.

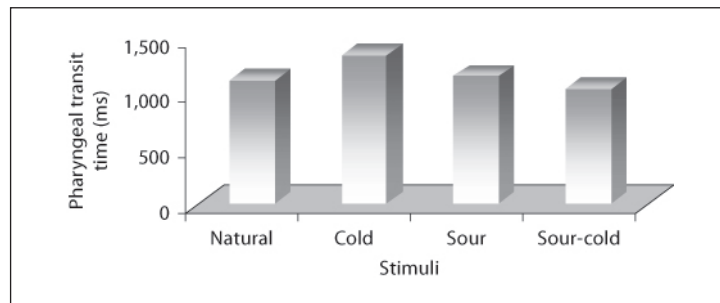
### Results

Both groups (G1 and G2) presented a shorter pharyngeal transit time with the sour-cold stimulus than with the other stimuli. G1 individuals presented a significantly shorter pharyngeal transit time with the sour-cold stimulus than with the other stimuli. G2 individuals did not present a significant difference in pharyngeal transit time between stimuli (fig. 1, 2).

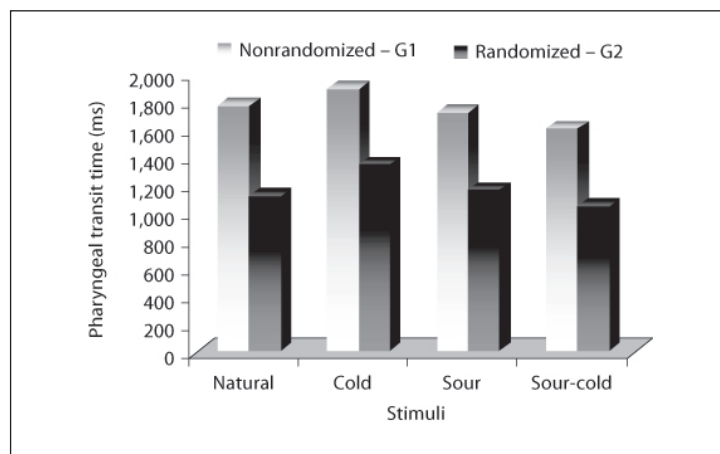
**Fig. 1.** Median pharyngeal transit time for the sequence of non-randomized stimuli.



**Fig. 2.** Median pharyngeal transit time for the sequence of randomized stimuli.



**Fig. 3.** Comparison of median pharyngeal transit time obtained with the nonrandomized and randomized stimuli.



Comparison of G1 and G2 showed that they differed significantly in pharyngeal transit time and response to the stimuli (fig. 3).

## Discussion

Sour taste and cold temperature are used during rehabilitation of dysphagic individuals after stroke. This study showed that these patients swallowed a sour-cold bolus faster than other stimuli, with changes in pharyngeal transit time. Thus, we confirmed our hypothesis that sour taste and cold temperature can influence pharyngeal transit time in stroke patients. Additionally, this study showed a difference between stimuli offered in a randomized and nonrandomized manner.

A favorable decrease in pharyngeal transit time with the sour-cold stimulus, involving healthy and neurological individuals, has been reported by many authors [2, 16, 19–29]. However, most of these studies used just one stimulus to determine the changes in swallowing. Studies that used stimuli involving taste and temperature offered nonrandomized [3] or randomized sequences [30], but did not compare them. Moreover, another study did not explain how the sequence was offered [2]. Thus, it is difficult to compare these studies to ours.

The present findings were compatible with those obtained in the previously mentioned studies. One study [2] observed that the sour taste diminished pharyngeal transit time. However, it was not possible to compare the sequence of offered stimuli, because the authors did not examine the relation between randomized and nonrandomized sequences. Moreover, another study [3] offered a nonrandomized sequence of stimuli to individuals with different neurological disorders. The authors hypothesized that a sour stimulus could influence the other stimuli and, therefore, they offered the sour stimulus last. They reported that a sour stimulus offers benefits to swallowing, increasing the trigeminal stimulation of the brain stem in individuals with neurological disorders. These results are similar to those obtained in the present study, but the authors did not compare randomized to nonrandomized offer.

The results of the present study conducted in stroke patients showed that sour taste and cold temperature influence pharyngeal transit time, but with a difference in relation to the sequence of the stimuli offered. G1 individuals presented a significantly shorter pharyngeal transit time with the sour-cold stimulus compared to the other stimuli. G2 Individuals did not show a significant difference in pharyngeal transit time after the different stimuli. However, it is important to mention that, despite the lack of statistical significance, the pharyngeal transit time was shorter with the sour-cold stimulus in G2.

The idea that can explain the results for G2 is that the sour-cold stimulus strongly affects the initiation of the pharyngeal phase [1], suggesting that this stimulus influenced the response to the other stimuli. Some studies that used a randomized sequence showed that taste and temperature influence swallowing [22–26, 30, 31].

## Conclusion

Our results showed that the sequence of offered stimuli influences the pharyngeal transit time in individuals after stroke in different ways. Additionally, they suggest that, when the sour-cold stimulus is offered in randomized sequence, it can influence the subsequent stimulus. Hence, the sour-cold stimulus could be used as a therapeutic aid in dysphagic stroke patients.

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