

THE INFLUENCE OF SOUR TASTE AND COLD TEMPERATURE IN PHARYNGEAL TRANSIT DURATION IN PATIENTS WITH STROKE

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ABSTRACT – Context - The effect of sour taste and food temperature variations in dysphagic patients has not been entirely clarified.

Objective - To determine the effect of sour and cold food in the pharyngeal transit times of patients with stroke. **Methods** - Patients participating in this study were 30 right-handed adults, 16 of which were male and 14 were female, aged 41 to 88 (average age 62.3 years) with ictus varying from 1 to 30 days (median of 6 days). To analyze the pharyngeal transit time a videofluoroscopy swallow test was performed. Each patient was observed during swallow of a 5 mL paste bolus given by spoon, totaling four different stimuli (natural, cold, sour and cold sour), one at a time, room temperature (22°C) and cold (8°C) were used. Later, the tests were analyzed using specific software to measure bolus transit time during the pharyngeal phase. **Results** - The results showed that the pharyngeal transit time was significantly shorter during swallow of cold sour bolus when compared with other stimuli. **Conclusion** - Sour taste stimuli associated to cold temperature cause significant change in swallowing patterns, by shortening the pharyngeal transit time, which may lead to positive effects in patients with oropharyngeal dysphagia.

HEADINGS – Stroke. Taste perception. Temperature sense. Deglutition disorders.

INTRODUCTION

The influence of taste and temperature on normal and abnormal swallowing has been studied in the last decades. The role of taste with or without temperature changes in dysphagic patients has not been entirely explained.

Some stimuli, such as taste and temperature, have an influence on swallowing and also on bolus displacement times^(5, 13). Kaatzke-McDonald et al.⁽¹⁵⁾ suggested the existence of thermo-receptive receptors at the pillars of fauces, which evoke swallowing when stimulated by a cold touch. There are controversies in the literature about healthy individuals⁽¹⁾.

As of the end of last century, videofluoroscopy swallow studies with the use of software started to appear, thus also enabling quantitative analysis, such as measuring bolus transit time as one of the swallowing phases^(16, 35).

The pharyngeal transit time (PTT) is considered the food bolus displacement time, beginning at the pillars of the fauces, which triggers swallowing down to the esophagus, which normally takes one second or less in healthy patients⁽²¹⁾.

Rosenbek et al.⁽³¹⁾ used videofluoroscopy to study the swallow process of 22 patients with history of one or more stroke involving different brain locations, and with oropharyngeal dysphagia. In one group, cold was applied to the pillars of the fauces with a laryngeal mirror before the patients swallowed the food boluses, while the other group of patients received no cold stimulus. The group who received cold application displayed shorter pharyngeal and oropharyngeal transit times than the group receiving no cold stimulation.

Pelletier and Lawless⁽²⁷⁾ studied 11 patients with different neurological disorders, cerebral palsy, cranial trauma, stroke, and Alzheimer's disease. They used videofluoroscopy to observe swallowing of sour and sweet foods separately. They concluded that sour minimizes laryngotracheal penetration and aspiration in patients with neurological disorders.

Chee et al.⁽⁵⁾ studied 42 healthy adults by performing a water test and videofluoroscopy swallowing test, using different tasting foods. They determined that swallowing is highly influenced by chemical-sensorial stimuli, and can be altered if the patient is more alert due to an increased awareness of the food bolus.

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This study, therefore, aimed to study the effect of sour taste and cold temperature in pharyngeal transit times of ischemic hemispheric stroke patients.

METHODS

Study population

This study gathered 30 ischemic hemispheric stroke right-handed adults, comproved by computed tomography, 16 of which were male and 14 were female, aged 41 to 88 years (average age 62.3), ictus from 1 to 30 days (median of 6 days).

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

The exclusion criteria were hemorrhagic stroke patients, patients with decreased level of consciousness, and clinically unstable patients, as confirmed by medical evaluation.

Method

To analyze pharyngeal transit time videofluoroscopy swallow test was performed. During the videofluoroscopy swallow test, the patients remained seated and the images were taken from a lateral position, with upper and lower borders from the oral cavity to the esophagus with the lips in front view, the pharyngeal wall at the back, nasopharynx in upper view and the cervical esophagus at the bottom^(5, 30, 31).

The equipment consisted of Prestilix seriographer model 1600X, 1000 MA, 130 KV – GE operated by remote control. The images were transmitted to a PVM-95E model Sony video monitor. The tests were recorded on video tape using an AG7400 model SVHS Panasonic VCR. A microphone was coupled with the video to enable audio recording.

Each subject was observed during swallowing of a 5 mL paste bolus given by spoon, totaling four different stimuli (natural, cold, sour, sour cold). The stimuli were presented to each subject in a nonrandomized sequence. For the videofluoroscopy, we used a paste consistence, as we considered it the safest for all the patients in this group⁽³¹⁾.

The paste bolus preparation was made with 4 g measure of Thick & Easy thickener by Hormel Health Labs of the U.S., 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.

Room temperature (22°C) and cold (8°C) were used, measured with a digital thermometer (07-402) by Nuclear Associates, Carle Place CE. The food temperature was checked before the tests began.

The exams originally recorded on VHS tapes were digitalized with acquisition rate of 29.97 frames per second, allowing a resolution of approximately 33 milli-seconds. For the computerized analysis of pharyngeal transit times, software was utilized to record the time in milliseconds through the analysis of the frames on video and swallow seriography⁽³⁵⁾. A frame-by-frame analysis of the test was performed and 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. Through videofluoroscopic images, the beginning of the pharyngeal phase swallowing was considered to be the moment when the food bolus reached the posterior part of the nasal spine, located at the end part of the hard palate, at the beginning of the soft palate. The end of the pharyngeal phase swallowing was considered the moment when the bolus passed the upper esophagus sphincter⁽¹⁷⁾.

In our study, the test analysis was evaluated by two speech and language therapists, with the same time of specialization in oropharyngeal dysphagia and training in videofluoroscopy: 2 years.

Since the values did not present regular distribution and uniform variances, non-parametric tests were performed. The interobserver used the Wilcoxon test for their comparisons. Since there was no statistically significant difference in the results found by the evaluators, an average between the two was used in the subsequent analyses. The Friedman test was utilized to compare stimuli. The level of significance used was 5%.

RESULTS

The results showed that the pharyngeal transit time is increased in post-ischemic hemispheric stroke. However, it was shorter when the bolus with the cold sour stimulus was swallowed, when compared separately with the other stimuli (Table 1).

TABLE 1. Median, first and third quartile, in brackets, relative to the pharyngeal transit time (milliseconds) according to stimuli

Stimuli	Phase
	Pharyngeal
Natural	1742 [1499, 2410] A
Cold	1868 [1251, 2483] A
Sour	1701 [1242, 2077] A
Cold Sour	1581 [1159, 1913] B

Friedman test ($P < 0.05$)
Same letters no statistical difference

This table shows that the average pharyngeal transit time was significantly shorter when the patients swallowed the cold sour bolus, when compared with the other stimuli separately, and close to normal values.

DISCUSSION

The average time of the pharyngeal phase swallowing in healthy patients is of about 1 second or less^(17, 21). The impairment in pharyngeal transit time was expected in the volunteers of this study, due to their compromised swallowing,

defined as neurogenic oropharyngeal dysphagia. Johnson et al.⁽¹⁴⁾ in a study with stroke patients, found delayed pharyngeal transit time, with significant difference when compared with healthy individuals.

There are controversies in the literature about healthy individuals, on pharyngeal transit time alterations through variations in bolus consistence, taste, and temperature. However, one of the aspects we should consider is the difference in methodologies employed in the different studies, as well as the relationship of these stimuli with the sense of taste. When we swallow something sour, in addition to the probable stimulation of a higher number of receptors, there is also the issue of pleasure or displeasure caused by the sour taste. People tend to reject the taste and this may lead to a different response in the act of swallowing, as it involves displeasure. Considering this aspect, studies may have to be conducted on the threshold of a sour taste, i.e., exactly how intense should this taste be in order to stimulate swallowing and still be pleasant.

Recent studies have investigated the complex interaction between the structural properties of flavor stimuli and the sense of taste, and the likelihood of activation of distinctive brain areas when comparing the activation of the taste stimulus with the activation of food pleasure by the sense of taste^(11, 25, 34).

This study investigated whether taste or temperature influence in a different way pharyngeal transit times in patients who had an ischemic stroke restricted to the brain hemispheres. Swallowing the food bolus with a cold sour stimulus had the shortest pharyngeal transit time, therefore faster pharyngeal response. Several studies aim to explain the mechanisms involved in the pharyngeal response in swallowing and its relationship with taste and temperature^(29, 32).

With regard to neurophysiology, the taste receptors located in the tongue's taste buds, soft palate, pharynx, and esophagus receive the stimuli and send them to be later modulated at the cortex^(2, 3, 4, 12, 19, 23, 24, 26). This leads to the assumption that when such receptors are stimulated by a more intense taste, sour in this case, several paths to the cortex are activated, which alters afference and efference.

Despite not having found in the literature any studies on this investigation through a set of uniform cases, therefore similar to our study, we have found studies which included patients with different neurological disorders which determined changes in swallowing patterns when taste and temperature factors were present. Such studies showed changes in swallowing activity and a correlation with the findings of our study, as they also involved the taste and temperature receptors^(13, 19, 22, 27).

However, the study of the sour taste and cold temperature factors through a miscellaneous set of cases compromises

the understanding of the cases when this beneficial effect can contribute toward patient recovery. Despite this, it seems that previous investigations, as well as our own study, have detected shorter pharyngeal transit time with such stimulation, and therefore a positive effect on the pharyngeal response^(5, 17, 27). The stimuli were presented to each subject in a nonrandomized sequence to presume sour stimuli may improve swallowing⁽²⁷⁾. However, another aspect that can be studied is related to the form that the stimuli were presented and, hence, future investigations will be realized to compare randomized sequence with nonrandomized sequence.

Studies using objective tests, videofluoroscopy, manometry, and surface electromyography in healthy individuals also found alterations in bolus transit time, in the pressure of the tongue against the hard palate, in the sequence of movements and also in the muscular activity involved in swallowing, when testing foods with varying volume, taste, and consistence^(7, 8, 9, 10, 18, 20, 28, 33, 36).

In view of the evidence, it is understood that stimuli such as sour and cold have an influence on the pharyngeal transit time, as they increase the perception of the food bolus and the afference through pairs of cranial nerves^(5, 6, 16).

We can therefore suppose that the presence of sour and cold during the act of swallowing stimulates the receptors from the oral cavity to the pharynx, and such action is capable of altering modulation of afferences and efferences, thus involving the peripheral and the central nervous system. In this manner, sour and cold action on the swallowing activity of patients with a hemispheric brain lesion, due to the relationship of these stimuli with the different brain areas, may interfere with oral modulation, and require studies on different lesion locations.

CONCLUSIONS

Sour taste and cold stimuli, used at the same time, shorten the pharyngeal transit time in ischemic hemispheric stroke patients. Moreover, shorter pharyngeal transit time in these patients implies a pharyngeal response, suggesting therapeutic benefits. However, future studies with neuroimaging are necessary to investigate the cortical representation of the swallowing mechanism and the food taste and temperature factors on patients with neurogenic oropharyngeal dysphagia.

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Cola PC, Gatto AR, Silva RG, Spadotto AA, Schelp AO, Henry MACA. A influência do sabor azedo e da temperatura fria na duração do trânsito faríngeo em indivíduos com acidente vascular encefálico. *Arq Gastroenterol.* 2010;47(1):18-21.

RESUMO – *Contexto* - O efeito do sabor azedo e as variações da temperatura dos alimentos em indivíduos disfágicos, ainda não foi totalmente esclarecidos. *Objetivo* - Verificar o efeito do sabor azedo e da temperatura fria no tempo de trânsito faríngeo da deglutição em indivíduos após acidente vascular encefálico hemisférico isquêmico. *Métodos* - Participaram deste estudo 30 indivíduos adultos, sendo 16 do gênero masculino e 14 do feminino, destros, com faixa etária variando de 41 a 88 anos (média de 62,3 anos) e ictus que variou de 1 a 30 dias (mediana de 6 dias). Para analisar o tempo de trânsito faríngeo da deglutição foi realizado o exame de videofluoroscopia da deglutição. Cada indivíduo foi observado durante a deglutição de bolo na consistência pastosa, oferecido em colher, com 5 mL cada, sendo ao todo quatro estímulos diferentes, um por vez. Posteriormente os exames foram analisados com auxílio de um software específico para medição do tempo de deslocamento do bolo pela fase faríngea. *Resultados* - Os resultados mostraram que o tempo de trânsito faríngeo da deglutição foi significativamente menor durante a deglutição de bolo azedo gelado quando comparado aos outros estímulos. *Conclusão* – Constatou-se que estímulos com sabor azedo associado à temperatura fria provocam significativa mudança na dinâmica da deglutição, diminuindo o tempo de trânsito faríngeo, podendo assim proporcionar efeitos positivos em indivíduos com disfagia orofaríngea.

DESCRITORES - Acidente cerebral vascular. Percepção gustatória. Sensibilidade térmica. Transtornos de deglutição.

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