

Pharyngeal transit adaptation to bolus volume and consistency in Chagas' disease

Adaptação do trânsito faríngeo ao volume e consistência do bolo deglutido na doença de Chagas

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ABSTRACT

Background: Esophageal Chagas' disease causes a longer pharyngeal bolus clearance, which may be an adaptation to the impairment of esophageal bolus transit. This adaptation should be present when we change volume or consistency of the swallowed bolus.

Methods: By the videofluoroscopic method, the correlation was calculated between bolus volumes of 5 and 10mL, and consistencies liquid and paste on pharyngeal clearance duration and hyoid movement duration using the Pearson correlation coefficient (r). It was evaluated 17 patients with Chagas' disease and 15 normal volunteers. **Results:** In both groups, there was no correlation between the pharyngeal clearance duration and the hyoid movement duration. In pharyngeal clearance there was a positive correlation between the volumes of 5 and 10mL and between liquid and paste boluses in patients with Chagas' disease, but not in controls. In hyoid movement duration the correlation between the volumes of 5 and 10mL was positive and significant in Chagas' disease patients for liquid and paste bolus, and only for paste in controls. **Conclusion:** Patients with Chagas' disease have a positive correlation of bolus flow through the pharynx related to change in bolus volume and bolus consistency, which suggested that they have a more important control of pharyngeal flow related to bolus volume and consistency than normal volunteers.

Keywords: Chagas' disease/complications; Deglutition; Deglutition disorders/etiology; Pharyngeal muscles; Pharynx/physiopathology; Fluoroscopy

RESUMO

Justificativa: Envolvimento do esôfago pela doença de Chagas provoca aumento na duração da depuração da faringe, o que pode ser uma adaptação consequente ao comprometimento do trânsito do bolo pelo esôfago. Esta adaptação deve estar presente quando variamos o volume e consistência do bolo deglutido.

Métodos: Foi realizada, com o método videofluoroscópico, avaliação da duração da depuração faríngea e da duração do movimento do osso hióide com a deglutição de bolos de 5 e 10mL, e consistências líquida e pastosa em 17 pacientes com doença de Chagas e 15 voluntários saudáveis. Foi calculada a correlação entre os resultados por meio do coeficiente de correlação de Pearson (r). **Resultados:** Em pacientes com doença de Chagas e voluntários, não houve correlação entre a duração da depuração da faringe e da duração do movimento do hióide. Em pacientes com doença de Chagas, na depuração da faringe, houve correlação positiva entre os volumes de 5 e 10mL e entre bolos líquido e pastoso, o que não foi observado nos voluntários. Na duração do movimento do hióide a correlação entre os volumes de 5 e 10mL foi positiva e significativa em pacientes com doença de Chagas para bolo líquido e pastoso, e apenas para pastoso nos voluntários. **Conclusão:** Pacientes com doença de Chagas têm correlação positiva do fluxo pela faringe relacionada com a alteração no volume e consistência do bolo, o que sugere um maior controle do fluxo pela faringe do que o observado em voluntários normais.

Descritores: Doença de Chagas/complicações; Deglutição; Transtornos de deglutição/etiologia; Músculos faríngeos; Faringe/fisiopatologia; Fluoroscopia

INTRODUCTION

The esophageal involvement by Chagas' disease (American Trypanosomiasis), caused by the hemoflagellate protozoan *Trypanosoma cruzi*, has as consequence the loss of ganglion cells within the esophageal myenteric plexus⁽¹⁾. The anatomic and functional consequence for the esophagus is megaesophagus, aperistaltic contraction in the esophageal body with no relaxation of the lower esophageal sphincter, motility alterations characteristic of esophageal achalasia^(2,3).

Dysphagia and regurgitation are the most frequent symptoms mentioned by these patients. They are the consequence of esophageal dysmotility and the impairment of esophageal bolus

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Data de submissão: 17/12/2013 – Data de aceite: 06/01/2014

There is no conflict of interest for Carla M Santos, Rachel A Cassiani, Weslania V Nascimento and Roberto O Dantas.

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transit. However, some alterations of pharyngeal transit have been described^(4,6).

Chagas' disease patients have a longer pharyngeal clearance with swallows of a 10mL liquid bolus⁽⁵⁾ and 10mL paste bolus^(4,6) than normal volunteers. The longer pharyngeal clearance should be an adaptation to the bolus retention and slower transit through the esophageal body, or an alteration of oral and pharyngeal phases of swallowing consequent of central nervous system (CNS) involvement by the disease. However, clinical, electroencephalographic and magnetic resonance imaging evaluation of the CNS found limited and focal dysfunction which does not justify any involvement with the symptom of dysphagia⁽⁷⁾, suggesting that there is no impairment of the CNS which could cause alterations of the oral and pharyngeal phase of swallowing in the disease.

Our hypothesis is that the increase in the pharyngeal clearance duration described in Chagas' disease patients with esophageal involvement is an adaptation to the impairment of esophageal bolus transit. If the hypothesis is true, we expect that in pharyngeal clearance duration of patients with Chagas' disease there is a more important control of the bolus flow than normal subjects when we modify bolus volume and bolus consistency, demonstrated by a positive and significant correlation between the bolus volumes of 5 and 10mL and liquid and paste consistencies. Patients with Chagas' disease need a more strict control of their pharyngeal flow, but normal subjects do not need such control. The objective of this investigation was to evaluate if there is any correlation between bolus volume of 5 and 10mL, and liquid and paste consistencies in pharyngeal clearance and hyoid movement durations, and in the proportion between pharyngeal clearance duration and hyoid movement duration in patients with esophageal involvement by Chagas' disease.

METHODS

We studied 17 patients with Chagas' disease and 15 asymptomatic volunteers, who previously participated in a previous publication⁽⁶⁾. The group of Chagas' disease patients consisted of 9 women and 8 men, aged 31-67 years, mean 53.3 years, with dysphagia and a positive serologic examination for Chagas' disease. The esophageal involvement caused by the disease was diagnosed by contrast radiography, which showed esophageal retention of 100% barium sulfate for more than 30 seconds after ingestion of a volume of 100mL, with an increase in distal esophageal diameter (higher than 4cm) in five patients. The control group consisted of asymptomatic healthy volunteers who had never lived in endemic areas for Chagas' disease, 7 women and 8 men, aged 35-69 years, mean 55.2 years. Subjects with heart diseases, diabetes, hypertension, respiratory, neurological, or renal diseases, or those who were taking drugs were excluded from both groups. No subject had been previously treated for esophageal or gastric diseases.

The study was conducted at the University Hospital of the Medical School of Ribeirão Preto, University of São Paulo, and the protocol of the investigation was approved by the Human Research Committee of the Medical School of Ribeirão Preto.

Written informed consent was obtained from each participant. The investigation was approved by the Comitê de Ética em Pesquisa do Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo, process number 5680/2005.

Pharyngeal clearance and hyoid movement were assessed by videofluoroscopy. The equipment used for radiological examination was the Arcomax angiograph unit (Phillips, model BV 300, Veenpluis, The Netherlands) The images were recorded at 60 frames per second using the digital processing system Ever Focus model EDSR 100 V1.2 (Taipei, Taiwan) with a DVR monitor (Ever Focus) and a digital clock that indicates time in minutes, seconds and the number of frames on each video frame. Mouth, pharynx and proximal esophagus were imaged in lateral projection, with the subjects sitting in a chair and both feet on the ground. Boluses of 5 and 10mL of a liquid and 5 and 10mL of a paste were swallowed in duplicate. For the liquid bolus, barium sulfate (Bariogel[®] 100%, Laboratory Cristalia, Itapira, SP, Brazil) was offered with the aid of a spoon. For the paste bolus, we added 30mL of 100% liquid barium sulfate to 3g of the food thickener Nutilis (Nutricia Cuyk B.V., DJ Cuyk, The Netherlands), which was also offered with a spoon.

Taking the time the bolus head arrived at fauces as the zero reference (onset of the pharyngeal phase of swallowing), we timed the onset and end of hyoid movement and the end of upper esophageal sphincter (UES) opening, when the bolus tail cross the UES. From these times, we calculated the pharyngeal clearance duration (bolus head at fauces to the end of UES opening) and the hyoid movement duration (time between onset and end of hyoid movement).

The coefficient was calculated considering the correlation between the pharyngeal clearance duration and the hyoid movement duration. The coefficient of correlation between the results found for the volumes of 5 and 10mL, and between the results found for liquid and paste bolus were calculated. The proportion between pharyngeal clearance duration and hyoid movement duration was also calculated. Statistical analysis was done using the Pearson correlation coefficient (r) and the Student t test. The correlation and differences were considered significant when $p \leq 0.05$ in a two-tailed statistical analysis.

RESULTS

There was no correlation between the pharyngeal clearance duration and the hyoid movement duration in patients with Chagas' disease and controls (Table 1).

In pharyngeal clearance with liquid and paste boluses, the correlation between the volumes of 5 and 10mL was positive and significant in patients with Chagas' disease ($p < 0.04$) but not in controls ($p > 0.09$). The correlation between liquid and paste boluses, with the volumes of 5 and 10mL, was also positive and significant in patients with Chagas' disease ($p < 0.04$) but not in controls ($p > 0.52$) (Table 2).

In hyoid movement duration, the correlation between the volumes of 5 and 10mL was positive and significant for liquid and paste boluses in patients with Chagas' disease ($p \leq 0.02$), and

for paste in controls ($p=0.02$). The correlation between liquid and paste boluses was positive and significant for the 10mL volume in patients with Chagas' disease ($p=0.03$), but not in controls ($p>0.69$).

The relation between pharyngeal clearance duration and hyoid movement duration in patients with Chagas' disease was similar to that of controls (Table 3, $p>0.20$). In both groups, there was no difference with the volumes of 5 and 10mL and with liquid or paste boluses ($p>0.05$).

Table 1. Correlation coefficient (r) between pharyngeal clearance duration and hyoid movement duration in patients with Chagas' disease ($n=17$) and controls ($n=15$)

	Controls		Chagas	
	r	p value	r	p value
5mL liquid	-0.38	0.163	0.15	0.561
10mL liquid	-0.03	0.917	0.14	0.591
5mL paste	0.17	0.550	0.12	0.644
10mL paste	0.03	0.919	0.32	0.217

Table 2. Effect of bolus volume and consistency on the correlation coefficient (r) in duration of pharyngeal clearance and in duration of hyoid movement in patients with Chagas' disease ($n=17$) and controls ($n=15$)

	Controls		Chagas	
	r	p value	r	p value
Pharyngeal clearance				
5mL x 10mL liquid	0.18	0.520	0.57	0.018
5mL x 10mL paste	0.45	0.093	0.52	0.032
Liquid x paste 5mL	0.18	0.524	0.51	0.036
Liquid x paste 10mL	-0.12	0.674	0.71	0.002
Hyoid movement				
5mL x 10mL liquid	0.44	0.098	0.72	0.001
5mL x 10mL paste	0.60	0.018	0.56	0.020
Liquid x paste 5mL	0.10	0.737	0.29	0.266
Liquid x paste 10mL	-0.11	0.691	0.52	0.031

Table 3. Results of the relation between pharyngeal clearance duration and hyoid movement duration in patients with Chagas' disease ($n=17$) and controls ($n=15$). Mean (SD)

	Controls	Chagas	p value
5mL liquid	0.82(0.23)	0.88(0.3 2)	0.544
10mL liquid	0.95(0.35)	0.95(0.27)	0.977
5mL paste	1.03(0.43)	0.91(0.32)	0.379
10mL paste	0.86(0.31)	1.02 (0.37)	0.201

DISCUSSION

The manifestations of Chagas' disease are dominated by cardiac and digestive disorders. Megaesophagus and megacolon

are the most frequent digestive manifestations^(2,3). Oral and pharyngeal physiology may also be affected by the disease⁽⁸⁾. The esophageal motility alterations caused by the disease is similar to that described in idiopathic achalasia, i.e. aperistaltic contraction in the esophageal body and no relaxation of the lower esophageal sphincter, causing dysphagia and regurgitation⁽³⁾.

Proximal alterations of the digestive motility have been described. The pharyngeal transit is longer in patients than in controls⁽⁴⁻⁶⁾, and in proximal esophagus there is a late response to swallowing and a decrease in contraction amplitude⁽⁹⁾, alterations that should be an adaptation to transit difficult through the esophageal body and/or the impairment of proximal esophageal motility.

There is a positive correlation in pharyngeal response with the bolus volume and bolus consistency. It indicated that pharyngeal clearance duration is related with the variation of bolus characteristic in Chagas' disease, but not in controls. However, the proportion between pharyngeal clearance duration and hyoid movement duration is the same in patients and controls, indicating that the control of transit and hyoid movement persisted in Chagas' disease, important for the maintenance of a safe swallow.

When the bolus reaches the pharynx during the swallow, it initiates the pharyngeal phase, which is composed of pharyngeal peristalsis, opening of the upper esophageal sphincter and closure of the glottis and is independent of both the oral and esophageal phases of swallowing⁽¹⁰⁾. The premotor nuclei that control the pharyngeal motility is located in the nucleus tractus solitarius and the motor nuclei are located in caudal dorsal motor nuclei and dorsal nucleus ambiguous⁽¹⁰⁾. The involvement of the CNS is not frequent in the chronic phase of Chagas' disease and observed alterations are not important^(7,11). By taking into consideration the previous studies of the involvement of the CNS by the disease, it is not likely that the alterations of pharyngeal phase of the swallowing previously⁽⁴⁻⁶⁾ observed are resultant of this involvement.

It is likely that the observed alterations in pharyngeal clearance are a consequence of adaptation to difficulty in bolus transit through the esophageal body. Esophageal diseases that cause impairment of bolus transit may also cause an alteration in the oral and pharyngeal phases of swallowing^(12,13). Longer pharyngeal clearance in Chagas' disease was found with swallows of liquid⁽⁵⁾ and paste boluses^(4,6). The positive correlation between the bolus volume of 5 and 10mL, and between liquid and paste bolus, suggested that there is a more important control of pharyngeal clearance by patients with Chagas' disease, probably to avoid the perception of dysphagia

Although there are no important alterations of oral and pharyngeal phases of swallowing in patients with achalasia caused by Chagas' disease in idiopathic achalasia it was observed cricopharyngeal prominence, asymmetry of pharyngeal contraction and lateral pharyngeal pouches were described⁽¹⁴⁾, suggesting that in this disease, the functional involvement of the pharynx is more important than that seen in Chagas' disease. Some differences were observed in esophageal motility alterations caused by the Chagas' disease and idiopathic achalasia⁽¹⁵⁾. The

explanation for a more important pharyngeal involvement in idiopathic achalasia than in Chagas' disease is that, in idiopathic achalasia, there is an alteration of the upper esophageal sphincter (UES) behavior during swallowing, with increase in UES residual pressure, reduction in UES relaxation duration, rapid onset of pharyngeal contraction after UES relaxation⁽⁶⁾, and alterations of UES belch reflex⁽¹⁷⁾. In Chagas' disease an increase in UES pressure was found⁽¹⁸⁾, but the movement of the catheter during the measurement causes this increase in sphincter pressure and may be explained by a different response of the muscles of the pharyngo-esophageal transition compared with controls and patients with idiopathic achalasia, and does not reflect the true sphincter pressure. The duration of UES transit after the swallow of a 10mL paste bolus is longer in Chagas' disease patients than in controls⁽⁶⁾, indicating the possibility that these patients have some difficulty in transit through the pharyngo-esophageal transition. However, more investigations about UES behavior during swallows are needed. Although in Chagas' disease the esophageal motility alterations are the most important cause of dysphagia, all phases of swallowing may be impaired⁽⁸⁾.

Considering that oropharyngeal dysphagia is a major complaint among older people, consequence from a wide range of structural or functional alterations⁽¹⁹⁾, it is possible that with the aging process there is a deterioration of pharyngeal control in Chagas' disease patients, causing a deterioration of pharyngeal function and an increase in their swallowing symptoms, hypothesis that need further investigations.

CONCLUSION

The results suggested that Chagas' disease patients have a more significant control of pharyngeal flow related to bolus volume and consistency than normal volunteers.

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