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Oral transit time in Alzheimer's disease

Tempo de trânsito oral na demência de Alzheimer

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ABSTRACT

Purpose: Evaluate oral transit time (OTT) with pudding consistency at the different stages of Alzheimer's disease (AD). **Methods:** Descriptive, cross-sectional, observational study conducted with a sample of 34 elderly aged 65-98 years, with AD at different stages. Participants were observed using videofluoroscopy of swallowing while ingesting pudding consistency, using the Kinovea timing program. Data were statistically analyzed at 5% significance level. **Results:** Participants with Clinical Dementia Rating - CDR 3 presented longer OTT compared with those with CDR 1, with means of 3.09 s (SD = 0.91) and 1.17 s (SD = 1.10), respectively. Individuals aged 90-100 years presented longer OTT than those aged 60-79 years, means of 3.90 s and 1.28 s, respectively. **Conclusion:** Individuals with dementia and advanced aged present longer OTT for pudding consistency and should receive special attention from family members and caregivers.

Keywords: Alzheimer's disease; Deglutition; Swallowing disorder; Fluoroscopy; Digestive system physiological phenomena

RESUMO

Objetivo: Avaliar o tempo de trânsito oral de alimento na consistência pudim nos diferentes estágios da demência de Alzheimer. **Métodos:** Estudo de caráter descritivo e observacional do tipo transversal com uma amostra de 34 idosos com idade entre 65 e 98 anos, com demência de Alzheimer em diferentes estágios. Os participantes foram observados por avaliação de videofluoroscopia da deglutição enquanto ingeriam alimento na consistência pudim usando o programa de cronometragem Kinovea. Os dados foram analisados estatisticamente em nível de significância de 5%. **Resultados:** Os participantes com o *Clinical Dementia Rating CDR 3* apresentaram maior tempo de trânsito oral quando comparados àqueles com *CDR 1*, média de 3,09 s (desvio padrão = 0,91) e 1,17 s (desvio padrão = 1,10), respectivamente. Participantes na faixa etária de 90 a 100 anos apresentaram maior tempo de trânsito oral do que os mais jovens, entre 60 e 79 anos, média de 3,90 s e 1,28 s, respectivamente. **Conclusão:** Indivíduos com demência e idade avançadas apresentam tempo de trânsito oral aumentado para alimento na consistência pudim, devendo ser alvo de atenção de familiares e cuidadores.

Palavras-chave: Doença de Alzheimer; Deglutição; Transtorno de deglutição; Fluoroscopia; Fenômenos fisiológicos do sistema digestório

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INTRODUCTION

Dementia of the Alzheimer type (DAT) is a neurodegenerative disease that causes cognitive loss, diminishing the intellectual function of individuals with impairments on every day activities such as feeding[1]. Alzheimer's disease (AD) is the most common form of dementia in the elderly, with prevalence of 6.8% among individuals aged >60 years[2].

In AD, executive functions also tend to be impaired. These functions indicate the cognitive ability and the organizing principle needed to cope with fluctuating and ambiguous situations on a daily basis, namely, formulation of objectives and concepts, motivation, planning, self-regulation, abstraction, analysis, manipulation of acquired knowledge, and mental flexibility[3]. They are fundamental psychic functions for the production of behavioral responses appropriate to different contexts, which are impaired in dementia[3].

Regarding the stomatognathic functions, dysphagia in AD includes inability to visually recognize food and difficulty in performing the motor act during the stages of swallowing, called orotactile agnosia[4]. The following may occur: uncoordinated tongue movements, difficulty initiating the oral phase, significant increase in oral transit time (OTT), difficulty in food bolus propulsion, delayed swallowing reflex, and decreased laryngohyoid excursion[5]. Compromises in this swallowing dynamics negatively influence the health of the elderly with AD, because they can cause malnutrition, dehydration, and even the possibility of developing aspiration pneumonia, which can lead to death[6]. In cases of advanced dementia, silent aspiration and, eventually, macro-aspiration are common[7].

Given that aspiration pneumonia is an important factor associated with morbidity and mortality in patients with AD, there is clear need to establish measures to minimize this process and improve swallowing functionality in these individuals[7]. Introduction of food in pudding consistency is a measure of facilitation and safety used by many caregivers, and it is the most indicated for patients with oral motor malfunction and malnutrition, because it is easier to manipulate and can reduce gagging[8]. However, it is worth emphasizing that efficacy will depend on the characteristics and severity of the patient's underlying disease, morphofunctional conditions of the stomatognathic system, degree of swallowing impairment, and level of consciousness and cognition.

The major changes in eating habits resulting from DAT are reduced or increased oral intake (with weight loss or gain), change in food preference, parorexia, inadequate use of utensils, and inability to adequately refer to signs of hunger, thirst, and satiety[9].

Swallowing biomechanics is composed of distinct stages, with refined neuromotor control and different duration times[10]. The oral phase of swallowing is a voluntary event and can be further divided into oral preparatory phase and the oral phase itself, with the first comprising the process of accommodation and organization of the food bolus in the oral cavity by means of a voluntary action, and the latter referring to the transit time in which the bolus is arranged, chewed, organized, and kept in the mouth[11]. The oral phase of swallowing itself begins with moving the food bolus in the anterior position of the oral cavity until it passes through the oropharynx and triggers the reflex of swallowing, in which a movement of laryngohyoid elevation is observed, when the pharyngeal phase of swallowing is already beginning[12]. For some authors, OTT is defined as the interval between the beginning of tongue movement with propulsion of the bolus posteriorly, until the food passes the tongue base and the angle of the mandible, when the laryngohyoid elevation occurs[11,12].

It is believed that the worse the level of dementia, the longer the OTT in the elderly with AD. Analysis of the OTT of pasty food in this population is important to identify propulsion time in individuals with different levels of dementia, and thus guide and establish therapeutic behaviors, considering the potential risks of dysphagia that they present even when eating pudding consistency food.

This study aimed to assess OTT with pudding consistency in elderly individuals at different stages of DAT.

METHODS

This descriptive, observational, cross-sectional study conducted with a non-probabilistic sample was approved by the Research Ethics Committee of the Federal University of Minas Gerais (CEP - UFMG) under protocol nº 17403613.9.0000.5149. The parents and/or legal guardians of participants signed an Informed Consent Form (ICF) prior to study commencement.

Examinations from 34 individuals were selected from a database. This study included the videofluoroscopy (VFS) of participants diagnosed with Alzheimer's Disease (AD) with Clinical Dementia Rating (CDR)[13] 1, 2, or 3, of both genders, age >60 years, with full oral feeding and ability to remain in the seated position. All participants were assessed regarding severity of dementia by a geriatrician trained to apply CDR at a referral health center for the elderly. The scale rates the cognitive performance of individuals in six important domains: memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care. Global CDR is represented in a 5-point scale as follows: CDR 0 indicates no dementia, and CDR 0.5, 1, 2, and 3 indicate questionable, mild, moderate, and severe dementia, respectively. This evaluation should be updated every six months in order to monitor the evolution of cognitive impairments[13].

Exclusion criteria comprised patients with associated neurological diseases or previous head and neck surgeries, individuals who had already undergone Speech-language Pathology (SLP) treatment for dysphagia, VFS examinations from patients who were unable to ingest pudding consistency or unable to swallow, as well as VFS examinations that could not be analyzed due to low definition.

VFS was performed with the participant sitting in right lateral position, with pudding consistency food intake contrasted with 100% barium sulfate, using a disposable dessert spoon. In order to reach the pudding consistency, 3.6 g of the thickener Resource® Thichen Up™ Clear were added to 100 mL of liquid and offered to the participants in 10 mL portions of pasty food. Because the individuals

presented with some degree of cognitive impairment, the portions were offered three times and only the best image was analyzed by the two evaluators, that is, the one in which the participant remained adequately within the image quadrant and sharpness was good during the oral phase of swallowing. It is worth mentioning that oral transit time (OTT) was similar for the three measures, considering that no variation in the volume offered was observed. For this reason, an option was made to analyze the best captured image. The images were obtained using a Diagnostic RX 0722, Philips seriograph connected to the TV monitor and a SD4071, Semp Toshiba DVD player, with images processed at 30 frames per second.

All examinations were recorded on DVD and inserted in the Kinovea software (Version 2, June 1991, available for download on the Web). This program enables detailed analysis of videos and manipulation of timestamp in up to milliseconds.

Thus, OTT was analyzed by means of the Kinovea software in a Win BPS, CCE PC. During VFS, food was offered to the participants and, for OTT analysis, the image was frozen at the moment the food bolus was in the anterior position of the oral cavity and propulsion towards the oropharynx began, considered as the beginning of the oral phase of swallowing[12] (Figure 1). At this moment, the program timer and the VFS image were simultaneously activated. The end of the oral phase of swallowing was considered when the food bolus head triggered deglutition and maximum, joint elevation of the larynx and the hyoid bone was observed[12] (Figure 2); the chronometer was then stopped.

VFS images were analyzed by a senior of the SLP course previously trained by a speech-language pathologist with 22 years of experience in VFS. Training was conducted through 20 VFS examinations not included in this study. Images of the 34 participants were analyzed blindly, with no knowledge about age and/or CDR.

Analysis of intra- and inter-rater agreement was conducted independently with 20% of the sample and verified by the Spearman's rank correlation coefficient, which showed $r = 0.786$ and $r = 0.964$ for inter- and intra-rater assessments, respectively, indicating good concordance.

In this study, the response variable was OTT and the co-variables were age group, gender, and CDR. The database was structured in Excel® spreadsheet and processed in SPSS 20.0 software.

Descriptive analysis of the data was performed by numerical synthesis for the continuous variables and distribution of absolute and relative frequency for the categorical variables. The following tests were applied for correlation analysis between the response variable and the co-variables: Kruskal-Wallis test, analysis of variance (ANOVA), and Tukey's test for identification of differences between the groups.

Significance level of 5% ($p<0.05$) and confidence interval of 95% (95% CI) were adopted for all statistical analyses.

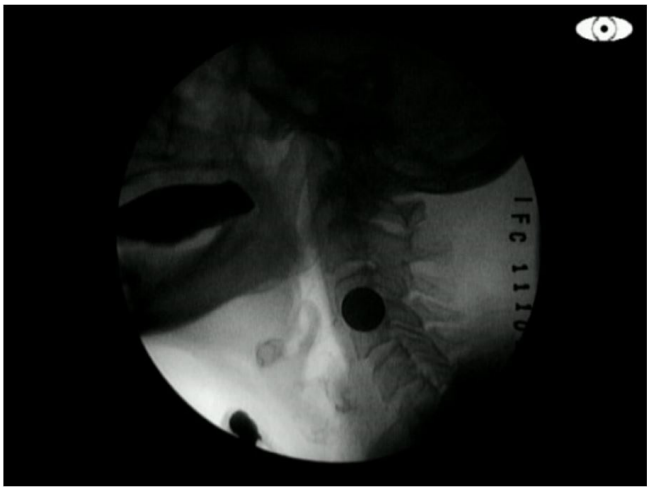

Figure 1. Beginning of the oral phase of swallowing

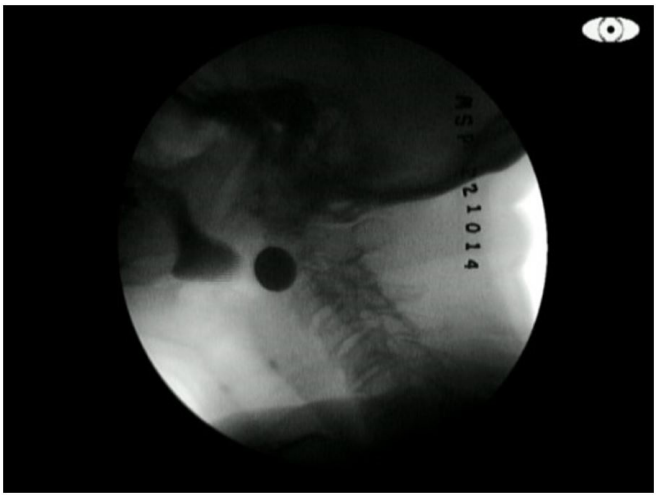

Figure 2. End of the oral phase of swallowing

RESULTS

Of the 34 elderly with Alzheimer's Disease (AD) assessed, 73.5% were female aged 65-98 years (mean = 84 years), and there was predominance according to the Clinical Dementia Rating of mild (CDR-1) and moderate (CDR-2) dementias, with 41.2% and 35.3%, respectively. The worse the level of dementia, the longer the oral transit time (OTT) (CDR 1 = 1.17 s and CDR 3 = 3.09 s). The same was observed regarding age, that is, the older the individual, the longer the OTT. CDR level and age were associated with OTT ($p<0.001$ and $p = 0.033$, respectively). Table 1 shows the OTT values according to the CDR, gender, and age group.

Analysis by pairs for the CDR showed correlation between levels 1 x 3 ($p = <0.001$) and 2 x 3 ($p = 0.010$). As for age group, statistically significant differences were observed between the 60-79 and 90-100 groups ($p = 0.026$), as well as between the 80-89 and 90-100 groups ($p = 0.033$). No correlation was found between gender and OTT, which may be associated with the size of the male sample (Table 2).

Table 1. Oral transit time (in seconds) according to the Clinical Dementia Rating, gender, and age group

Variables analyzed	n	%	Minimum	Maximum	Mean	Median	Standard Deviation	*p*-value
CDR								
1	14	41.2	0.24	4.32	1.17	0.84	1.01	**<0.001**[1]
2	12	35.3	0.57	3.70	1.69	1.50	0.88	
3	8	23.5	1.56	4.47	3.09	3.29	0.91	
Gender								
Male	9	26.5	0.43	3.47	1.24	0.77	1.02	0.104[2]
Female	25	73.5	0.24	4.47	2.01	1.56	1.23	
Age group								
60-79 years	7	29.6	0.40	3.41	1.28	1.09	0.29	**0.032**[3]
80-89 years	20	58.8	0.24	4.31	1.61	1.25	1.07	
90-100 years	7	26.6	1.79	4.47	3.90	2.61	1.91	

[1]Tukey's test; [2]Non-parametric tests; [3]Tukey's test
Subtitle: n = number of participants; CDR = Clinical Dementia Rating; CDR 1 = mild dementia; CDR 2 = moderate dementia; CDR 3 = severe dementia

Table 2. Comparison of oral transit time between the different levels of Dementia of the Alzheimer Type (DAT)

Variables	Difference between means OTT	*p*-value
CDR		
1 x 2	-0.51	0.396[1]
2 x 3	-1.92	**0.010**[1]
1 x 3	-1.41	**<0.001**[1]
Age group (years)		
60/79 x 80/89	-0.34	0.769[1]
80/89 x 90/100	-1.28	**0.033**[1]
60/79 x 90/100	-1.62	**0.026**[1]

[1]Tukey's test
Subtitle: OTT = oral transit time; CDR = Clinical Dementia Rating

DISCUSSION

Results of this study revealed that oral transit time (OTT) increases significantly in cases of severe Clinical Dementia Rating - CDR 3 and in the elderly aged >89 years, and they are higher than those described in the specific scientific literature. A study reported that OTT in typical individuals aged 80-87 years varied from 0.4 to 1.5 seconds for pudding consistency food (10 mL) depending on the points considered for beginning and end of the oral phase[14]. A literature review showed that OTT in young adults was 0.35 s for men and 0.38 s for women, and significantly longer than 1.5 s in healthy dentate elderly aged 80-87 years[15]. The OTT for the younger elderly with lower levels of dementia described in the literature is similar to that found in this survey.

Worsening of dementia may lead to increased OTT because of orotactile agnosia[4], which can compromise the rate and amount of oral intake, impairing nutritional status, and probably facilitating laryngeal penetration and/or laryngotracheal aspiration prior to swallowing. No studies addressing level of cognitive impairment and OTT in Alzheimer's Disease (AD) have been found in the literature. A correlation between these variables was observed in the present survey, with longer OTT associated with worse CDR.

Another aspect that is worth a reflection refers to the executive function. In Dementia of the Alzheimer Type (DAT), there may be an increase in OTT and a decline in executive function[16]. This skill is one of the first to decline with aging and it becomes even more noticeable in cases of dementia, which justify the values found in this study. Age also significantly influences executive performance, attention, and working memory, with information processing speed as the most impaired, that is, older individuals need more time to reach the same level of accuracy in task performance than younger individuals[16]. This directly influences the entire feeding process, because it requires organization, planning, and execution of many coordinated actions, which could be observed in this study, in which patients at older age or with worse CDR presented increased OTT.

In addition to decline in executive function and to orotactile agnosia, increased OTT in elderly patients with AD may be due to difficulty in manipulating the food bolus at the time of ejection, because these patients may present with decreased tongue mobility, including tongue base mobility[17].

The main difficulties in the oral phase of swallowing in AD found in the literature were impairments in the oral preparatory phase, delayed triggering of the swallowing reflex, longer OTT, and presence of residues in the oral cavity after deglutition[18]. When stage of evolution of AD and feeding difficulties are associated, it is possible to observe predominance of swallowing impairment and dependence on feeding time in elderly individuals with more severe dementia[17], causing them to progressively require food adequacy and assistance from caregivers to performed these activities.

Impairments in oropharyngeal swallowing, including laryngotracheal aspiration, are more prevalent in elderly patients with AD than in typical elderly individuals[19].

In the process of healthy aging, there is reduction in sensory acuity, whether visual, auditory, gustatory and/or olfactory, affecting the stomatognathic system and thus compromising the functions of swallowing[20]. This fact is justified by the changes that occur in the oral cavity, such as lip muscle atrophy, alterations in the hypertrophic tongue and oral mucosa, decreased saliva flow, changes in muscle constitution, dental failure, complete or partial absence of teeth, etc. In senescence, sarcopenia is also common, a process characterized by involuntary, gradual and generalized loss of muscle tissue and strength that presents the

risk of adverse outcomes such as physical impairment, poor quality of life, and increased mortality[21]. Sarcopenia hinders the musculoskeletal function, thus limiting the functional capacity and autonomy of the elderly. It should be remembered that the occurrence of sarcopenia also reduces the amount of total body water in 15-20%, leading the elderly to risk of dehydration[21]. When these expected impairments of senescence are combined with the impairments predicted in DAT, impact on individuals may be even greater.

A study[22] that analyzed two healthy elderly and three elderly with AD observed that OTT for solid consistency food was significantly longer in the latter compared with the first.

In the choice of ideal consistency for safe feeding, it is observed that foods containing liquids and solids increase the risk of aspiration, and some authors warn that liquid consistency causes the most laryngeal penetration and laryngotracheal aspiration[23]. Analyzing this dynamics, pudding consistency food remains as a measure of facilitation and safety in feeding, and it is the most indicated for patients with oral motor control impairments or more serious dysphagia because it can be more easily manipulated.

Although laryngeal penetration and/or laryngotracheal aspiration commonly occur in cases of severe dementia because of problems characteristic of disease progression, defining an OTT pattern facilitates therapists to exercise greater control over the feeding of these patients, assisting them with intervening at the right moment in the stages of swallowing[24].

Findings of this study show that individuals with dementia from an older age group present longer OTT. Therefore, special care and attention is required considering that these patients may present important compromises resulting from dysphagia, such as malnutrition and risk of bronchoaspiration.

As the disease progresses and age advances, the stomatognathic functions and structures change and executive function decline and orotactile agnosia accentuate, thus the necessity to observe patterns found in the stages of swallowing of patients so that intervention strategies that may assist with the possibility of maintaining safe and efficient oral feeding can be established.

Sample size was one of the limitations to this study, because it entailed difficulties in determining whether there is a relationship between gender and OTT. Scarcity of specific studies on the theme was also a limitation, showing the need for further research addressing the OTT pattern in AD, so that the time of all stages of swallowing can be defined, and that this transit time can be established as a standard that applies to this population.

CONCLUSION

Individuals with Dementia of the Alzheimer Type (DAT) and advanced aged present longer oral transit time (OTT) for pudding consistency, and should receive special attention from family members and caregivers.

The present study contributes to knowledge about OTT in patients with DAT, and can assist therapists with development of strategies to facilitate intervention, especially in the oral preparatory and oral phases of swallowing.

REFERENCES

1. Herrera E Jr, Caramelli P, Silveira AS, Nitrini R. Epidemiologic survey of dementia in a community dwelling Brazilian population. *Alzheimer Dis Assoc Disord*. 2002;16(2):103-8. http://dx.doi.org/10.1097/00002093-200204000-00007. PMid:12040305.
2. Bottino CMC, Azevedo D Jr, Tatsch M, Hototian SR, Moscoso MA, Folquitto J, Scalco AZ, Bazzarella MC, Lopes MA, Litvoc J. Estimate of dementia prevalence in a community sample from São Paulo, Brazil. *Dement Geriatr Cogn Disord*. 2008;26(4):291-9. http://dx.doi.org/10.1159/000161053. PMid:18843181.
3. Bertolucci PH, Okamoto IH, Brucki SM, Siviero MO, Toniolo J No, Ramos LR. Applicability of the CERAD neuropsychological battery to Brazilian elderly. *Arq Neuropsiquiatr*. 2001;59(3-A):532-6. http://dx.doi.org/10.1590/S0004-282X2001000400009. PMid:11588630.
4. Chouinard J. Dysphagia in Alzheimer disease: a review. *J Nutr Health Aging*. 2000;4(4):214-7. PMid:11115803.
5. Suh MK, Kim H, Na DL. Dysphagia in patients with dementia: Alzheimer versus vascular. *Alzheimer Dis Assoc Disord*. 2009;23(2):178-84. http://dx.doi.org/10.1097/WAD.0b013e318192a539. PMid:19474573.
6. Almeida OP, Crocco EI. Percepção dos déficits cognitivos e alterações do comportamento em pacientes com Doença de Alzheimer. *Arq Neuropsiquiatr*. 2000;58(2A):292-9. http://dx.doi.org/10.1590/S0004-282X2000000200015. PMid:10849630.
7. Kalia M. Dysphagia and aspiration pneumonia in patients with Alzheimer's disease. *Metabolism*. 2003;52(10, Suppl 2):36-8. http://dx.doi.org/10.1016/S0026-0495(03)00300-7. PMid:14577062.
8. Costa MMB. Videofluoroscopy: the gold standard exam for studying swallowing and its dysfunction. *Arq Gastroenterol*. 2010;47(4):327-8. http://dx.doi.org/10.1590/S0004-28032010000400001. PMid:21225139.
9. Ney DM, Weiss J, Kind A, Robbins J. Senescent swallowing: impact, strategies and intervention. *Nutr Clin Pract*. 2009;24(3):395-413. http://dx.doi.org/10.1177/0884533609332005. PMid:19483069.
10. Lynch CS, Chammas MC, Mansur LL, Cerri GG. Biomecânica ultra-sonográfica da deglutição: estudo preliminar. *Radiol Bras*. 2008;41(4):241-4. http://dx.doi.org/10.1590/S0100-39842008000400008.
11. Cassiani RA, Santos CM, Parreira LC, Dantas RO. The relationship between the oral and pharyngeal phases of swallowing. *Clinics*. 2011;66(8):1385-8. http://dx.doi.org/10.1590/S1807-59322011000800013. PMid:21915488.
12. Logemann JA, Gensler G, Robbins J, Lindblad AS, Brandt D, Hind JA, Kosek S, Dikeman K, Kazandjian M, Gramigna GD, Lundy D, McGarvey-Toler S, Miller Gardner PJ. A randomized study of three interventions for aspiration of thin liquids in patients with dementia or Parkinson's disease. *J Speech Lang Hear Res*. 2008;51(1):173-83. http://dx.doi.org/10.1044/1092-4388(2008/013). PMid:18230864.
13. Chaves ML, Camozzato AL, Godinho C, Kochhann R, Schuh A, Almeida VL, Kaye J. Validity of the clinical dementia rating scale for the detection and staging of dementia in Brazilian patients. *Alzheimer Dis Assoc Disord*. 2007;21(3):210-7. http://dx.doi.org/10.1097/WAD.0b013e31811ff2b4. PMid:17804953.
14. Yoshikawa M, Yoshida M, Nagasaki T, Tanimoto K, Tsuga K, Akagawa Y, Komatsu T. Aspects of swallowing in healthy dentate elderly persons older than 80 years. *J Gerontol A Biol Sci Med Sci*. 2005;60(4):506-9. http://dx.doi.org/10.1093/gerona/60.4.506. PMid:15933392.
15. Soares TJ, Moraes DP, Medeiros GC, Sassi FC, Zilberstein B, Andrade CR. Oral transit time: a critical review of the literature. *Arq*

Bras Cir Dig. 2015;28(2):144-7. http://dx.doi.org/10.1590/s0102-67202015000200015. PMid:26176255.

16. Meguro K, Shimada M, Yamaguchi S, Ishizaki J, Ishii H, Shimada Y, Sato M, Yamadori A, Sekita Y. Cognitive function and frontal lobe atrophyin normal elderly adults: implications for dementia not as aging-related disorder and the reserve hypothesis. *Psychiatry Clin Neurosci*. 2001;55(6):565-72. http://dx.doi.org/10.1046/j.1440-1819.2001.00907.x. PMid:11737788.

17. Correia SM, Morillo LS, Jacob W Fo, Mansur LL. Swallowing in moderate and severe phases of Alzheimer's disease. *Arq Neuropsiquiatr*. 2010;68(6):855-61. http://dx.doi.org/10.1590/S0004-282X2010000600005. PMid:21243241.

18. Dantas RO, Aguiar Cassiani R, Santos CM, Gonzaga GC, Alves LMT, Mazin SC. Effect of gender on swallow event duration assessed by videofluoroscopy. *Dysphagia*. 2009;24(3):280-4. http://dx.doi.org/10.1007/s00455-008-9202-z. PMid:19241103.

19. Matsui T, Yamaya M, Ohrui T, Arai H, Sasaki H. Risk factors of aspiration pneumonia in Alzheimer's disease patients. *Gerontology*. 2002;48(3):194-5. PMid:11961375.

20. Marchesan IQ. O que se considera normal na deglutição. In: Jacobi JS, Levy DS, Silva LMC, editores. *Disfagia: avaliação e tratamento*. Rio de Janeiro: Revinter; 2004. p. 3-17.

21. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, Martin FC, Michel JP, Rolland Y, Schneider SM, Topinková E, Vandewoude M, Zamboni M. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age Ageing*. 2010;39(4):412-23. http://dx.doi.org/10.1093/ageing/afq034. PMid:20392703.

22. Sanches EP, Bilton T, Suzuki H, Ramos LR. Estudo da alimentação e deglutição de idosos com doença de Alzheimer leve e moderada. *Dist Comum.* 2003;15(1):9-37.

23. Saitoh E, Shibata S, Matsuo K, Baba M, Fujii W, Palmer JB. Chewing and food consistency: effects on bolus transport and swallow initiation. *Dysphagia*. 2007;22(2):100-7. http://dx.doi.org/10.1007/s00455-006-9060-5. PMid:17347905.

24. Humbert IA, McLaren DG, Kosmatka K, Fitzgerald M, Johnson S, Porcaro E, Kays S, Umoh EO, Robbins J. Early deficits in cortical control of swallowing in Alzheimer's disease. *J Alzheimers Dis*. 2010;19(4):1185-97. http://dx.doi.org/10.3233/JAD-2010-1316. PMid:20308785.