Biomechanical analysis of hyolaryngeal displacement: integrative review

Análise biomecânica do deslocamento hiolaríngeo: revisão integrativa

Análisis biomecánico del desplazamiento hyolaryngeal: revisión integradora

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Abstract

Objective: *to conduct an integrative review of the literature on quantitative assessment procedures of the hyolaryngeal desplacement in the videofluoroscopy.* ***Methods:*** *Databases Lilacs, Scielo, Medline via Pubmed, Cochrane Library and Web of Science/ISI were used, with the inclusion of 15 studies, published between 2000 and 2014, in the English and Portuguese languages.* ***Results:*** *Most of the researchers used the ImageJ program, considered the fourth cervical vertebra as the point of origin, used coin in the chin of the subject to system calibration, evaluated swallowing of 5 and 10ml of liquid, did not describe the number of evaluated swallowing and used two evaluators in the analysis. The main anatomical points were anterior-upper and anterior-lower regions of hyoid and posterior-upper of the subglottic air column as a reference of the larynx.* ***Conclusion:*** *There is a description of the amplitude variation of hyolaryngeal displacement between genders, age groups, and dysphagia healthy subjects and procedures for analysis of the biomechanics of swallowing.*

Keywords: *Swallowing; swallowing disorders; biomechanical phenomena; hyoid bone; larynx.*

Resumo

Objetivo *realizar revisão integrativa da literatura sobre procedimentos de avaliação quantitativa do deslocamento hiolaríngeo na videofluoroscopia.* ***Método:*** *Foram utilizadas as bases de dados Lilacs, Scielo, Medline via Pubmed, Biblioteca Cochrane e Web of Science/ISI, com inclusão de 15*

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estudos, publicados entre os anos 2000 e 2014, nos idiomas inglês e português. ***Resultados:*** *A maioria utilizou o programa ImageJ, considerou a quarta vértebra cervical como o ponto de origem, utilizou moeda no queixo dos sujeitos para calibração do sistema, avaliou deglutição de 5 e 10ml de líquido, não descreveu o número de deglutições avaliadas e utilizou dois avaliadores na análise. Os principais pontos anatômicos foram região anterior-superior e anterior-inferior de hioide e posterior-superior da coluna de ar subglótica como referência da laringe.* ***Conclusão:*** *Há uma variabilidade de descrição da amplitude de deslocamento hiolaríngeo entre gêneros, faixas etárias, sujeitos saudáveis e disfágicos e nos procedimentos para análise da biomecânica da deglutição.*

Palavras-chave: *deglutição; transtornos de deglutição; fenômenos biomecânicos; osso hioide; laringe.*

Resumen

Objetivo *revisión integradora de la literatura sobre los procedimientos de evaluación cuantitativos del desplazamiento hyolaryngeal en la videofluoroscopia.* ***Método:*** *Se utilizaron las bases de datos Lilacs, Scielo, Medline a través de Pubmed, Biblioteca Cochrane y la Web of Science/ISI, con la inclusión de 15 estudios, publicados entre 2000 y 2014, en los idiomas Inglés y Portugués.* ***Resultados:*** *La mayoría utilizó el programa ImageJ, consideró la cuarta vértebra cervical como el punto de origen, utilizó moneda en el mentón de temas para calibración del sistema, evaluó deglución de 5 y 10 ml de líquido, no describió el número de degluciones evaluadas y utilizó dos evaluadores en el análisis. Los principales puntos anatómicos fueron región anterior-superior y anterior-inferior del hioides y posterior-superior de la columna de aire subglótica como referencia de la laringe.* ***Conclusion:*** *Hay una descripción de la variación de la amplitud del desplazamiento hyolaryngeal entre sexos, grupos de edad, y disfagia en sujetos sanos como los procedimientos para el análisis de la biomecánica de la deglución.*

Palabras claves: *deglución; trastornos de la deglución; fenómenos biomecánicos; hueso hioides; laringe.*

Introduction

The swallowing mechanism consists in transporting the bolus from the mouth to the stomach. Oropharyngeal dysphagia is a common symptom in some diseases and its origin can be neurological and/or mechanical[1]. The assessment of dysphagia through more objective methods is essential to determine which interventions are more appropriate for each patient[2].

Videofluoroscopy is a radiological and dynamic examination, recorded in real time and it is considered the gold standard for the research of the swallowing biomechanics in patients with dysphagia. Its use by Speech Therapy complements the clinical evaluation, as it allows the visualization of all stages of swallowing, as well as its alterations and causes, and it allows testing therapeutic maneuvers, helping in the conduct. The recording of images allows the review of the events without the need of exposure to radiation and the comparison of the function of swallowing between healthy subjects and the ones with dysphagia[3].

The physiology of swallowing can be analyzed qualitatively and quantitatively by videofluoroscopy. Quantitative analysis comprises the measurement of temporal[4-8] and/or spatial[3,6-12] events. Studies that analyze the displacement of the swallowing structures use programs that allow you to make the measurements through the analysis of each event sequence of the images. For this, four main steps are required: image scanning, identification of reference points and anatomical points of interest, the calculation of the coordinates and the generation of spatial position graphics[7,8].

One of the quantitative evaluation of the swallowing by videofluoroscopy includes the analysis of complex hyolaryngeal displacement, of the area of maximum pharyngeal constriction and opening and closing of the pharyngoesophageal segment (PES)[7-10, 12]. The ImageJ program from the National Institute of Health, used in some studies, allows the measurement of areas, angles and lengths of

structures involved in swallowing[13], but there are other programs used for this purpose.

The different methodologies for the analysis of hyolaryngeal displacement may interfere with the data concerning the biomechanics of swallowing, which may explain the variability of responses found in the literature[14]. Thus, it becomes necessary to determine more equitable methodologies for the data of scientific research to be comparable. Thus, this review aims to identify which procedures are more used in the literature for the quantitative assessment of hyolaryngeal displacement by videofluoroscopy.

Methods

This is an integrative review of the literature on the parameters used for quantitative analysis of hyolaryngeal displacement during swallowing. The following stages were: elaboration of the guiding question, search in the literature and critical analysis[15]. The guiding question that supported the review was: what are the more used procedures and parameters for biomechanical analysis of hyolaryngeal displacement in adults and/or elderly during swallowing in videofluoroscopy?

The databases used were: Medical Literature Analysis and Retrieval System on-line (Medline), Literatura Latino-Americana e do Caribe em Ciências da Saúde (Lilacs, 'Latin American and Caribbean Literature in Health Sciences'), Scientific Electronic Library Online (Scielo), Web of Science/ISI and Cochrane Library. The descriptors used were swallowing, biomechanical phenomena, larynx, movement, hyoid bone, swallowing disorders and free terms: biomechanics, displacement, dysphagia, excursion, hiolaring* and videofluoroscopy. Several combinations among the descriptors and among the free terms in English, Spanish and Portuguese were performed.

The literature search produced 661 articles. Articles with full available texts were included, published between the years 2000 and 2014 and that analyzed quantitatively the hyolaryngeal displacement during swallowing in adults and/or elderly, being healthy or with dysphagia. Duplicate articles, the ones that did not use videofluoroscopy and studies of review and treatment, by deficit in the description of the methods of quantitative evaluation, were excluded.

Results

Of the 661 that were found, only 15 articles met the inclusion criteria. All studies were found in Medline and five were repeated in the Cochrane Library, three in Lilacs and six in Web of Science/ISI. No study of Scielo was selected, as well as none in Spanish (Figure 1).

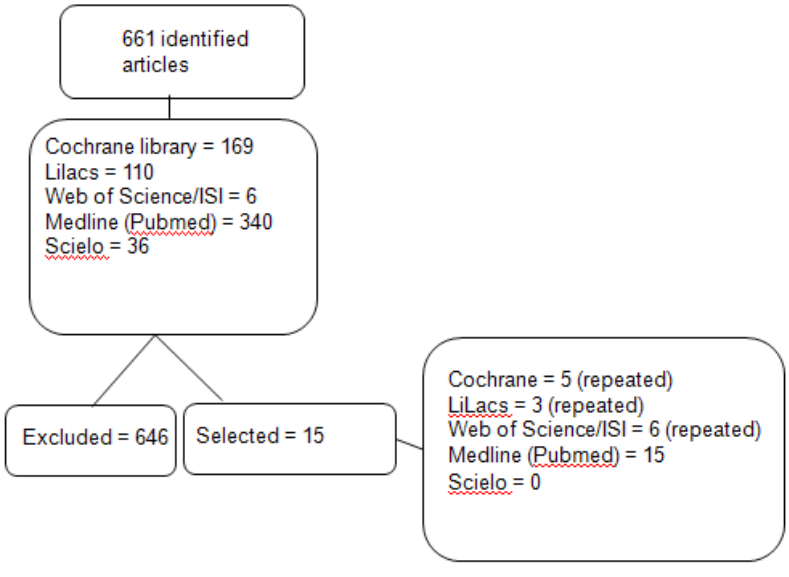


Figure 1. Flowchart of the article selection

The analysis of the publications allowed the identification of two main themes: procedures and parameters of biomechanical evaluation of swallowing and measurements of hyolaryngeal displacement (HLD) in healthy subjects and in the ones with dysphagia. Thus, the results of the HLD were presented in separate charts with the studies that analyzed in healthy subjects and in the ones with dysphagia (Charts 1 and 2).

Procedures and parameters of biomechanical evaluation of hyolaryngeal displacement

Most studies, 13 (86.6%), used only thin liquid for swallowing evaluation with variation of both the analyzed volume and the number of swallows by bolus.

By analyzing the displacement of the hyoid, different programs were mentioned in the studies. Five of those studies (33.3%) used several programs, five of them (33.3%) used *ImageJ*, three (20%) used MATLAB and two (13.4%) did not describe their use.

In relation to the reference points, nine researches (60%) described the reference applied to the hyoid bone, four (26.7%) in the larynx, twelve (80%) in the point of system origin and 15 (100%) described the calibration. Thus, four studies (44.4%) performed markings on the anterior-superior region of the hyoid, three (33.4%) in the anterior-inferior region and two (22.2%) in different regions. All studies that performed markings on the larynx considered the posterior-superior region of the subglottic air column as the reference for the structure displacement calculations. Regarding the point of origin, nine (75%) considered the fourth cervical vertebra (C4) and three (25%) presented different descriptions. Regarding the calibration of the system, five studies (33.4%) used coin in the chin of the subjects, two (13.4%) considered the third cervical vertebra (C3), two (13.4%) the distance between the second vertebra (C2) and the fourth one (C4), two (13.4%) reported a known length of loop in the chin of the subjects, and the rest (26.4%) used other calibration references.

Among the 15 selected studies, nine (60%) reported the existence of more than one evaluator. Of these, seven (77.7%) had two judges and two (22.3%), four evaluators. Five studies (33.4%) did not report the number of evaluators and one (6.6%) mentioned only intra-evaluator agreement and it may result in less robust conclusions. The intra-evaluator agreement ranged between 0.76 and 0.99 and the inter-evaluator one ranged between 0.60 and 1.0. There is an inter-evaluator agreement variation between 0.26 and 0.84 in the qualitative evaluation of the events of the pharyngeal phase of swallowing[16,17].

Hyolaryngeal displacement measurements in healthy and dysphagic subjects

It is still controversy in the literature the influence of the bolus volume in spatial measures of swallowing. A survey showed that changes in the bolus volume does not exert significant changes in the displacement of the hyoid bone during swallowing[18]; but some studies showed volume effects in the range of movement of the hyoid bone and the larynx[7,8,19]. In the figures 2 and 3, hyolaryngeal displacement values between genders, in both healthy and dysphagic subjects described in the studies, are arranged.

As to age, older women had higher amplitude of hyoid and larynx displacement in relation to the young ones[8]. In contrast, young men showed greater range of movement[7]. According to the authors, this behavior is due to the fact that women present better muscle reserves during aging and that the increase of hyolaryngeal displacement may occur to compensate the effects of aging in the duration of hyolaryngeal elevation and opening of the PES.

As for HLD values described in different age groups, the hyolaryngeal excursion measures are generally higher among young people in relation to the elderly. Elderly have lower excursion amplitude in relation to young people as there is reduction of the muscle reserve during aging[9]. A study showed that there is increase of the vertical displacement of hyoid (VDH) with the increase of age. However, the sample was composed mostly by women, a factor that may have influenced the result[20].

The anterior displacement of hyoid (AHD) and the larynx anterior displacement (LAD) in healthy men and women were lower than the respective values of vertical displacement[7-9]. The difference can be explained by the fact that VDH is more related to the closing and protection of airways, with more recruited muscles for the movement, which would justify greater amplitude of vertical movement[9].

Chart 1. Procedures and parameters of biomechanical evaluation of swallowing in healthy subjects

Reference	Sample (gender and age)	Volume/ consistency/ number of swallows	Program/ calibration	Points of reference/ origin	Evaluators and agreement	Hyolaryngeal displacement	Conclusion
Ueda el at, 2013(Japan) [18]	21 subjects (8M;13W) Mean=26 years	2.5; 5, 10 and 20ml of liquid (without specifying the number of swallows)	*Dipp MotionPro* Metal ball in C3	Anterior-posterior of hyoid bone Point in tragus(origin)	Absence of agreement and number of evaluators	AHD: 1.55 a 1.59 cm VDH: 1.61 a 1.69cm	The increase of the bolus volume did not influence in the hyoid displacement
Logeman et al,2000(USA) [7]	16 men 8 (between 21-29 years) 8 (between 80-94 years)	1 and 10ml of liquid barium (2 swallows)	Interactive Coin in the chin	Anterior-superior hyoid region Posterior-superior region of subglottic air column C4 (origin)	2 evaluators Intra-evaluator: 0.90-0.99 Inter-evaluator:0.89-0.98	AHD in young:1.46cm/ elderly:0.84cm VDH in young:2.50cm/ elderly:1.45cm LAD in young:0.81cm/ elderly:0.61cm LVD in young:3.38cm/ elderly:2.42cm	The increase of the volume raised the hyolaryngeal displacement and the displacement was lower among elderly in relation to the young.
Logeman et al,2002(USA) [8]	16 women 8 (between 21-29 years) 8 (between 80-93 years) Data compared with Logman, 2000.	1 and 10ml of liquid barium (2 swallows)	*Interactive* Coin in the chin	Anterior-superior hyoid region Posterior-superior region of subglottic air column C4 (origin)	2 evaluators Intra-evaluator: 0.90-0.99 Inter-evaluator:0.89-0.98	AHD in young:1.01cm/ elderly:1.03cm VDH in young:1.29cm/ elderly:1.54cm LAD in young:0.81cm/ elderly:0.81cm LVD in young:2.18cm/ elderly:2.71cm	The increase of the volume raised the hyolaryngeal displacement. In young the displacement is greater in men and in elderly in relation to the young.
Leonard et al,2000(USA) [19]	60 subjects (30M;30W) Between 18-73 years	1,3 and 20ml of liquid (without specifying the number of swallows)	*ImageJ* Radiopaque disc in the chin	Hyoid bone Vertebral column (origin)	4 evaluators Inter-evaluator: 0.75 to 0.90	HDmax in women: 1.39 to 1.81cm HDmax in men: 2.0 to 2.47cm	The increase of the bolus volume raised the hyoid displacement. Men showed higher amplitude of hyoid elevation.
Kang et al, 2010(Korea) [20]	60 subjects (20M;40W) G1(mean):35.9years G2(mean):51.3years G3(mean):59.4years G4(mean):71 years	2ml of liquid (without specifying the number of swallows)	*Matlab* Coin in the chin	Posterior-superior margin of hyoid C4 (origin)	Absence of description of the agreement and number of evaluators	AHD: G1) 1.33 cm; G2) 1.27cm; G3) 1.20cm G4): 1.33 cm VDH: G1) 0.97cm; G2) 0.82cm; G3) 0.85cm G4) 1.20cm	There is raise of hyoid vertical displacement as the age increases.
Kim et al,2008(EUA) [9]	40 subjects (20M;20W) G1: 21 to 51 years G2:70 to 87 years	5 and 10ml of liquid (2 swallows)	*ImageJ* C3	Hyoid bone C4 (origin)	2 evaluators Intra-evaluator: 0.88 Inter-evaluator:0.83	HD_{max} in young: 1.63cm to 1.80cm/elderly: 0.98 a 1.16cm. AHD in women: 1.48 to 1.59cm/men: 1.20 to 1.30cm VDH in women:1.52 to 1.63 cm/ men: 1.50 to 1.53cm	Young show higher anterior hyoid displacement. There was no significant difference in relation to the genders.

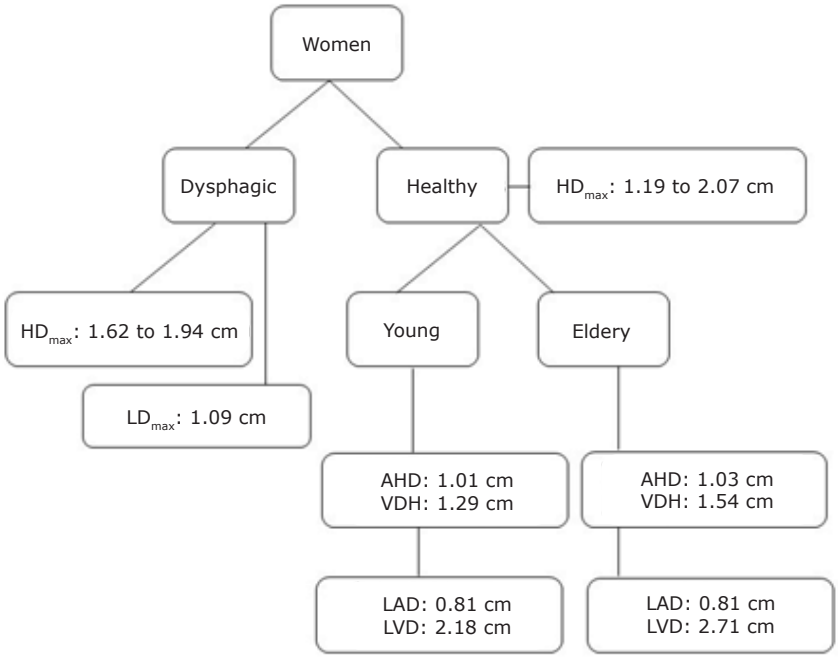
Legend: C3 = third cervical vertebra; C4 = fourth cervical vertebra; AHD = anterior hyoid displacement; VDH = vertical hyoid displacement;HD_{max} = maximum hyoid displacement; LAD = laryngeal anterior displacement; LVD = laryngeal vertical displacement; G = group; M = men; W = women

Chart 2. Procedures and parameters of biomechanical evaluation of swallowing in dysphagic subjects (continuation)

Reference	Sample (gender and age)	Dysphagia / Base disease	Volume/ consistency/ number of swallows per bolus	Program/ calibration	Points of reference/ origin	Evaluators and agreement	Hyolaryngeal displacement	Conclusion
Bingjie et al,2010 (China) [10]	105 subjects (57M; 48W) Mean=65.2 years 100 control (M) Mean = 62 years	Cerebrum-vascular Accident	1ml of liquid with barium 10ml of liquid with barium 10ml of apple with barium 3 cookies with barium (without specifying the number of swallows)	*Xiphoid* Coin in the chin	Anterior-superior region of the hyoid Posterior-superior region of the subglottic air column C4 (origin)	Absence of agreement description and number of evaluators	AHD in the control group: 0.97 to 1.18cm/ Patients who aspired: 0,82 to 1.03cm Patients who did not aspire: 0.87 to 1.08cm/ VDH in the control group: 1.21 to 1.45cm/ Patients who aspired: 0.57 to 1.02cm/ Patients who did not aspire: 1.01 to 1.25cm LAD in the control group: 0.53 to 0.61cm/ Patients who aspired: 0.51 to 0.57cm/ Patients who did not aspire: 0.55 to 0.57cm LVD in the control group: 2.11 to 2.58cm/ Patients who aspired: 0.93 to 1.09cm/ Patients who did not aspire: 2.30 to 2.37cm	The oral transit time, the pharyngeal transit time, maximum vertical extension of the larynx and the hyoid movement are predictors of aspiration.
Paik et al, 2008 (Korea) [12]	10 subjects (7W;3M) Mean=63 years 9 healthy (2M; 7W) Mean= 60 years	Cerebrum-vascular Accident Myopathy	5ml of liquid with barium (without specifying the number of swallows)	*Matlab* Coin in the chin	Anterior-superior region of the hyoid Posterior-superior region of the subglottic air column C4 (origin)	Absence of agreement description and number of evaluators	AHD: control group: 1.5cm/CVA: 1.1cm/ myopathy: 0.4cm VDH: control group: 1.3cm/CVA: 1.2cm/ myopathy: 0.8cm	Movements of the hyoid bone and epiglottis are different according to the etiology of dysphagia, with lower amplitude in subjects with myotonic.
Leonard et al, 2001 (USA) [21]	18 subjects (12M;6W) between 18 and 73 years 60 control ones (30M/30W) Between 18 and 73 years	Myotonic muscular dystrophy	20ml of liquid (without specifying the number of swallows)	*ImageJ* Wire loop in the chin	No description	4 evaluators Inter-evaluator= 0,90	HD_{max} in healthy men: 2.47cm/ sick men: 1.90cm/ healthy women: 1.80cm/ sick women: 1.94cm/ LD_{max} in healthy men: 1.25cm/ sick men: 1.23cm/ healthy women: 1.07cm/ sick women: 1.09cm/	The hyoid displacement did not differ between men and women. It only differed between men with myotonia and the ones without the disease.

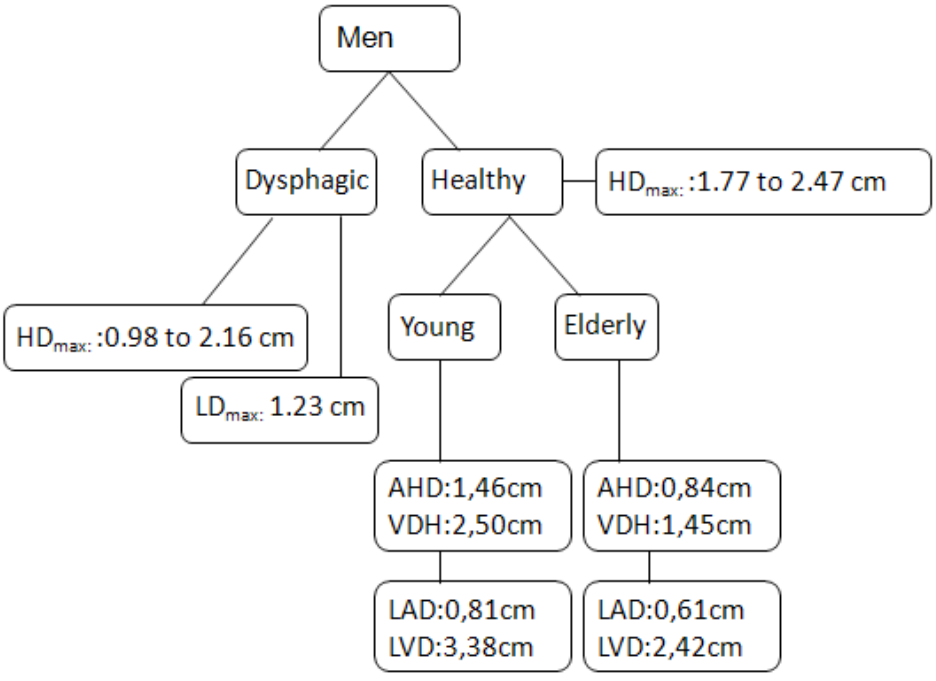
Reference	Sample (gender and age)	Dysphagia / Base disease	Volume/ consistency/ number of swallows per bolus	Program/ calibration	Points of reference/ origin	Evaluators and agreement	Hyolaryngeal displacement	Conclusion
Wang et al, 2010 (Taiwan) [22]	33 subjects (25M;8W) Mean=55.5 years 10 control ones (7M;3W) Mean=53.9 years	Nasopharyngeal carcinoma	5ml of thin liquid (3 swallows)	*Matlab* Radiopaque clip recorded on the screen	Anterior-inferior region of hyoid C3(origin)	2 evaluators Intra-evaluator = 0.92- 0.98 Inter-evaluator = 0.71- 0.83	AHD in the control group: 1.65cm/ Subjects who aspired: 0.64cm/ Subjects who did not aspire: 0.96cm VDH in the control group: 1.38cm/ Subjects who aspired: 1.01cm/ Subjects who did not aspire: 1.37cm	The hyoid displacement is reduced in irradiated individuals, and those who aspired showed lower excursion.
Kendal et al, 2001 (USA) [23]	65 subjects (65 years or more) 83 healthy (40M;43W) G1: 18 to 62 years G2: 67 to 83 years	Dysphagia for various causes	1 to 20ml of liquid barium (without specifying the number of swallows)	*ImageJ* Wire loop in the chin	No description	Absence of agreement description and number of evaluators	HD_{max} in sick women: 1.62 to 1.91cm/ healthy young women: 1.19 to 1.56cm/ healthy elderly women: 1.63 to 2.07cm/ HD_{max} in sick men: 0.98 to 2.16cm/ healthy young men: 1.77 to 2.27cm/ healthy elderly men: 1.98 to 2.47cm/	The greatest displacement of hyoid among some dysphagic subjects may be a compensation to reduce the effects of the elevation duration of the structure
Choi et al, 2011 (Korea) [3]	70 subjects (41M;29W) Mean= 67.8 years	Dysphagia for various causes	5ml of thickened (2 swallows)	No program description Symbol recorded in the jaw	No description	1 evaluator Intra-evaluator=0.90	There was no description of absolute numbers	The hyolaryngeal elevation is a risk factor for aspiration of thickened liquid.
Molfenter et al, 2014 (Canada) [6]	42 subjects (11M; 31W) M: mean=58 years W: mean=63.5 years	Neurological diseases	Bolus smaller or equal to 5ml (minimum of 2 and maximum of 5 swallows)	No program description Distance between C2-C4	Anterior-inferior extremity of hyoid C4 (origin)	2 evaluators Intra-evaluators= 0.76 to 0.99 Inter-evaluators= 0.74 to 1.0	There was no description of absolute numbers	There was no evidenced difference in the excursion of the hyoid boné between individuals who aspired and who did not aspire.
Kim et al,2010 (USA) [11]	60 subjects (55M;5W) Mean=67.8 years	Cerebrovascular Accident	5 to 10 ml of thin liquid (2 swallows)	*ImageJ* C3	Hyoid (rest and maximum displacement) C4 (origin)	2 evaluators Inter-evaluators= 0,85 Intra- evaluators= 0,90	AHD in subjects who aspired: 0.91 to 1.07cm/ did not aspire:1.07 to 1.15cm /VDH in subjects who aspired :1.39 to 1.89cm/ did not aspire: 1.49 a 1.60cm	There was no difference in the displacement of the hyoid between those who aspired who did not aspire.
Steele et al, 2011 (Canada) [24]	28 subjects (13W;15M) W:55 e 77anos M:54 a 70 anos	Dysphagia for various causes	5ml of liquid (3 swallows)	*Visual Studio* Distance between C2-C4	Anterior-inferior extremity of hyoid C4 (origin)	2 evaluators Inter-evaluators= 0,60 (measures of various events of swallow)	There was no description of absolute numbers	Anterior displacement of reduced hyoid is associated with the increase of risk of penetration and aspiration of residue.

Legend: C3 = third cervical vertebra; C4 = fourth cervical vertebra; AHD = anterior hyoid displacement; HD_{max} = maximum hyoid displacement; VDH = vertical hyoid displacement; LAD = laryngeal anterior displacement; LD_{max} = maximum larynx displacement; LVD = laryngeal vertical displacement; M = men; W = women



Legend: LAD: Laryngeal anterior displacement; LD_{max}: Maximum larynx displacement; LVD: laryngeal vertical displacement; AHD: anterior hyoid displacement; HD_{max}: maximum hyoid displacement; VDH: vertical hyoid displacement

Figure 2. Hyolaryngeal displacement between dysphagic and healthy women

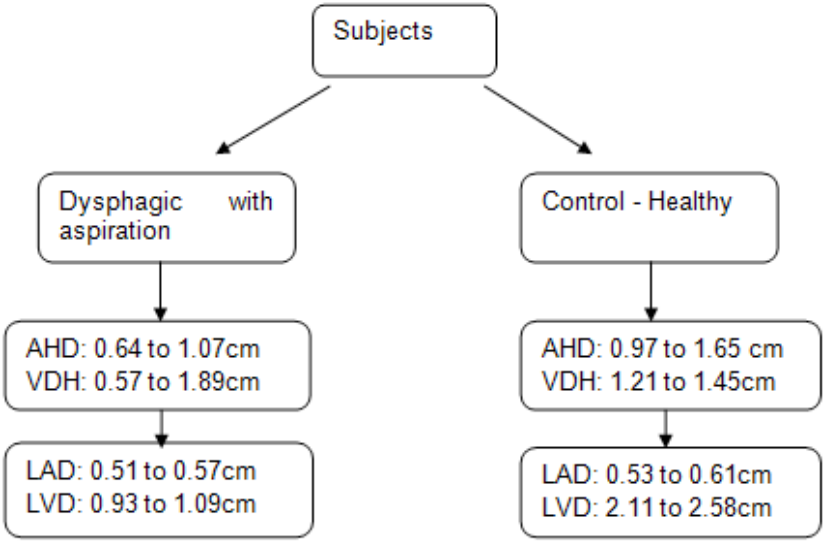


Legend: LAD: Laryngeal anterior displacement; LD_{max}: Maximum larynx displacement; LVD: laryngeal vertical displacement; AHD: anterior hyoid displacement; HD_{max}: maximum hyoid displacement; VDH: vertical hyoid displacement

Figure 3. Hyolaryngeal displacement between dysphagic and healthy men

As to gender, two studies showed greater amplitude of DHL among men[8,19]. The largest maximum hyoid displacement measurements (HD_{max}) among men could be explained by the larynx position in the neck, and therefore there would be movements of greater amplitude during swallowing for the protection of the airways.

Studies evaluating the biomechanics of swallowing in dysphagic individuals[10,12,21-23] showed smaller amplitude of movement of the hyolaryngeal complex in some subjects compared to the healthy ones. Among men, the HD_{max} presented lower amplitude among dysphagic individuals when compared to healthy ones. However, HD_{max} was higher among some dysphagic women. Some authors have reported the existence of adaptive mechanism of the elevation of the hyoid bone in some individuals with dysphagia to reduce effects of the reduction in the duration of the laryngeal elevation[23]. In Figure 4, there are HLD measured among dysphagic subjects with aspiration and healthy ones.



Legend: LAD: Laryngeal anterior displacement; LVD: laryngeal vertical displacement; AHD: anterior hyoid displacement; VDH: vertical hyoid displacement

Figure 4. Hyolaryngeal displacement between dysphagic subjects with aspiration and healthy ones

The penetration and aspiration characteristics have also been quantitatively evaluated[3,6,10,11,22,24]. In most cases, individuals with aspiration show lower amplitude of hyolaryngeal movement in relation to healthy ones. It is noteworthy that some studies did not describe the moment of aspiration and, in addition, there is a volume and consistency variability of the assessed diet, factors that may have favored this overlapping of measures in dysphagic subjects compared to healthy ones.

A study compared the swallowing of subjects after Cerebrovascular Accident (CVA) and healthy ones and demonstrated association between aspiration and the reduction of the maximum vertical extension of the larynx and the hyoid bone[10]. Other researches have shown that the reduction of the hyolaryngeal excursion is associated with the highest risk of aspiration, including post-swallowing residues[3,22,24]. However, other studies did not show differences in the displacement of hyoid between subjects who aspired and who did not aspire[6,11]. The discrepancy among studies may be due to the absence of discrimination of the aspiration moment and therefore the mechanisms involved in the reduction of the airway protection could be related to other causes and not to the pharyngeal stage of swallowing. Thus, some authors suggested studies with analysis of swallowing considering the aspiration moment.

Conclusion

After the review, methodological differences were observed among the studies. However, there is a tendency to use the *ImageJ* program for the analysis of the measures, coin in the chin as reference of system calibration, fourth cervical vertebra as point of origin and swallowing analysis of thin liquid.

As methodology, hyolaryngeal displacement values were variables between genders, age and healthy and dysphagic subjects. This fact indicates the need for methodological standardization of quantitative investigation of hyolaryngeal displacement to favor the evidence-based practice.

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