Original Article

Comparative Analysis of Swallowing Efficacy in Young Adults and Geriatric Population by 100 mL Water Swallow Test

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Abstract

Introduction: This study aimed to carry out a comparative analysis of swallowing efficacy in young adults and geriatric population using the 100 mL Water Swallow Test (WST). **Materials and Methods:** A total population of 100 individuals performed WST which included 50 young adults and 50 geriatrics. Individuals were given 100 mL of water and were asked to drink at their comfortable pace with no spillage, gulp or residue in the cup. Meanwhile, the clinician counted the number of hyolaryngeal movements for swallowing by using the four-finger test and monitored the time taken to drink 100 mL of water using a stopwatch. **Results:** Result of the study revealed that among the parameters obtained, swallowing capacity and time per swallow was better in young adults than geriatrics. Volume per swallow parameter carried similar values in both young adults and geriatrics. **Conclusion:** The study findings thus show that 100 mL WST can be a tool to monitor and identify the swallowing efficiency. This study shows the importance of considering the influence of age-related changes in an elderly individual before reaching a diagnosis and carrying out rehabilitation of geriatrics with swallowing dysfunction.

Keywords: 100 mL Water Swallow Test, dysphagia, geriatrics, swallowing efficacy, young adults

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Introduction

The swallowing mechanism is susceptible to age-related changes due to variation in anatomical structures and physiology of the body. As age increases, there can be an alteration in the process of swallowing among adults and geriatrics.[1] Changes in swallowing mechanism are due to changes in anatomical structures involved in the swallowing process which can be attributed to the increased effort in swallowing, reduced muscular reserve in swallows and reduced muscular strength in elderly.[1-3]

The literature has reported a shorter distance between C2 and C4 in geriatrics as compared to that of young adults.[3] This can lead to the reduced maximum vertical and anterior hyoid movement in geriatrics as compared to young adults. Research shows that the decline in muscle strength due to a change in morphology and biochemistry of the fiber composition of the muscles can be the main reason for increased effort in swallowing by the elderly population.[4,5] The changes in the swallowing mechanisms and processes with age can influence the geriatric population's susceptibility to dehydration, malnutrition, dysphagia, and aspiration. Hence, it is necessary to screen the presence of dysphagia in elderly. The procedure of diagnosing a patient with dysphagia starts with a detailed case history and visual examination. Patients who are suspected of having dysphagia are screened using a variety of simplified screening tests that are available. Some of them include Burke Dysphagia screening test,[6] the Modified Evans Blue Dye Test,[7] and Water Swallow Test (WST).[8]

Among these tests, the 100 mL WST is a simple noninvasive procedure which is often used in clinical practice to screen individuals who might be at the risk of aspiration due to neurological problems.[8] The test is easy to administer and is cost-effective. It is quick and detects aspiration with high accuracy by having the patient swallow water.[9]

The clinical utility of this test has also been used in individuals with head and neck cancer to monitor their swallow performance.[8] The criteria for referral for further swallowing evaluation can

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include signs of aspiration, cough, postswallow gurgly voice quality, or inability to complete the task. The quantitative measures obtained from this test can serve as a measure of swallow efficacy over time. The swallowing behavior varies across different tastes such as neutral, sweet, sour, salt, and bitter. The literature has reported the neutral solution (i.e., plain water) has the greatest swallowing capacity, least time per swallow, and highest volume per swallow compared to other four tastes.[10] The literature has reported a specificity of over 50% and sensitivity of over 70% for carrying out WST in identifying swallowing dysfunction in individuals.[11]

This information guided us to study the swallowing efficacy in young adults and geriatrics by carrying out 100 mL WST in these groups of individuals. The performance of 100 mL WST by geriatrics and young adults can provide us with the quantitative measures which can reflect the age-related changes in the mechanism of swallowing. These numerical data can also help us understand the nonpathological changes that occur due to aging. Hence, the need for our study was to obtain the numerical data in our Indian population which can provide a stronger foundation for diagnosis and treatment of dysphagia.

Hence, the present study was aimed to carry out a comparative analysis of swallowing efficacy in young adults and geriatric population by 100 mL WST. Our objectives were to (1) obtain the numerical value of measures of swallowing performance among healthy young adults and geriatrics, in terms of swallow capacity, volume per swallow, and time per swallow and (2) understand the influence of gender in swallowing performance of healthy young adults and geriatrics.

Methods

The study was conducted after obtaining approval from the Institute Ethical Committee, and oral consent was obtained from all the individuals who were willing to participate in the study.

Study design

This study was a cross-sectional study carried out in three phases: Phase 1 – Data collection, Phase 2 – Data analysis, and Phase 3 – Statistical analysis.

Study population

A group of healthy young adults and geriatric individuals from southern India were selected randomly for the study. Both groups consisted of equal number of male and female population (25 males and 25 females).

Inclusion criteria

Individuals aged between 18 and 25 years (for young adults) and 60 and 88 years (for geriatric) of both gender in Indian population. Individuals who were well oriented, alert, and willing to undergo the test were only included in the study.

Exclusion criteria

Individuals with any history/presence of speech and language problems, cognitive deficits, neurological problems, or surgery done at the level of oral cavity, pharynx or larynx were excluded from the study. This information was obtained by reviewing their medical files and interaction with their caretakers.

Phase 1 – Data collection

A total population of 100 individuals performed WST which included 50 young adults within the age range of 18–25 years (mean: 19.78) and 50 geriatrics within the age range 60–88 years (mean: 69.44). The test procedure was explained in the individuals known language.

Procedure

Individuals were given 100 mL of plain water at normal room temperature which was measured in a standard measuring cup. The individuals were instructed to sit in a chair maintaining an upright posture and were asked to drink water continuously at their comfortable pace without any spillage or gulp. They were also instructed not to leave the liquid residue in the cup and hence should consume the whole 100 mL of water. The test was discontinued if the individual exhibited coughing or other signs of discomfort.

During the task, the number of hyolaryngeal movements for swallowing was counted by using four finger test and by lateral observation of the hyolaryngeal movement. The time was monitored using a digital stopwatch in seconds measure. Swallowing time was calculated from the time the water touched the lips till the subject exhibited final hyolaryngeal resting moment. Therefore, one elevation and one depression of the hyolarynx were counted as one swallow.

Phase 2 – Data analysis

The numerical parameters obtained from WST were as follows:

1. Volume per swallow = 100 mL of water/total number of swallows (ML/swallow)
2. Time per swallow = total time taken to swallow 100 mL of water in seconds/total number of swallows (s/swallow)
3. Swallow capacity = 100 mL of water/time taken to swallow 100 mL of water (mL/s).

Phase 3 – Statistical analysis

The analysis of numerical data was done using SPSS Statistics for Windows, Version 24.0 (IBM SPSS 21, IBM Corp., Armonk, NY: USA). Mean and standard deviation for the parameters was determined. Statistical analysis was carried out using the parametric *t*-test. Mann–Whitney U test nonparametric test was carried out for swallowing capacity measures across age and across gender in young adults since measurement values did not fall into the normal distribution curve. The values were considered as significant if it had a cutoff value of 0.05 ($P < 0.05$) is considered statistically significant.

Results

All the individuals were successfully able to swallow the complete 100 mL of water without leaving any residue on the cup.

The results and data obtained are as follows:

Swallowing capacity

This measurement monitors the time taken by the individual to take in 100 mL of water. The unit of measurement is mL/s. The result of the study indicated that the young adults were able to have an intake of more amount of water in 1 s than geriatrics, indicating better swallowing capacity in young adults. These values were found to be statistically significant and are represented in Table 1.

Tables 2 and 3 indicate a comparison of the swallow capacity across genders among young adults and geriatrics, respectively. The values obtained for swallowing capacity across gender in young adults indicated better swallowing capacity in males than females. In geriatrics, females had greater values for swallowing capacity than males. The numerical values in both groups were statistically significant

Time per swallow

The time per swallow measurement is useful in indicating mean time taken for carrying out one hyolaryngeal movement involved in the swallowing process by an individual. This is measured in s/swallow. The mean value obtained for this measurement is depicted in Table 4, which revealed less duration in young adults for completing one swallow as compared to that of geriatrics. The values were observed to be statistically significant in young adults as compared to that of geriatrics.

When compared across genders, Table 5 reflects statistically insignificant value across gender in young adults. Table 6 indicates males as having longer time per swallow measurement values than females in geriatric population, which was statistically significant

Volume per swallow

The measurement of volume per swallow represented the volume of water intake during each swallow and is represented in the unit of mL per swallow. Table 7 reflects the numerical values obtained for this measurement which was found to be similar in young adults and geriatrics. There was no statistically significant difference between these groups. This indicates that the amount of water intake was the same in young adults and in geriatrics.

When the volume per swallow was compared across gender in young adults, Table 8 shows that male have more volume per swallow than female. Table 9 represents volume per swallow compared across gender in geriatrics; results revealed female had a greater value than males for the same. Both findings were found to be statistically significant

Discussion

The study findings indicate that 100 mL WST is an effective tool to monitor and identify the swallowing efficiency in geriatrics. The result supports the literature and proves the hypothesis of the study stating that the swallowing efficiency reduces with aging. The term "presbyphagia" is the term quoted in the studies for referring to such changes in swallowing mechanism in elderly.[12]

Table 1: Mean swallowing capacity in young adults and geriatrics

Parameter measured	Young adults		Geriatrics	
	Mean	SD	Mean	SD
Swallowing capacity (ml/sec)	9.77	3.96	7.23	3.36
P	0.000			

SD: Standard deviation

Table 2: Mean swallowing capacity across gender in young adults

Parameter measured	Male		Female	
	Mean	SD	Mean	SD
Swallowing capacity (ml/sec)	11.54	4.6	8.01	1.95
P	0.004			

SD: Standard deviation

Table 3: Mean swallowing capacity across gender in geriatrics

Parameter measured	Male		Female	
	Mean	SD	Mean	SD
Swallowing capacity (ml/sec)	6.21	0.46	8.24	0.78
P	0.031			
t	−2.21			
df	48			

SD: Standard deviation

Table 4: Mean time per swallow in young adults and geriatrics

Parameter measured	Young adults		Geriatrics	
	Mean	SD	Mean	SD
Time per swallow (sec/swallow)	1.23	0.28	1.82	0.64
P	<0.001			
t	−5.88			
df	98			

SD: Standard deviation

Table 5: Mean time per swallow across gender in young adults

Parameter measured	Male		Female	
	Mean	SD	Mean	SD
Time per swallow (sec/swallow)	1.23	0.06	1.24	0.04
P	0.89			
t	−0.13			
df	48			

SD: Standard deviation

The reduced swallowing capacity of geriatrics can be attributed to the reduction of the mean volume of the bolus, and prolongation of each swallow which could be due to increased effort in swallowing among geriatrics.[1] Another reason for the same can be related to the decline in the muscle strength as the age declines.[4]

Table 6: Mean time per swallow across gender in geriatrics

Parameter measured	Male		Female	
	Mean	SD	Mean	SD
Time per swallow (sec/swallow)	2.09	0.31	1.55	0.09
P	0.002			
t	3.20			
df	48			

SD: Standard deviation

Table 7: Mean volume per swallow in young adults and geriatrics

Parameter measured	Young adults		Geriatrics	
	Mean	SD	Mean	SD
Volume per swallow (ml/swallow)	11.73	4.63	12.07	4.28
P	0.710			
t	−0.37			
df	98			

SD: Standard deviation

Table 8: Mean volume per swallow across gender in young adults

Parameter measured	Males		Females	
	Mean	SD	Mean	SD
Volume per swallow (ml/swallow)	13.53	1.06	9.93	0.60
Value	0.005			
t	2.95			
df	48			

SD: Standard deviation

Table 9: Mean volume per swallow across gender in geriatrics

Parameter measured	Male		Female	
	Mean	SD	Mean	SD
Volume per swallow (ml/swallow)	8.01	0.39	11.77	0.84
Value	<0.001			
t	−4.04			
df	48			

SD: Standard deviation

While considering the gender comparison, in young adults, male had better swallowing capacity than females. This finding was supported by literature which reported longer oropharyngeal transit time, longer upper esophageal opening time in women than in men, leading to better swallowing capacity in males than in females.[13] However, in geriatrics, females had a better swallowing capacity than males. Authors assume that this could be due to the age-related changes that could have been reflected more evidently in males than in females.

The comparison of mean value obtained for time per swallow indicated longer time was needed for geriatrics, as compared to that of young adults. The increased time taken by geriatric individuals for swallowing supports the literature indicating that the swallowing efficiency reduces with aging.[14] The first factor for this finding could be reduced strength and range of motion of muscles in the oral cavity and aerodigestive system of elderly.[15] The other factor might be the breathing pauses, due to the changes in the swallowing breathing coordination, as a compensatory protective mechanism rather than decreased muscular mobility.[16] The longer time per swallow in geriatrics can be understood as a part of the temporary cessation of breathing that can delay the process of swallowing in elderly.[17] Across gender, there was no significant variation in young adults indicating similar timing in males and females during swallow. In geriatrics, there was lesser time taken for females than in males. This can be due to shorter inter swallow intervals reported in females than in males.[13]

The comparison of the mean value obtained for the volume per swallow indicated slight increase in the value for geriatrics, which could be attributed to their increase in the overall size of the oral cavity compared to the young adults. However, this was not statistically significant. On comparison of gender effect, in young adults males had larger volume per swallow measure than females. This supports the study which reported larger oral and pharyngeal cavity in men than in women, which allows a large bolus volume to be swallowed by men.[18,19] The literature supports this finding by reporting higher anthropometric measures in men which indicates that men have the capacity to place a larger volume of water inside their mouth than women.[20]

Conclusion

The speech and swallowing therapist should consider the influence of age-related changes in an elderly individual before reaching a diagnosis and carrying out rehabilitation of geriatrics with swallowing dysfunction. The study concludes by observing that among the three parameters, only swallowing capacity and time per swallow was significantly varied among young adults and geriatrics. Young adults could take in more amount of water in a second, indicating better swallowing capacity in young adults than in geriatrics. Similarly, the time taken for each swallow was shorter for young adults than geriatrics. Thus, indicating that the swallowing capacity and time per swallow is the key parameters that can reflect the age-related changes in the mechanism of swallowing. Across gender, in young adults, male had better swallowing measures than female, and in geriatrics, female was observed to have better measures than male. This was seen evidently in the numerical values obtained mainly for swallowing capacity and volume per swallow. Thus, of the 100 individuals tested, the mean values obtained for the swallowing capacity and time per swallow were found to be statistically significant across the age groups. The higher value of swallowing capacity of young adults indicates better swallowing capacity in young adults as compared to that of geriatrics.

The future direction for the study also involves identifying the ideal volume of water to be consumed during the screening tests and trying to obtain normative across wider age range, to avoid false-positive results. The necessity for screening elderly for swallowing functions will improve our quality of service to the population

The main strength of the study was the number of participants and the simple procedure of WST. The numerical values can be considered as another important point which can add on to the correlation of our perceptual findings regarding swallowing status of the individual. The limitation of the study points toward restriction of study data to one specific area of the city. The lack of normative data among the Indian population for the comparison of the present data for better validity of result can be considered as another drawback of study.

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Conflicts of interest

There are no conflicts of interest.

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