Effect of visual feedback on manipulation of effort during swallowing in Persons with Parkinson's disease and age and gender matched normal aging individuals: A comparison

by Unknown Author

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Abstract

Key words: Swallow sound, Cervical Auscultation, Visual Feedback, Parkinson's disease

Swallowing is complex mechanism marked by a chain of events timed in a successive manner. One such event is the production of the swallow sound which signifies the protective mechanism i.e. the closure of the respiratory tract and the opening of the upper oesophageal sphincter. Swallow sound can be recorded using Cervical Auscultation (CA) procedure, wherein a microphone is placed at the level of the thyroid lamina and swallow sound is recorded. The present study aimed at comparing two measures i.e duration and amplitude measure using CA procedure in persons with Parkinson's disease (PD) (Group I) and age matched typically aging individuals (Group II) in with (Condition I) and without visual feedback (Condition II) conditions. Participants included 10 males with first stage of PD as diagnosed by Neurologist and equal number of age matched typically aging individuals. 10 ml honey thick liquid was used. Two microphones were taken and housed inside the earpiece of a stethoscope which was then attached with a Velcro strap. The wires from the microphones were joined together and connected to a Personal computer loaded with PRAAT software. Patients were made to swallow the liquid with the steth placed at the level of thyroid lamina in both the conditions and the measures are recorded. Statistical analysis revealed significant difference between both the groups and the conditions. With visual feedback alone there was improvement in the strength of swallow which implies that CA can be projected an effective assessment as well as therapeutic tool.

Background

As easy as it may appear to be, swallowing is a complex process marked by a chain of successive events, one among which is the production of swallow sound (Shelley, Ellis, Brookes & Flack, 1990). Lear et al. (1965) suggested that swallowing sounds may arise from opposition and parting of the mucous membrane while the bolus flows into the pyriform sinus. The origin of this swallow sound however has been a matter of great debate. A number of studies have reported various physiological origins of the swallow sound, which includes opening of upper oesophageal sphincter and descend of the larynx (Selley, Ellis, Flack, Baylis & Pearce, 1994), beginning of the apnic period (Perlamn, Ettema & Barkmeier, 2000), sub mental muscular activities and onset of apnic period (Klahn& Perlman, 1999).

For the ease of assessment and treatment, this complex process is further divided into four different phase i.e. oral preparatory phase, oral phase, pharyngeal phase and oesophageal phase. Any difficulty in any one or combination of these phases can lead to swallowing problem or dysphasia. Anyone can have a swallowing disorder, but it is more likely in the elderly and in persons with congenital or acquired neurological conditions. Swallowing problems are commonly seen in persons with Cerebral Palsy, Stroke, Parkinson's disease, Gastroesophageal Reflux disease (GERD), Head or spinal cord injury, Cancer of the head, neck or oesophagus, etc.

One of the most popular non-invasive methods of recording this swallow sound is Cervical Auscultation (CA), wherein a microphone is placed at the level of the thyroid lamina and swallows sound is recorded.CA has gain popularity by the fact that it helps to easily identify persons who have aspiration (Zenner, Losinski & Mills, 1995). One such condition wherein the problem with swallowing is more is Parkinson's disease (PD). Studies suggest that the persons with PD have increased risk of aspiration, decreased posterior tongue movement, residue in pyriform sinuses and vallecular (Leopold, 1997; Leopold & Kagel,

1997). In a recent study by Luchesi, Kitamura and Mourao (2015), the authors used CA procedure in persons with PD and reported presence of stasis or penetration with aspiration risk. So far CA has majorly been used as a diagnostic tool. There are no studies which report the usage of CA procedure as a therapeutic tool especially as a visual feedback device.

Heuvel et. al. (2013) used visual feedback as a therapeutic tool for balance training in individuals with PD. However there are no studies which have used feedback in swallowing issue in persons with PD. It would be clinically relevant to see the production of swallow sound in this group and how it can be manipulated using visual feedback. Considering that CA is a sensitive measure, a study employing CA procedure and visual feedback would give us more insight on treating swallowing issues in the clinical group of interest. The aim of the present study was to compare duration and amplitude measure using CA procedure in persons with PD and typically aging individuals in with and without visual feedback conditions. And with effort and without effort swallowing condition.

Material and Method:

Participants: The participants in the study were divided into two groups; control group (group I) and clinical group (group II). Group I consisted of 10 males diagnosed with PD (early stage of PD as diagnosed by neurologist). The participants in group II consisted of age matched typically aging individuals. All the participants were in the age-range of 60-70 years. Participants in both the groups were screened for any kind of sensory, motor, neurological and/or cognitive impairment using appropriate screening tool.

Materials and Instruments: For the purpose of data collection, honey thick liquid was used. This consistency was obtained by mixing one spoon to thickener with three spoons of water and shaking it. 10 ml of this liquid was measured with the help of a measuring cup and given to the participants to swallow. The recording device was made by taking two microphones

which were housed inside the earpiece of a stethoscope. This was then attached with a Velcro strap. The wires from the microphones were joined together and connected to a Personal computer loaded with PRAAT software. This acted as the recording device. The instrumental set-up used in the present study is shown below in figure 1.

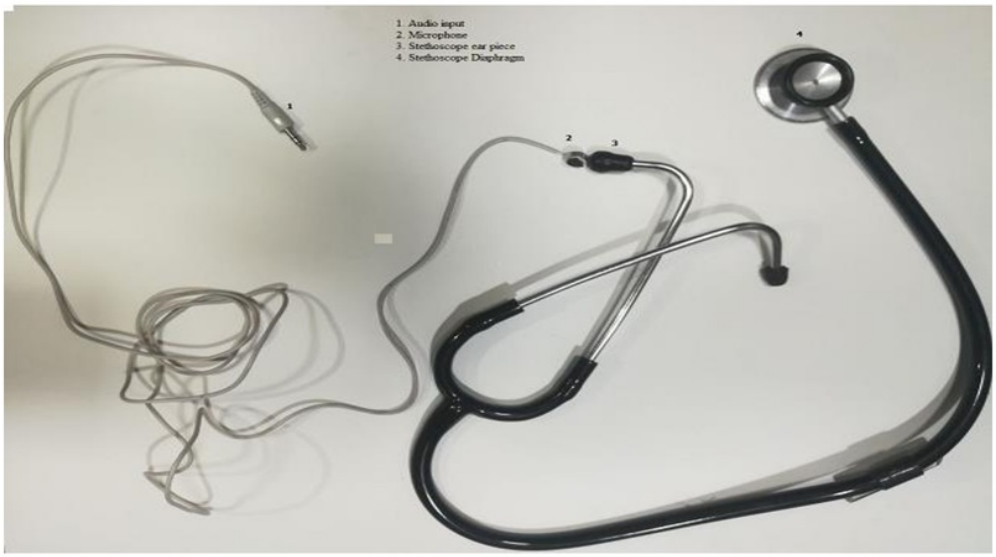

Figure 1: The instrumental set-up used for the purpose of data collection

Procedure: The participants were made to sit comfortably on a chair and were prepared for data collection by cleaning the laryngeal region with diluted spirit. The collection of data took place in two steps. In the first step (condition I), the investigator located the thyroid lamina of the participant by asking his/her to swallow saliva (dry swallow). Then Thyroid lamina was cleaned with spirit and the diaphragm of the stethoscope was placed. Later the participants were given 10ml of honey thick liquid and asked to swallow. The data was recorded by asking the participants to swallow effortlessly. The recorded swallow sound waveforms were shown to the participants. In the second step (condition II), the participants were instructed to swallow by putting more effort so that the amplitude of the swallow sound recorded is more than that in first step. For each of the step, three trials were given and the

best one was selected for analysis. The recorded swallow sound was analyzed for relative amplitude and duration in the first and second step. The amplitude was measured from baseline to the maximum visible activity on the swallow sound waveform as shown in figure 2. The duration of the swallow sound was measured from the beginning to the end of the waveform. The values obtained were compared within and across group. The analyzed data was subjected to statistical analysis using SPSS 17.0.

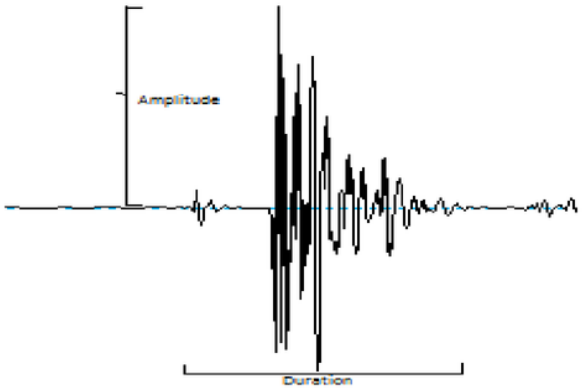

Figure 2: The swallow sound waveform as recorded using PRAAT software

Results

Comparison of swallow sound duration in group I and II for condition I and II

The duration was calculated manually by the investigator by moving the cursor on the computer screen from the beginning of the waveform to the end of it as shown in figure 2. The data collected was statistically analyzed using SPSS 17.0. Test of normality was carried out to see if the data followed normal distribution. Based on the results of this test, non-parametric statistics was used. The mean duration of swallow sound for group I and II for both the conditions are shown in table 1 and the same is depicted in figure 3.

Mann Whitey U Test was done to see if there was any significant difference between the groups for condition I and II for duration parameter measured. The results of the test revealed significant difference between the groups for condition I and II ($p<0.05$).

Table 1

Mean duration of swallow sound in group I and II for condition I and II

Number of participants	**Persons with PD (Group I)**		**Typically aging individuals (Group II)**	
	Without visual feedback (Condition 1)	With visual feedback (Condition II)	Without visual feedback (Condition 1)	With visual feedback (Condition II)
1.	7.709	3.775	1.77	1.89
2.	3.306	2.251	2.81	1.273
3.	3.148	2.415	1.95	1.84
4.	3.394	2.263	1.69	1.48
5.	6.105	5.561	1.68	2.08
6.	12.94	7.607	2.22	1.414
7.	3.376	1.95	2.68	1.69
8.	2.89	1.86	1.87	1.92
9.	5.839	2.761	1.68	1.43
10.	4.48	3.02	1.54	1.22

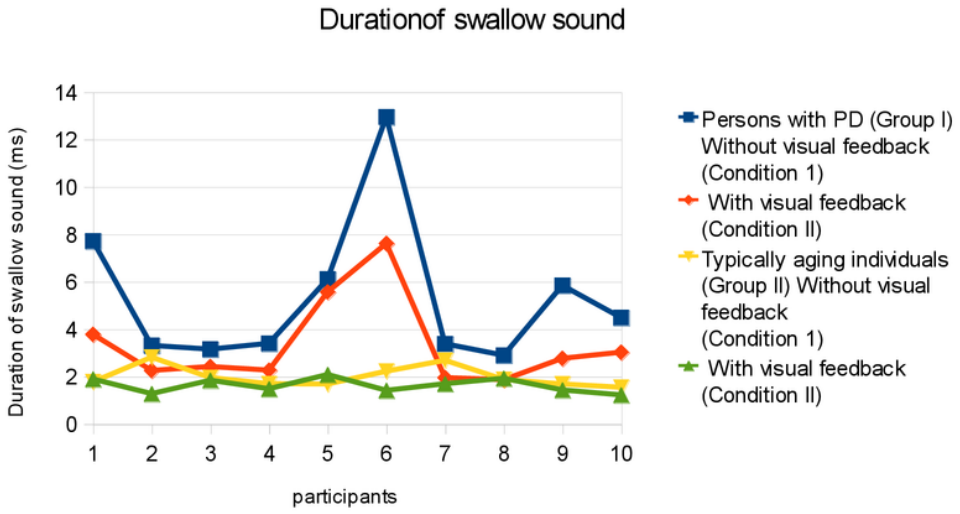

Figure 3: Mean duration of swallow sound in group I and II for conditions I and II

Comparison of swallow sound amplitude in group I and II for condition I and II

The amplitude of the swallow sound was calculated manually by the investigator from the baseline of the visible waveform to the peak. Amplitude was calculated separately for all the participants for both the conditions. The mean amplitude of swallow sound in group I and II for both the conditions is given in table 2 and the same is depicted in figure 4. For the purpose of Statistical Analysis, Mann Whitey U Test was carried out to see if there was any significant difference in the amplitude measured between the groups for condition I and II. The results revealed that there was no significant difference between groups for both the conditions ($p>0.05$). This implies that the strength of swallowing which is depicted as amplitude in the present study was similar across groups of participants. Further to see if there was significant difference within the group for condition I and II, Wilcoxon Signed Rank test was used, which revealed significant difference in group I for duration measure

($p<0.05$). However there was no significant difference seen in group II for this measure ($p>0.05$).

Table 2

Mean amplitude of swallow sound in group I and II for condition I and II

Number of participants	**Persons with PD (Group I)**		**Typically aging individuals (Group II)**	
	Without visual feedback (Condition 1)	With visual feedback (Condition II)	Without visual feedback (Condition 1)	With visual feedback (Condition II)
1.	68.20	80.91	81.88	83.10
2.	55.48	67.34	82.31	83.79
3.	74.82	79.67	80.14	82.81
4.	60.21	73.07	70.17	79.49
5.	73.1	80.79	70.32	75.26
6.	61.3	69.9	69.20	80.84
7.	71.35	78.04	59.88	78.15
8.	68.56	75.36	67.02	72.93
9.	65.26	73.21	74.70	83.27
10.	62.21	68.81	72,63	77.84

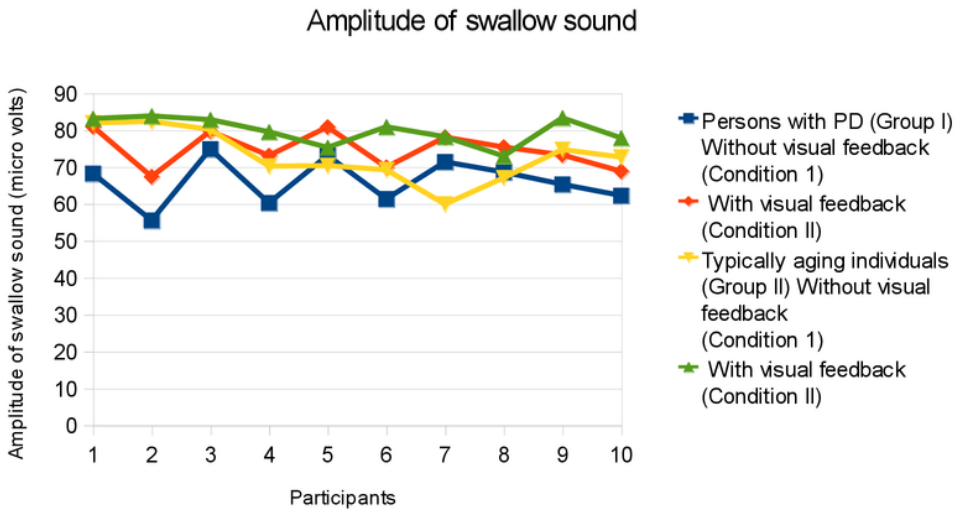

Figure 4: Amplitude of swallow sound in group I and II for conditions I and II

Discussion

The findings of the present study have given insights on the possible use of feedback as therapeutic tool for treatment of swallowing deficits in persons with PD. The duration of swallow required for normal aging individuals was lesser compared to persons with PD. This finding can be justified by the fact that rigidity is one of the most common clinical symptoms of PD as a result of which there would be delay in transition of bolus from one phase to another. Similar findings were also reported in another study by Howard and Kirshner (1986) wherein the authors reported abnormal oropharyngeal movement patterns and timing during the volitional oral as well as the pharyngeal stage of swallowing. There was reduction in the duration of swallow in condition II which implies that with visual feedback there was better manipulation of bolus movement.

The amplitude of swallow sound was again lesser in persons with PD compared to normal aging individuals which again can be attributed to rigidity of muscles involved in swallowing thus leading to restricted movement. The amplitude increased in condition II in the clinical group. It implies that with visual feedback there was improvement seen in the

bolus transition time of persons with PD but not that of typically aging individuals. Thus visual feedback can be advocated as a therapeutic tool in treatment of swallowing deficits. However, for these findings to be generalised, the study needs to be replicated with a larger group of participants in both the groups

Conclusion:

This study is first of its kind to employ a simple stethoscope and use it as a feedback device to in addressing swallowing deficits in Persons with PD. The study was a preliminary attempt and the findings of the present study only give a rough insight on how visual feedback can be used as a therapeutic tool for treating swallowing disorders. This study has used a simple stethoscope with a microphone to record the swallow sound. The instrumental set-up used in the study is very simple, feasible and can easily be handled by Speech Language Pathologist with little knowledge on swallowing physiology. However, the findings should be generalised to caution. A similar study employing larger number of subjects in both the groups and wider clinically diverse population would given a more promising conclusion.

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