

# Swallowing Impairments in Persons with Brain Damage

*by* Goswami S.p.

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## PROJECT PROPOSAL

### Part –A

- 1.0 Title of the Project** : Swallowing Impairments in Persons with Brain Damage
- Area of Research** : Speech, Language, Hearing
- 1.1 Principal Investigator** : Dr. S.P.Goswami
- 1.2 Principal Investigator(s) Co-** : Ms. Gayathri Krishnan, Ms. Manju Mohan  
Dr. Muralidharan Nair, & Dr. Sylaja
- 1.4 Collaborating Institution** : Sree Chithira Thirunal Institute of Medical Sciences,  
Trivandrum
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- 1.5 Total Grants Required** : ₹ 4,53,000  
**2 figures and in words)** Four Lakh Fifty three thousand Rupees Only
- 1.6 Duration of the Project** : One year

**2.0 Project Summary(Max. 300 words):**

Prevalence of swallow function impairments in persons with various neurological condition ranges from 8.1% to 81% (Takizawa, Gemmell, Kenworthy & Speyer, 2016). Though characteristics of post stroke dysphagia is widely studied, there is a dearth of data on physiology of swallowing impairments in conditions other than stroke such as Parkinson's disease, Amyotropic Lateral Sclerosis, and Motor Neuron Diseases. Studies reported in this direction over the past two decades have focused on pharyngeal functions without understanding the influence of impairments in the oral and esophageal stages. This study will aim at identifying the most prevalent impairment in physiology of swallow in persons with neurological disorders at the oral, pharyngeal and esophageal stages of swallow and comparing the bolus accommodations made by the impaired swallow system in these individuals. The study will include 'n' number of dysphagic participants with a CNS impairments who will undergo a detailed videofluoroscopic swallowing study using five bolus consistencies. Each swallow will be analyzed on 17 oral, pharyngeal and esophageal components of Modified Barium Swallow Impairment Profile (MBSImp™). Comparison of the MBSImp scores across neurological conditions and across bolus consistencies in each condition will be performed using non-parametric tests. The findings of this study will provide details of the most common physiological function impaired in various neurological conditions for effective rehabilitation planning and will act as a base against which other non-invasive assessment measures can be sensitized for routine assessments. The finding of intergroup comparison is expected to reveal the differences in pathophysiology of neurological impairment in the participant group.

### 3.0 Introduction

#### 3.1 Definition of the problem:

Prevalence of swallow function impairments in persons with various neurological condition ranges from 8.1% to 81% (Takizawa, Gemmell, Kenworthy & Speyer, 2016). Though characteristics of post stroke dysphagia is widely studied, there is a dearth of data on swallowing impairments in conditions other than stroke such as Parkinson's disease, Amyotrophic Lateral Sclerosis, and Motor Neuron Diseases. Studies reported in this direction over the past two decades have focused on pharyngeal functions without understanding the influence of impairments in the oral and esophageal stages.

#### 3.2 Objectives:

The specific objectives of the study is :

1. To score the VFSS recordings of persons with neurological dysphagia on MBSImP™ protocol for swallow of five bolus consistencies and obtain mean scores for each oral, pharyngeal and esophageal component of swallow.
2. To compare the mean impairment scores of the oral, pharyngeal and esophageal component of swallow across neurological conditions.
3. To compare the mean impairment scores of the oral, pharyngeal and esophageal component of swallow across bolus characteristics within each neurological condition.

#### 1 3.3

#### Review of status of research and development in the subject:

Swallowing is a semi-automatic function through which food placed inside the mouth is pushed into the stomach through a series of complex, interlinked actions of the structures of mouth, pharynx and esophagus. This action is triggered and controlled by cortical and brainstem structures through complex neuronal networks. Execution of the swallowing act is brought about by the sensori-motor interplay of central and peripheral nervous system. A lesion at any level of nervous system (Central or Peripheral) can thus result in an impaired swallowing function called neurologic dysphagia.

Dysphagia is a condition of impaired swallowing at the oral, pharyngeal and/or esophageal stages with its effects not limited to having swallowing difficulty but can lead to poor physical and emotional well being. Direct effect of dysphagia includes malnutrition, loss of weight and poor physical health but can extend itself to poor quality of life due to its social impact (Nguyen et.al., 2005; Chen, Golub, Hapner & Johns, 2009). Identification and diagnosis of swallowing impairments rely on clinical assessment procedures (Logemann, Veis & Colangelo, 1999; Ramsey, Smithard & Kalra, 2002; Mathers-Schmidt & Kurlinski, 2003) as well as various imaging procedures such as Videofluoroscopic Swallowing Study (VFSS), Flexible Endoscopic Evaluation of Swallowing (FEES), Scintigraphy, Ph Monitoring and X-ray. Among these, Videofluoroscopy is

considered as the 'Gold Standard' in swallowing assessment procedures though concerns of its radiation hazards are frequently addressed. Methodologies that limit the time of radiation exposure without compromising on details of the swallowing impairment have been developed so as to provide the speech-language pathologist with opportunities to understand the swallowing impairment of a client (Martin-Harris & Brodsku, Michel, Castell, Schleincher, Sandidge, Maxwell & Blair, 2008).

Symptoms of dysphagia in persons with neurological conditions include drooling, difficulty in initiation of swallowing reflex, nasal regurgitation, difficulty managing oral secretions, choking or episodes of cough while feeding and globus sensation at the upper or lower pharyngeal area (Buchholz, 1994). These symptom presentations are also seen in other muscular and structural abnormalities of swallow system (Koufman, 1991; Vakil & Levine, 2004; Prasse, 2009). Thus, there is no clear differentiation of neurological and non-neurological causes of dysphagia from its symptom presentation. However, there may be differences in physiology of impaired swallow that causes dysphagia symptoms in a person with neurological impairments.

Videofluoroscopic Swallowing Examination (VFSE), also called Modified Barium Swallow Study (MBSS) is one imaging method with which detailed information on swallowing physiology can be obtained real time on a radiographic film. The procedure is conducted in a radiology room with a radiologist and speech-language pathologist (SLP) with the SLP leading the test with decisions on barium mixed bolus type, volume, and method of presentation to the person undergoing the procedure. The effect of modified swallowing strategies on safety of swallow can also be obtained using this procedure. The VFSS procedures are extensively used in studies related to typical and atypical swallow characteristics. However, the risk factors involved such as long duration and dosage of exposure to radiation in VFSS alarms caution on its application. There are VFSS protocols developed by Logemann (1993) and Martin-Harris et.al. (2009) which outlines the duration of safe exposure to x-ray radiation in VFSS Studies. The protocol described by Martin-Harris et.al. (2009) is presently gaining popularity and is being used in recent published reports such as Sandidge (2009) and Gullung, Hill, Castell, Martin-Harris (2012) for studying atypical swallowing physiology.

- 3.4 International and national status:  
Recent studies on neurological dysphagia is confined to understanding prevalence of dysphagia in neurological disorders (Marik, 2003; Gonzalez-Fernandez, Kuhlemeir, & Palmer, 2008; Falsetti, acciai, Palilla, Bosi, carpinteri, & Zingarelli, 2009; Takzawa, Gemmell, Kenworthy & Speyer, 2016) and few other studies report the symptom presentation in this group of clients (Johnston, Li, Castell & Castell, 1995; Kalia, 2003; Singh, 2006; Barichella, Cereda, Madio, Iorio, Pusani, & Cancellato; 2013).



A review of published literature on specific swallowing impairments in neurological dysphagia reported impaired oral and pharyngeal stage functions (Kendall & Leonard, 2000; Ellerston, Heller, Houtz & Kendall, 2016; Kendall, Ellerston, Heller, Houtz, Zhang & Presson, 2016; Suttrup & Warnecke, 2016), sluggish rather than decreased hyo-laryngeal movements in post stroke dysphagia (Seo, Oh, & Han, 2015) and reduced pharyngeal constriction, delayed airway closure in persons with Parkinson's disease. Though the reports suggest pharyngeal impairments rather than oral and esophageal impairments in persons with neurological dysphagia, the coexistence of speech impairments in persons with neurological conditions suggest a possible oral stage involvement. Also, a study by Gullung, Hill, Castell, and Martin-Harris (2012) found an association between components of pharyngeal and esophageal functions. Similar associations may exist between oral and pharyngeal components of swallow, which needs to be probed further.

Further, studies on understanding neurologic dysphagia are skewed towards understanding post stroke dysphagia (Singh, 2006; Cary, Carnaby, Sia, Khanna, & Waters, 2013; Falsetti, acciai, Palilla, Bosi, carpinteri, & Zingarelli, 2009; Gonzalez-Fernandez, Kuhlemeir, & Palmer, 2008; Cecconi, Campiglio, Toscano, Petolicchio, Capiluppi, & Bertora, 2011) and neglect other neurologic causes of dysphagia. Studies to understand the pathophysiology behind swallowing disorders in acquired neurologic conditions other than stroke is scarce and this lacunae needs to be filled for enhancing our knowledge of most prevalent swallowing impairments in such clinical population.

From Indian scenario, limited attempts have been made to study the underlying physiology of swallow in persons with acquired neurologic conditions.

Studies on swallowing impairments in persons with neurologic conditions report that neurogenic dysphagia prevale in 8.1 to 81% of the clinical population. Diagnosis and rehabilitation plan is made based on clinical observations and Video-fluoroscopic swallowing study (VFSS) in most clinical set up. However, the reports on neurogenic dysphagia scatters around dysphagia symptoms presented by persons with neurologic dysphagia and variation of these symptoms as a function of bolus characteristics (Buchholz, 1994; Clave, Kraa, Arreola, Girvent, Farre, Palomera & Serra-Prat, 2006; Hughes & Wiles, 1996; Logemann, Pauloski, Colangelo, Lazarus, Fujii & Kahrilas, 1995), rather than reporting the swallow function that is impaired in these clients. Most of the reported findings in VFSS confine to presence or absence of penetration-aspiration. This lacuna shows an incomplete understanding of the swallowing impairment in persons with neurogenic dysphagia.

The review of studies reported in the past two decades on

physiology of atypical swallows concentrates on aging population (Kendall & Leonard, 2000; Kendall, Leonard, McKenzie, 2004, Kendall, Leonard, McKenzie, 2004) and post stroke dysphagia (Seo, Oh, & Han, 2015). Limited reports are available on physiological impairments in other neurological conditions such as Parkinson's disease (Argolo, Sampaio, Pinho, Melo, & Nobrega, 2015; Ellerston, Heller, Houtz & Kendall, 2016), Amyotropic Lateral Sclerosis (Solazzo, Monaco, Del Vecchio, Reginelli, Iacobellis, Capasso, Tamburrini, eritto, Barillari, Monsurro, Martino & Grassi, 2016), and Motor neuron diseases. A recent review by Takizawa, Gemmell, Kenworthy, and Speyer (2016) on dysphagia in Stroke, Parkinsons disease and Alzheimers Disease also reported limited number of studies in Parkinson's and Alzheimer's disease.

Studies that report of swallow function impairments in persons with neurological dysphagia are skewed towards measurement of kinematic variables such as transit times (Kendall, Ellerston, Heller, Houtz, Zhang & Presson, 2016; Kendall, McKenzie, Rebecca, Leonard, Goncalves, Walker, 2000, Ellerston, Heller, Houtz & Kendall, 2016, Kendall, Leonard, McKenzie, 2004; Argolo, Sampaio, Pinho, Melo, & Nobrega, 2015), timing of hyo-laryngeal movements (Kendall, Ellerston, Heller, Houtz, Zhang & Presson, 2016, Kendall, McKenzie, Rebecca, Leonard, Goncalves, Walker, 2000, Leonard, Kendall, McKenzie, Goncalves & Walker, 2000, Ellerston, Heller, Houtz & Kendall, 2016, Kendall & Leonard, 2000, Kendall, Leonard, McKenzie, 2004; Seo, Oh, & Han, 2015; Solazzo, Monaco, Del Vecchio, Reginelli, Iacobellis, Capasso, Tamburrini, eritto, Barillari, Monsurro, Martino & Grassi, 2016) and UES function (Kendall, Ellerston, Heller, Houtz, Zhang & Presson, 2016; Kendall, McKenzie, Rebecca, Leonard, Goncalves, Walker, 2000; Leonard, Kendall, McKenzie, Goncalves & Walker, 2000; Kendall & Leonard, 2000; Solazzo, Monaco, Del Vecchio, Reginelli, Iacobellis, Capasso, Tamburrini, eritto, Barillari, Monsurro, Martino & Grassi, 2016). Studies on oral function and esophageal functions in persons with neurological dysphagia are scarce. Understanding the pharyngeal impairments cannot be complete with negligence of oral and esophageal components as their exists associations between various swallow functions at each stage of swallow (Gullung, Hill, Castell, Martin-Harris, 2012)

It is hypothesized that if associations exist between impaired swallow functions at the oral, pharyngeal and esophageal stages of swallow in neurological dysphagia, detailed understanding of the impaired physiology in this population may reveal patterns of impairment specific to the condition the participant is diagnosed with. If such patterns are revealed, it can be helpful for the speech-language pathologists working on rehabilitation of neurological swallowing disorders to design a most appropriate swallow strategy specific to the clinical population. For example, specific techniques for enhancing tongue base retraction may be helpful in neurologic dysphagia group susceptible to tongue base retraction deficits.

The VFSS procedure can provide details on various swallow functions in typical and atypical swallows and these functions can be evaluated using standardized protocols such as the Modified Barium Swallow Impairment Profile (MBSImp™). This protocol evaluates each swallow on 17 components and provides scores from a range of 0-4. Understanding the variability of atypical swallows in neurological dysphagia across various neurological conditions and bolus characteristics can provide information on differences in the underlying pathophysiology and the ways in which an impaired neurological system accommodates variations in bolus characteristics for maintaining safe swallow.

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#### **Importance of the proposed project in the context of current status:**

This study is proposed to fill in some of the lacunae identified in the literature on physiology of swallow in neurological dysphagia using the 'gold standard' in dysphagia assessment, i.e. Videofluoroscopic Swallowing Study, scored on a recent, standardised and internationally applied protocol called Modified Barium Swallow Impairment Profile (MBSImP™) on few categories of neurological dysphagia to understand the oral, pharyngeal and esophageal components of swallow that are impaired. This study also aimed at understanding the bolus accommodations made by the swallow system in the neurological conditions studied.

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### **Work Plan**

#### **4.1 Method**

##### ***Participants***

The study will consist of N number of persons with acquired neurogenic dysphagia ( $N \geq 10$ ) such as Stroke, Motor Neuron Disease, Parkinson's disease, and Amyotrophic Lateral Sclerosis referred for swallowing assessment at the outpatient clinic of collaborating institution, selected based on the following inclusion criteria:

1. Report of symptoms of difficulty in swallowing as in the Clinical Evaluation Protocol for swallowing in Adults (Indigenous protocol developed by Gayathri & Manjula, 2014)
2. Diagnosed with a neurological condition by a qualified medical professional.
3. Has been on oral feed for daily living.
4. Ready to provide written consent for participation in the study.
5. No structural abnormalities of oral, pharyngeal, laryngeal or esophageal structures.
6. No history of swallowing disorders prior to onset of the diagnosed neurological condition.

##### ***Equipment Used***

Videofluoroscopic Imaging instrument and five type of bolus consistencies (Water, Rice starch, Honey, Yogurt, Biscuit)

##### ***Procedure***



The participants will be made to undergo a detailed videofluoroscopic swallowing study (VFSS) in a radiology room under the supervision of a speech-language pathologist and also a radiologist in a pre-determined bolus presentation protocol developed by Martin-Harris et.al. (2008) (Table 1).

Table 1: The bolus presentation protocol used for obtaining the VFSS recordings (Martin-Harris et.al., 2008)

Swallow number	Type of bolus	Bolus volume	Mode of presentation	Type of swallow
<b>Lateral View</b>				
1.	Thin liquid (Water)	5 ml	Tea spoon	Single
2.	Thin liquid (Water)	5 ml	Tea spoon	Single
3.	Thin liquid (Water)	Client directed	Cup	Single
4.	Thin liquid (Water)	Client directed	Cup	Sequential
5.	Nectar thick Liquid (Rice Starch)	5 ml	Tea spoon	Single
6.	Nectar thick Liquid (Rice Starch)	Client directed	Cup	Single
7.	Nectar thick Liquid (Rice Starch)	Client directed	Cup	Sequential
8.	Honey thick Liquid (Honey)	5 ml	Tea spoon	Single
9.	Pudding consistency (Yogurt)	5 ml	Tea spoon	Single
10.	Solid (Biscuit)	½	Plate	Client directed
<b>Anterior- Posterior View</b>				
11.	Nectar thick Liquid (Rice Starch)	5 ml	Tea spoon	Single
12.	Pudding consistency (Yogurt)	5 ml	Tea spoon	Single

#### 4.2. Analyses

A total of 12 swallows will be obtained from each participant and each of these swallows will be scored on the 17 components (6 oral, 10 pharyngeal, 1 esophageal) of swallow defined by the Modified Barium Swallow Impairment Profile. Table 2 shows the format for impairment profiling using MBSImP™ for each participant with a neurological condition (Table 2 provided in Appendix).

Non-parametric statistical tests will be used to compare

1. Overall Impairment score and average impairment scores across neurological conditions reported
2. Average Impairment scores for Thin Vs Nectar thick Vs Honey thick Vs Pudding Vs Solid in each neurological conditions reported



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#### 6.0 Implications of the results of the study (Illustrative)

- a) Presentation of scientific papers in professional seminars / publication of articles : Approximate number of outputs from the present study:  
Research publications: 2
- b) Discussion with professionals : This is a collaborative initiative with another center of national importance. The project method ensures contribution from medical professionals such as a neurologist, Radiologist, Gastroenterologist, Rehabilitation professionals along with speech-language pathologists.
- c) To utilize the results in the development of remediation : The results of the present study can be utilized to understand the underlying cause of impaired swallow function which in turn may help professionals working in the field of rehabilitation of swallowing disorders to derive specific swallow strategies to accelerate recovery of clients with dysphagia.

#### 7.0 Utilization of results of the study

It is expected that the project will provide sufficient insight into the type, characteristics and features of swallowing impairments in persons with a variety of neurogenic dysphagia. Further, such information is important in clinical as well as theoretical understanding of this condition.

# Swallowing Impairments in Persons with Brain Damage

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