Swallowing Difficulties with Tracheostomy: A Neuro-Rehabilitation Perspective

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ABSTRACT

Swallowing and breathing are complex and highly coordinated functions. These functions depend on well-coordinated work of many organs with larynx and nervous system playing a critical role. Disturbance in one of these functions negatively affects the other. Surgical airways like tracheostomies are required in a number of situations, including but not limited to major head and neck procedures, cases with decreased lung function, excessive bronchial secretions and cases requiring neuro-rehabilitation when prolonged airway is required for mechanical ventilation. Extensive neuro-rehabilitation is required since patients with surgical airway may develop swallowing difficulties including dysphagia and/or aspiration with a very high prevalence, which can pose a threat to life. This article reviews the current status of the diagnostic and therapeutic modalities for swallowing difficulties with special emphasis on current neuro-rehabilitative strategies. Electronic databases including Medline, Web-of-science, Cochrane Library, and Google scholar were used for literature search. Downloaded articles were subsequently assessed independently by two researchers to determine suitability for inclusion in the study.

Key words: Neurorehabilitation, Tracheostomy, Transcranial direct current stimulation, Transcranial magnetic stimulation, swallowing difficulty

Introduction

Breathing and swallowing are essential and highly coordinated functions. These functions depend on well-coordinated work of many organs with larynx and nervous system playing a critical role. Disturbance in one of these functions negatively affects the other. Swallowing being a complex neurological process plays an essential part in food digestion. Its main role is lower respiratory tract (LRT) protection, demanding precise coordination between the essential functions of breathing and swallowing. This is mediated through a swallowing reflex. Any pathological or physiological deficiency or impairment of central nervous, neuromuscular, musculoskeletal or cardiopulmonary system may modulate the swallow reflex arc and lead to a potential delay, deficiency or disorder in swallowing function.1

Cite this article. Saqulain G, Mumtaz N. Swallowing Difficulties with Tracheostomy: A Neuro-Rehabilitation Perspective. J Islamabad Med Dental Coll 2020; 9(1):59-64. Doi: 10.35787/jimdc.v9i1.290

Funding Source: Nil
Conflict of Interest: Nil
Surgical airways like tracheostomies are required in a number of situations including but not limited to major head and neck procedures, in cases with decreased lung function, excessive bronchial secretions and cases requiring neuro-rehabilitation when prolonged airway is required for mechanical ventilation. According to Loss et al. a large percentage (41.5%) of patients requiring intensive unit care, require mechanical ventilation (MV) with 9.9% requiring MV for prolonged period. Of these critically ill survivors, many face dysphagia and in these cases tracheostomy is an important risk factor. Thus, in the intensive care units (ICU) mechanical ventilation after tracheostomy may lead to loss of pulmonary protection or swallowing abnormality. The prevalence of swallowing disorders in critical tracheostomized patients who are on MV ranges from 50 to 83%. Regardless of the presence or absence of neuromuscular issues it has been reported to be 3 to 62% in another study, nevertheless its real incidence is not yet established. The swallowing reflex can be modulated by pathological as well as some physiological conditions. The placement of tracheostomy disturbs the normal vertical hyoid and laryngeal movements essential for normal swallowing. Tracheostomy also reduces the sensitivity of the larynx, and the cuff of tracheostomy tube may alter the stimulation of the pressure receptors in the subglottic area, which can result in aspiration. Hernandez et al. have claimed that deflation of tracheostomy tube cuff in these patients shorten the weaning thus reducing the respiratory infections and improving swallowing. Hence tracheostomy tube results in difficulty in verbal communication and reduction in laryngeal movement results in further compromise in swallowing. Also tracheostomy has been noted as an independent risk factor for development of aspiration and dysphagia. Extensive neuro-rehabilitation is required since patients with surgical airway may develop swallowing difficulties including dysphagia and / or aspiration with a very high prevalence, which can pose a threat to life.

This paper attempts to review the current status of therapeutic modalities for swallowing difficulties with special emphasis on current neuro-rehabilitative strategies. This has significance since such cases are neglected and result in morbidity and mortality. Literature search was conducted using electronic databases including Medline, Web-of-science, Cochrane Library, and Google scholar for articles published between 2000 to 2018 using keywords like “Neurorehabilitation”, “Tracheostomy”, “Transcranial direct current stimulation”, “Transcranial magnetic stimulation”, “Swallowing difficulty” and a combination of these words. Downloaded articles were subsequently assessed independently by two researchers to determine suitability for inclusion in the study.

Discussion

Tracheostomy is a common airway procedure associated with complications of swallowing difficulties as well as airway protection abnormalities. These complications demands a multidisciplinary team approach, with good coordination between its team members, for evaluation and rehabilitation to ensure the safety and quality care of these patients. In a study, Mah et al. concluded that, “the introduction of care bundle for post tracheostomy care to the multidisciplinary tracheostomy service significantly improve oral diet intake as well as de-cannulation”. Thus restoration of function of respiration, phonation, feeding and swallowing demands a strict integration and participation among different members of the multidisciplinary rehabilitation team. A number of strategies are used conventionally to facilitate swallowing and prevent aspiration easing de-cannulation including digital occlusion of tracheostomy during swallowing, use of one-way valves, adjustment of tidal volume and timing of swallow with expiratory
cycle for patients on MV. These strategies, increase subglottic pressure and prevents aspiration, with partial or complete cuff deflation as the case may be, allowing deglutition and phonation system rehabilitation. Also, the tracheostomy cannula should preferably not fill more than two-third to three-fourths of the tracheal lumen, since it will make rehabilitation difficult.\(^9\)

Evaluation is usually carried out using existing simple screening tools like 3-oz water tests as well as specific assessment tools. These include Video fluoroscopy, Modified barium swallows, Fiber-optic Endoscopic Evaluation of Swallowing (FEES) with the validated grading measures. The grading measures include Modified Barium Swallow Impairment Profile (MBSImP) and Penetration-Aspiration Scale. MBSImP provides a standardized protocol to interpret and communicate swallowing impairment in an accurate and objective manner with 17 components grouped in three functional domains each to access Oral Impairment, Pharyngeal Impairment, and Esophageal Impairment.\(^13\) Knowledge is incomplete for using these tools to assess post extubation dysphagia. FEES being the method of first choice is easy to use, with bedside evaluation, and can help remove misjudgment in dysphagia diagnosis and help revise diet in around 70% cases.\(^14\)

To assess swallowing reflex, the integrity of the Oropharyngeal-cortical afferent pathways can be assessed by electroencephalography (EEG) while generating sensory-evoked potentials by pharyngeal electrical stimulation and the Cortical-pharyngeal efferent pathways can be considered by electromyography through motor-evoked potentials by transcranial magnetic stimulation.\(^15\)

When tracheostomy tube is in place, swallowing can be assessed by oral motor and vocal cord assessment with adduction of vocal cord by phonation and strength of cough reflex and Pharyngeal assessment with per oral trials. Air Leak around Tracheostomy Tube can be assessed by occluding tracheostomy tube by a finger during exhalation with instruction to phonate while feeling for pressure on finger and listening for air movement and phonation. Good air leak is indicated by clear phonation, no pressure on finger and no pressure release when finger is removed. Poor air leak is indicated by none or strangled phonation, pressure on finger and air pressure release when finger is removed. However, if the cuff cannot be fully deflated a minimal leak technique can be considered. Due to risk of silent aspiration, cuff manometry is a better option.\(^16\) Chronic MV patients who require full cuff inflation can be assessed by FEES. If the air leak is good then the tracheostomy tube is capped to observe oxygen saturation, respiratory rate, difficulty in clearing secretions and signs of breathing difficulty. If all remains fine orders can be obtained to leave cap as tolerated. De-Cannulation can be done if the patient tolerates 48 hours of capping without need of deep suction; however different centers follow different criteria.

Most guidelines regarding the management of swallowing disorders in these patients basically aim to prevent complications,\(^17\) with conventional compensatory strategies like modification in diet including changes in consistency; bolus presentation i.e. amount, frequency and placement; other strategies like non oral options (no straw), liquid by spoon, moisten mouth before swallow; and other safe swallowing techniques like digital occlusion during swallow etc.\(^18\) Changes in posture involve Chin Tuck, Head Turn, Head Tilt and Head Back. Other facilitation technique includes Effortful Swallow, Mendelshon Maneuver, Supraglottic swallow and Super-supra-glottic swallow maneuver along with Laryngeal Closure Exercises.
| Class                        | Type                          | Technique                                                                 |
|-----------------------------|-------------------------------|---------------------------------------------------------------------------|
| Conventional Compensatory   | Modification in Diet          | • Consistency                                                              |
| Strategies 18,19             |                               | • Bolus Presentation                                                       |
|                             |                               | • Amount                                                                   |
|                             |                               | • Frequency                                                                |
|                             |                               | • Placement                                                                |
|                             | Non-Oral Options              | • Liquid by Spoon                                                          |
|                             |                               | • Moisten Mouth before Swallow                                             |
|                             | Other Safe swallowing         | • Digital occlusion during swallow                                         |
| Techniques                  |                               | • Chin Tuck                                                               |
|                             | Changes in Posture            | • Head Turn                                                               |
|                             |                               | • Head Tilt                                                               |
|                             | Other Facilitation Techniques | • Head Back                                                               |
|                             | Oral Exercises                | • Oral Motor exercises                                                    |
|                             | Pharyngeal Exercises          | • Tongue Base exercises                                                   |
|                             |                               | • Pharyngeal exercises (Masako)                                           |
|                             | Laryngeal Exercises           | • Laryngeal elevation and closure exercises                               |
|                             | Thermal Tactile Stimulation   | • Sour Bolus exercises                                                    |
|                             | Peripheral Non-invasive       | • Neuromuscular Electrical Stimulation                                     |
| Neurehabilitation Treatment  | Stimulation                  | • Oro/Facial Electrical Stimulation                                        |
| 19,20,21                    |                               | • Deep Pharyngeal Neuromuscular Stimulation                               |
|                             |                               | • Pharyngeal Electrical Stimulation—For Neuroplasticity 23                |
|                             |                               | • Palatal Electrical Stimulation                                         |
|                             |                               | • Functional Magnetic Stimulation                                         |
|                             | Central Non-invasive Brain    | • Repetitive Transcranial Direct Current Stimulation                      |
| Stimulation 15, 26, 27, 28   |                               | • Paired Associative Stimulation                                          |
|                             |                               | • Transcranial Magnetic Stimulation                                       |

Focus of these strategies being compensation rather than physiological restoration of function.\textsuperscript{19} The therapeutic techniques commonly used include Oral Motor Exercises, Tongue Base Exercises, Pharyngeal Exercises (Masako), Laryngeal Elevation and Laryngeal Closure Exercises, Thermal Tactile Stimulation and Sour Bolus Swallow.\textsuperscript{20}

Oropharyngeal dysphagia still lacks specific neurehabilitation treatment with current advances including peripheral and central non-invasive stimulation.\textsuperscript{21} According to Cabib et al., rehabilitation strategies are shifting from compensatory techniques to promotion of brain plasticity with the aims of recovering swallow function as well as swallow dysfunction caused by neurological damage.\textsuperscript{21} Electrical and magnetic stimulation has gained momentum in the treatment of dysphagia to improve physiological restoration of swallowing with a number of therapeutic interventions gaining interest.

VitalStim Therapy (VST) also known as Neuromuscular electrical stimulation (NMES) has been used for neuromuscular re-education in cases with oropharyngeal dysphagia.\textsuperscript{19,20} The oral/facial electrical stimulation is applied to restore muscle function and Deep Pharyngeal Neuromuscular
Stimulation (DPNS) for restoring reflexes within the pharynx. FDA (USA) protocol for dysphagia recommends use of electrode positioning on submental musculature. Humbert et al.\textsuperscript{22} noted significant results especially for muscle strengthening in cases with oropharyngeal dysphagia. Pharyngeal electrical stimulation (PES), using a catheter-electrode placed intra-luminal in the pharynx and attached to stimulator unit to generate the required stimulus has been explored for exploitation of neuroplasticity in motor cortex and has been found to be of benefit as it results in less aspiration and dysphagia.\textsuperscript{23} Palatal electrical stimulation has also been used by some researchers to initiate sensory feedback, so as to get swallow reflex involuntarily, with controversial results.\textsuperscript{24}

Momosaki et al.\textsuperscript{25} used Functional Magnetic Stimulation (FMS) and noted a statistically significant improvement in swallowing function, both in terms of capacity and speed of swallowing. In this noninvasive method instead of electrodes, parabolic coil is used to deliver FMS at 30 Hz to suprahypoid muscles in a 20 second train for 10 minutes and total 1200 pulses were given. It is said to reach a greater depth compared to electrical stimulation without causing discomfort.\textsuperscript{26}

Recent neurorehabilitation development includes Non-Invasive Brain Stimulation (NIBS) comprising of transcranial magnetic stimulation (TMS) as well as transcranial direct current stimulation (TDCS) and paired associative stimulation (PAS), with a number of studies suggesting promising results.\textsuperscript{15,26,27} Simons et al found mixed results when used for management of neurogenic dysphagia and pointed out controversies that exist regarding treatment with this modality. These controversies include the appropriate site of stimulation, strength and the time duration of the stimulus for producing the most beneficial effect.\textsuperscript{26} Kim et al found repetitive (r) TMS to be useful for recovery of swallow function in cases with brain injury and dysphagia, with superior results compared to conventional interventions,\textsuperscript{26} while Dionisio et al.\textsuperscript{28} in a systematic review found rTMS to be a useful tool in rehabilitation of stroke cases. Lee et al., studied the effect of rTMS according to site of stimulation and reported that stimulation of the area of brain cortex which generated motor evoked potentials (MEP) from suprahypoid muscles caused maximum improvement in swallowing function when compared to that over the interconnected site.\textsuperscript{29}

Different researchers have also studied reorganization of intact hemisphere for the purpose of recovery from post-stroke dysphagia (PSD). Significant results have been reported in connection with the use of NIBS on the contralateral side of the brain as a therapeutic potential for PSD rehabilitation in different studies.\textsuperscript{27}

**Conclusion**

The complications of tracheostomy and swallowing impairment decree an accurate assessment using modern methodologies like FEES with MBSImP and Penetration aspiration scale. Individualized treatments including most recent neuro-rehabilitation with DCS and TCS is of utmost significance.

**References**

1. Nishino T. The swallowing reflex and its significance as an airway defensive reflex. Front Physiol. 2013; 3: 489.
2. Loss SH, de Oliveira RP, Maccari JG, Savi A, Boniatti MM, Hetzel MP, et al. The reality of patients requiring prolonged mechanical ventilation: a multicenter study. Rev Bras Ter Intensiva. 2015; 27(1): 26-35.
3. Macht M, King CJ, Wimbish T, Clark BJ, Benson AB, Burnham EL, et al. Post-extubation dysphagia is associated with longer hospitalization in survivors of critical illness with neurologic impairment. Crit care. 2013; 17(3): 119.
4. Zielske J, Bohne S, Brunckhorst FM, Axer H, Guntinas-Lichius O. Acute and long-term dysphagia in critically ill patients with severe sepsis: results of a
prospective controlled observational study. Eur Arch Otorhinolaryngol. 2014; 271(11): 3085–93.

5. Fernández A, Macías I, Gutiérrez R, Martínez P, Díaz MA, Dysphagia following prolonged mechanical ventilation and tracheostomy in critical ill patients. Results of edisval study pilot phase. Intensive Care Med Exp. 2015; 3(Suppl 1): 677.

6. Jung S J, Kim DY, Kim YW, Koh YW, Joo SY, Kim ES. Effect of decannulation on pharyngeal and laryngeal movement in post-stroke tracheostomized patients. Ann Rehabil Med. 2012; 36(3): 356–364.

7. Feldman SA, Deal CW, Urguhart W. Disturbance of Swallowing after tracheostomy, Lancet 1966; 1(7444): 954-5.

8. Gross RD, Mahlmann J, Grayhack, JP. Physiologic effects of open and closed tracheostomy tubes on the pharyngeal swallow. Ann Otol Rhinol Laryngol. 2003; 112(2): 143-52.

9. Hernandez G, Pedrosa A, Ortiz R, Cruz Accuaroni Mdel M, Cuena R, Vaquero Collado C et al. The effects of increasing effective airway diameter on weaning from mechanical ventilation in tracheostomized patients: a randomized controlled trial. Intensive Care Med. 2013; 39(6): 1063-70.

10. Garuti G, Reverberi C, Briganti A, Massobrio M, Lombardi F, Lusuardi M, et al. Swallowing disorders in tracheostomised patients: a multidisciplinary/multiprofessional approach in decannulation protocols. Multidiscip Respir Med. 2014; 9(1): 36.

11. Bonvento B, Wallace S, Lynch J, Coe B, McGrath BA. Role of the multidisciplinary team in the care of the tracheostomy patient. J Multidiscip Healthc. 2017; 10: 391-398.

12. Mah JW, Staff II, Fisher SR, Butler KL. Improving Decannulation and Swallowing Function: A Comprehensive, Multidisciplinary Approach to Post-Tracheostomy Care. Respir Care. 2017; 62(2): 137-143.

13. Martin-Harris B, Brodsky MB, Michel Y, Castell DO, Schleicher M, Sandidge J, et al. MBS measurement tool for swallow impairment—MBSimp: establishing a standard. Dysphagia 2008; 23(4): 392-405.

14. Braun T, Juenemann M, Viard M, Meyer M, Fuest S, Reuter I, et al. What is the value of fibre-endoscopical evaluation of swallowing (FEES) in neurological patients? A cross-sectional hospital-based registry study. BMJ Open 2018; 8: e019016. Doi: 10.1136/bmjopen-2017-019016

15. Gallas S, Moiriot, P, Debono G, Navarre I, Denis P, Marie et al. Mylohyoid motor-evoked potentials relate to swallowing function after chronic stroke dysphagia. Neurogastroenterol Motil. 2007; 19 (6): 453-8.

16. Hess DR, Altobelli NP. Tracheostomy Tubes. Respir Care.2014; 59 (6): 956-3.

17. Simons A, Hamdy S. The Use of Brain Stimulation in Dysphagia Management. Dysphagia. 2017; 32(2): 209-15.

18. Rosenvinge SK, Starke ID. Improving care for patients with dysphagia. Age Ageing. 2005; 34(6): 587-93.

19. Vose A, Nonnenmacher J, Singer ML, González-Fernández M. Dysphagia Management in Acute and Sub-acute Stroke. Curr Phys Med Rehabil Rep. 2014; 2(4): 197–206. Doi:10.1007/s40141-014-0061-2

20. Johnson DN, Herring HJ, Daniels SK. Dysphagia Management in Stroke Rehabilitation. Curr Phys Med Rehabil Rep. 2014; 2: 207-218. Doi:10.1007/s40141-014-0059-9

21. Cabib C, Ortega O, Kumru H, Palomeras E, Vilardell N, Alvarez-Berdugo D et al. Neurorehabilitation strategies for poststroke oropharyngeal dysphagia: from compensation to the recovery of swallowing function. Ann N Y Acad Sci. 2016; 1380(1): 121-38.

22. Humbert IA, Robbins J. Dysphagia in the elderly. Phys Med Rehabil Clin N Am. 2008; 19(4): 853–x. Doi:10.1016/j.pmr.2008.06.002

23. Scutt P, Lee HS, Hamdy S, Bath PM. Pharyngeal Electrical Stimulation for Treatment of Poststroke Dysphagia: Individual Patient Data Meta-Analysis of Randomised Controlled Trials. Stroke Res Treat. 2015; 2015: 429053.

24. Park CL, O’Neill PA, Martin DF. A pilot exploratory study of oral electrical stimulation on swallow function after stroke: an innovative technique. Dysphagia. 1997; 12(3): 161–6.

25. Momosaki R, Abi M, Watanabe S, Kakuda W, Yamada N, Mochio K. Functional magnetic stimulation using a parabolic coil for dysphagia after stroke. Neuromodulation. 2014; 17(7): 637–41.

26. Kim L, Chun MH, Kim BR, Lee SJ. Effect of repetitive transcranial magnetic stimulation on patients with brain injury and Dysphagia. Ann Rehabil Med. 2011; 35(6): 765-71.

27. Wang Z, Song WQ, Wang L. Application of noninvasive brain stimulation for post-stroke dysphagia rehabilitation. Kaohsiung J Med Sci. 2017; 33(2): 55-61.

28. Dionisio A, Duarte IC, Patricio M, Branco MC. The Use of Repetitive Transcranial Magnetic Stimulation for Stroke Rehabilitation: A Systematic Review. J Stroke Cerebrovasc Dis. 2018; 27(1): 1-31.

29. Lee JH, Kim SB, Lee KW, Lee SJ, Lee JU. Effect of Repetitive Transcranial Magnetic Stimulation According to the Stimulation Site in Stroke Patients with Dysphagia. Ann Rehabil Med. 2015; 39(3): 432-9.