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RESEARCH ARTICLE

POSTOPERATIVE DYSPHAGIA AS A COMPLICATION OF ANTETIOR CERVICAL SPINE SURGERY

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ABSTRACT

Background: Postoperative dysphagia is a common occurrence for the patients undergoing anterior cervical spine surgery. Although multiple risk factors for developing dysphagia have been reported in the literature, but the controversial still exists among different studies. This study mainly focuses on the recent literature review and summarizes the general overview on the incidence, risk factors, pathophysiology, clinical signs and symptoms, assessment, treatment, and prevention of postoperative dysphagia.

Methods: A computerized review of literature concerning with the dysphagia after anterior cervical spine surgery was searched on Pubmed. The literature search was confined to the published articles from 2005 to 2016.

Results: Patients presenting with postoperative dysphagia after anterior cervical surgery have a range of clinical symptoms from the difficulty initiating a swallow, chewing problem to nasal regurgitation, choking, coughing etc. Patient medical history, detailed physical examination, lateral X-ray radiographs, laryngoscopy and video fluoroscopic swallow evaluation (VSE) are the primary assessment tools for examining dysphagia. Universally validated objective method for measuring dysphagia is still lacking. The most commonly applied assessment tool is the Bazaz Dysphagia Scoring system. Dysphagia is purely the subjective sensation of discomfort, patient self-reported symptoms are more reliable and effective in recognizing swallowing disorders. The etiology of postoperative dysphagia after anterior cervical spine surgery remain multifactorial which include surrounding mucosal structures, muscular and, neuronal components. Most of the dysphagic problems are usually transient, which begins within one week of postoperative period but in some cases may last longer after surgery. The reported incidence of dysphagia has been observed upto 80% within one week following ACSS among different studies. The big variation in incidence rate can be related to different surgical techniques, duration of surgery, size and material of the implant used, variations in different measurement tools and definition of dysphagia, follow-up time intervals, and comparatively small sample studies. The most common contributing factors causing postoperative dysphagia are multilevel procedures, female gender, longer operative time, and advanced age (>60 years), use of rhBMP-2. Rehabilitation including dietary modification and training in swallowing techniques and maneuvers are the treatment strategies for the dysphagia by maintaining the patients' adequate nutritional intake and maximizing airway protection. Certain preoperative maneuver likes tracheal traction exercise, intraoperative (use of steroids) and postoperative techniques could help in decreasing the incidence of postoperative dysphagia after anterior cervical spine surgery.

Conclusions: Well designed, multicenter prospective studies of large sample size are necessary to conclude the incidence, exact etiology, risk factors, pathomechanisms and long-term follow-up for the development of postoperative dysphagia after ACSS, and also to discover preventative measures. Also the specific measurement; that is universally valid and reliable, is needed, which would include global, functional, physical, and psychosocial parameters to provide comparisons among different variables. The results of these large prospective studies can be employed to upgrade in surgical techniques and perioperative management, which may decrease the incidence of dysphagia after ACSS.

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INTRODUCTION

Since the 1955s, the anterior approach to the cervical spine has become the approach of choice for many operative procedures performed today (Robinson and Smith, 2010). Much of the pathoanatomy necessitating surgery is located in the anterior column of the cervical spine, which lends itself to the direct anterior approach in treating degenerative, traumatic, neoplastic, infectious, and deformity condtions (Benedikt *et al.,* 2016; Song and Choi, 2014).

Although the procedure is speculated to relieve a radicular and localized pain, one of the most common complication is postoperative dysphagia after anterior cervical spine surgery (Leonard and Belafsky, 2011; Anderson and Arnold, 2013). Dysphgia is a subjective sensation of difficulty or abnormality of swallowing, which represents a physiological alteration in the neuronal pathway of the involved structures in voluntary/involuntary phase of swallowing mechanism (Logemann and Larsen, 2012). Postoperative dysphgaia after ACSS causes an impaired movement of the food materials through the mouth to the upper esophagus which may cause

patient to choking, coughing, nasopharyngeal regurgitation, aspiration, malnutrition if the problems last longer than 1 month (Zeng *et al.,* 2013). Postoperative dysphgia is one of the most potential complications of ACSS. It has been regarded as an inevitable consequence of the anterior cervical surgery rather than a surgical complication (Daniels *et al.,* 2013; Wu *et al.,* 2016). The normal swallowing mechanism is a complex neuromuscular activity consisting of three swallowing phases (Lembo, 2013). Dysphagia can arise during any of three swallowing phases, containing the oral phase, the pharyngeal phase; and the esophageal phase (Mendoza-Lattes *et al.,* 2008). From a clinical and patients' perspective view, dysphagia can result in failure to maintain adequate nutritional intake and respiratory complications, which can lead to a number of physical, social, and psychological consequences, including (i) weight loss or failure to gain weight, (ii) increased susceptibility to chest infections due to aspiration, (iii) breathing problems due to upper or lower airway blockage secondary to aspiration into the larynx, and (iv) poorer quality of life that may be associated with a loss of enjoyment of eating, fear of choking, embarrassment, and/or social isolation secondary to coughing, spluttering, and prolonged feeding times (Jones *et al.,* 2016).

Incidence

Postoperative dysphagia after ACSS is a relatively common complication in the early postoperative period. It is, however, a relatively transient symptom with the majority of patients resolving within 3 months postoperatively (Lee *et al.,* 2014). The incidence rate of postoperative dysphgia greatly varies from 1 to 79% among different studies (Cho *et al.,* 2013). The incidence rate was found to be 28 to 57% in followed –up patients at 1 and 6 weeks (Anderson *et al.,* 2013; Smith-Hammond *et al.,* 2004). As the patient self-reported dysphagia is more reliable; the objective evaluation may estimate the lower incidence (Riley *et al.,* 1976). Study by Danto et al found the higher incidence of dysphagia if the patients are repeatedly asked about their dysphagic symptoms than self-reported patients (Danto *et al.,* 2012). The incidence rate among different study is listed in Table 1.

The wide fluctuation in incidence rates of dysphgia may be associated with different factors such as surgical approach and techniques, total surgical time, size and material of the implants used, time intervals of postoperative follow-ups and the relative small sample size as well as lacking of universally accepted methods for determining and measuring the dysphagia (Mendoza-Lattes *et al.,* 2012; Skeppholm *et al.,* 1976; Chin *et al.,* 2007). Most of the previous studies are retrospective and have some limitations which may have underestimated the incidence rates of dysphagia due to patient poor recall lapse, preoperative swallowing problems, different criteria for assessing dysphagia and approach related(right versus left-sided) (Smith-Hammond *et al.,* 2004). Since the study on dysphagia after anterior cervical spine surgey by Lee et al in 2005, several authors have focused on deep understanding of postoperative development and its incidence (Lee *et al.,* 2007). Multicenter retrospective study by Riley et al observed the incidence of dysphagia in 454 patients after ACSS to be 28.2, 6.8, and 7.0% at 3, 6, and 24 months of follow-up respectively whereas the prevalence of persistent swallowing dysfunction still remained to be 21% at both 6 and 24 months (Riley *et al.,* 2005). Similarly, Kalb et al retrospectively reviewed 249 patients with cervical spondylotic disease undergoing ACSS and found only 27 out of 249 patients presented with dysphgia in the first 6 months after surgery. Among 27 patients, the incidence was 88.4 at 6 weeks, 29.6 at 3 months and 7.4% at 6 months respectively. By 12 months, no dysphagia was found in any patients (Kalb *et al.,* 2012). A prospective study by same authors after five years reported the average incidence rates of dysphagia after ACSS were 53.2% at 1 month, 31.6% at 3 months; 19.8% at 6 months; 16.8% at 1 year; and 12.9% at 2 years which reached a plateau between 13 to 21% at 1 year after surgery (Lee *et al.,* 2007; Riley *et al.,* 2005; Kalb *et al.,* 2012; Lee *et al.,* 2005). The overall incidence of 30% at 3 months is considered to be accepted rate is consistent with other literature reports (Riley *et al.,* 2010; McAfee *et al.,* 2010). The presentation and severity of dysphagic symptoms greatly correlates its clinical significance and incidence rate after ACSS as the incidence of dysphgia tends to be higher in the immediate postoperative period due to severity of dysphgia but reduce slowly over time. Majority of patients presenting with dysphagia are mild to moderate and transient in nature which resolves gradually over time of 3 months (Yue *et al.,* 2005; Rihn *et al.,* 2011). Most cases of postoperative dysphagia subside within 1 year without any intervention [28]. Some cases (5 to 7%) still have persistent dysphagia at 6 to 24 months after ACSS (Yue *et al.,* 2005; Olsson *et al.,* 2015), Study by Lee et al on dysphagia showed the decreasing prevalence rates over time as follows: 54.0%, 33.6%, 18.6%, 15.2%, 13.6% at 1, 3, 6, 12 and 24 months which differs with the current and previous reports of 21% at 6 and 24 months. At 2-year follow-up, dysphagia was found more in women than man, in revision and multilevel surgery, and with instrumentation use (Lee *et al.,* 2007; Riley *et al.,* 2005).

RISK FACTORS

The authors have attempted to define the risk factors for postoperative dysphagia. Several studies have correlated demographics (age, gender, alcohol/tobacco consumption, hypertension, diabetes mellitus) and surgical factors such as duration of surgery, use of material, design and thickness of a cervical plate, intraoperative retraction time, ET tube cuff pressure, steroids use, numbers of levels operated, revision versus primary surgery with the occurrence of postoperative dysphagia after anterior cervical spine surgery, but the results showed wide-range of variations and hardly could draw any firm conclusions (Kalb *et al.,* 2012). Cervical plate as a confounding factor for postoperative dysphagia can be challenging to define as the surgery requires fusion after decompression. Most common factors associated with causing postoperative dysphgia are advanced age(aged >60 years), female gender, increase number of operated levels, increase operative time (Wu *et al.,* 2016; Riley *et al.,* 2010; Kalb *et al.,* 2012; Vaidya *et al.,* 2007; Kang *et al.,* 2011;). The most common risk factors contributing to dysphagia after ACSS are shown in Table 2. Other factors which are found not to be correlated with the increase risk of postoperative dysphagia are headache; incision type (longitudinal, transverse ,oblique); heights of plate and preoperative osteophytes; implant loosening and/or breakage; graft malunion/nonunion, subsidence; pressure on esophageal walls ; ET intubation or difficult intubation; severity of myelopathy; osteoarthritis; alcohol/substance abuse; and body mass index(BMI) (Mendoza-Lattes *et al.,* 2008; Chin *et al.,* 2007; Riley *et al.,* 2005; Kalb *et al.,* 2012; Yue *et al.,* 2005; Rihn *et al.,* 2011; Fehlings *et al.,* 2012; Siska *et al.,* 2011).

Table 1. Incidence rate of dysphgia after ACSS among different studies

Author, year	Year	No. of patients	Study design	Assessment tool used	Immediate dysphagia (1-2week)	1 month	3 months	6 months	12 months
Lee *et al.*	2005	156	Prospective	Bazaz Dysphagia Score by telephonic interview		48.9%	37.0%	20.9%	15.4%
Riley *et al.*	2005	454	Retrospective	Oswestry Neck Disability Questionnaire			28.2%	6.8%	
Yue *et al.*	2005	74	Retrospective	Bazaz Dysphagia Score by telephone				45.9%	
Chin *et al.*	2007	64	Prospective	Bazaz Dysphagia Score	34%		17%		
Lee *et al.*	2007	310		Bazaz Dysphagia Score		54%	33.6%	18.6%	15.2%
Papavero *et al.*	2007	92	Prospective	Modified dysphagia questionnaire	49.3%				
Tervonen *et al.*	2007	114	Prospective	Transoral endoscopic evaluation and videofluorographic,VAS	69%		27%		
Vaidya *et al.*	2007	18	Retrospective	Bazaz Dysphagia Score	56%	39.0%	22%		
Buttermann	2008	66	Prospective	Bazaz Dysphagia Score					14%
Mendoza_Lattes *et al.*	2008	17	Prospective	M.D. Anderson Dysphagia Inventory		52.94%	47.0%		
Anderson *et al.*	2008	463	Randomized controlled study	Bazaz Dysphagia score					10.7%
McAfee *et al.*	2010	251	Prospective randomized clinical study	Bazaz Dysphagia Score; VAS		57.8%	38.5%	27.2%	
Riley *et al.*	2010	N/A	Systematic review	N/A	1-79%	53.2%	31.6%	19.8%	16.8%
Pattavilakom and Seex	2011	26	Prospective randomized study	Self-assessment of dysphagia quantified with Likert scale	32%		5%		
Rihn *et al.*	2011	38	Prospective	Bazaz Dysphagia Score	71%	26%	8%		
Kang *et al.*	2011	45	Retrospective	Bazaz Dysphagia Score		26.6%	26.6%	20%	
Fehlings *et al.*	2012	302	Prospective	Included only clinically apparent and significant forms		3%			
Kalb *et al.*	2012	249	Retrospective	Dysphagia Disability Index		88.4%	29.6%	10.8%	
Khaki *et al.*	2013	67	Prospective	Bazaz Dysphagia Score	79%	48%	39%		13%
Zeng *et al.*	2013	186	Prospective	Bazaz Dysphagia Score	26.9%				
Jang *et al.*	2014	50	Retrospective	Bazaz Dysphagia Score b			20%	14%	
Kang *et al.*	2014	72	Prospective	Bazaz Dysphagia Score		69.4%	30.6%		
Wu *et al.*	2016	358	Retrospective	Bazaz Dysphagia Score	10.9%		6.4%	2.7%	

NEUROANATOMY /PATHOPHYSIOLOGY

Multiple factors cause postoperative dysphagia which involves surrounding mucosal, muscular, and neuronal structures (Lee *et al.,* 2005Rommel and Hamdy, 2016; Pattavilakom and Seex, 2011). Study by Smith Hammond et al noticed that some dysphagia has also been found in posterior cervical approach(21%) rather than anterior approach (50%) alone suggesting that other mechanisms are also associated with its cause (Smith-Hammond *et al.,* 2004). Rihn et al noted that the anterior approach itself can cause dysphgia rather than general anesthesia and ET tube cuff replacement. Soft tissue swelling, impaired sensation of nerves resulting from the traction and esophageal dysmotility may have the role for the development of postoperative dysphagia (Rihn *et al.,* 2007). Any alteration in the particular phase of swallowing process may indicate its respective causes (Lee *et al.,* 2004). Injury to the hypoglossal nerve may cause difficulty initiating swallowing during the oral phase, whereas difficulty in the pharyngeal stage may be caused by retraction injury to the pharyngeal plexus and pharyngeal muscles (Nanda *et al.,* 2006). Oral preparatory phase dysfunction may manifest as difficulty in initiating swallowing, prolonged chewing time, poor bolus control, oral residue, reduced lingual strength, poor labial and facial muscle function.

Similarly, dysfunction in pharyngeal stage can cause coughing, wet voice, choking, nasal regurgitation, delayed triggering of pharyngeal response causing premature spillage to the pharynx, pharyngeal residue, sticking sensation, reduced laryngopharyngeal sensation, repeated swallowing to propel fluid or food from the pharynx due to sensory and motor involvement (Rommel *et al.,* 2016). Knowledge of the neuroanatomy may help in decreasing the incidence of postoperative dysphagia.RLN has been regarded as the most common nerve involvement causing dysphagia and aspiration after ACSS. It has asymmetrical recurrent innervations on each side of the neck. The recurrent laryngeal nerves (left and right RLN) are branch of the vagus nerve (CN X) which carry sensory information from the mucous membranes of the larynx below the vocal cords, as well as sensory, secretory and motor fibres to the cervical segments of the esophagus and the trachea. Injury to the recurrent laryngeal nerves can result in a weakened voice, problems in the respiratory tract, denervation of the inferior constrictor and cricopharyngeus muscles (Chen, 2006). The superior laryngeal nerve (SLN) has two branches. The external laryngeal nerve supplies branches to pharyngeal plexus and the superior portion of the inferior pharyngeal constrictor, and communicates with the superior cardiac nerve behind the common carotid artery. Injury to the SLN leaves the vocal cord abducted and poses an aspirartion risk.

Table 2. Significant risk factors for dysphagia following anterior cervical spine surgery

Risk factor	Supporting study(study design, number of subjects)
Advanced age	Smith-Hammond et al (prospective, n=83)
Female gender	Bazaz et al (prospective, n=156)
Multilevel surgery	Bazaz et al (prospective, n= 156)
Revision surgery	Riley et al prospective, n=454) Bazaz et al (prospective, n=310)
Duration of procedure	Riley et al (prospective, n=454)
Prominent plate profile	Rihn et al (prospective, n=94)
Use of rhBMP-2	Bazaz et al (prospective, n=156) Buttermann et al (prospective, n=66)
Longer duration of Neck pain	Vaidaya et al (retroprospective, n=46)
Higher Operative levels (C3–4 versus C5–7)	Riley et al (prospective, n=454) Chin et al (prospective, n=64) Bazaz et al (prospective, n=310)
Blood loss > 300 mL	Kang et al (retroprospective, n=45)
Increased operative time (>175 min)	Riley et al (prospective, n=454) Chin et al (prospective, n=64)
Excessive /prolonged esophageal retraction pressure	Kalb et al (retroprospective, n=249) Chin et al (prospective, n=64) Mendoza-Lattes et al(prospective, n=17)
ACDF versus disk replacement/arthroplasty	Kepler et al (prospective, n=43) McAfee et al(prospective, n=251)
Prevertebral soft tissue swelling	Kang et al(retroprospective, n=45) Riley et al (prospective, n=454)
Soft tissue injury	Lee et al (prospective, n=310)
Smokin	Kepler et al (prospective, n=43) Siska et al (prospective, n=29)

Table 3. Causes of potential complications related to anterior approach and technique

Anterior approach/technique	Potential complications
Retraction /dissection of tracheoesophgeal sheath	Local tissue injury with subsequent edema SLN injury, Injuries to the pharyngeal plexus/ vagus nerve/glossopharyngeal nerve/hypoglossal nerve (upper level cervical surgery), Dysfunction of the pharyngeal plexus
Retraction or dissection of the longus colli muscle	Subperiosteal and muscle bleeding; prevertebral soft tissue swelling
Retraction	Denervation of the pharyngeal plexus
Forceful, excessive or prolonged retraction	Dysphagia Esophageal edema, impingement, ischemia ,denervation, reperfusion injury Posterior pharyngeal wall edema, soft tissue swelling, soft tissue fibrosis
Excessive tension during lateralization of the larynx	RLN injury, vocal fold paralysis
RLN stretch injury and/ RLN compression injury from ET cuff placement	RLN palsy with vocal fold paresis
rhBMP-2 Use	Early local inflammatory response to rhBMP-2
Intraoperative traction on both the RLN and pharyngeal plexus	RLN injury
Direct esophageal injury	Impaired opening of the upper esophageal sphincter, Localized denervation of portions of the esophagus and hypopharynx
Hemostatic or coagulopathy	Hematoma formation
Instrumentation use	Mechanical irritation or impingement against the esophagus,Differences in postoperative cervical kyphotic-lordotic deformity
Thickness or anterior profile of anterior cervical plates and instrumentation	Local irritation and inflammation
Use of graft	Graft protrusion, cord compression

Also, the upper cervical surgery puts the internal laryngeal nerve at risk of injury. Bilateral SLN injury will cause complete loss of the laryngeal cough reflex, increasing risk of aspiration pneumonia (Chen, 2006). In the revision surgery, ENT (ear, nose, and throat) evaluation should be performed to assess the function of both vocal cords. If one of the RLN involvement is found abnormal on laryngoscopy, the revision surgery should be performed from the same side as previously, the aim of the same side approach is to avoid injury to the normal one nerve in revision surgery. Although the exact pathomechanism cascade behind postoperative dysphagia after ACSS differs among various studies. Study by Nanda et al observed that immediate dysphagia is usually caused by postoperative pharyngeal edema due to prolonged oesophageal retraction, trauma or injury during endotracheal cuff placement, whereas intermediate dysphagia is related to the injury to the innervations of the pharyngeal muscles and is generally ascribed to surgical manipulation, forceful retraction of trachea-esophageal sheath, and aggressive use of monopolar diathermy (Nanda *et al.,* 2006). In a prospective study of multilevel ACDF surgery, Papavero et al noted no significant association between the intraoperative esopharyngeal retraction pressure and the postoperative dysphagia within 5 days (Papavero *et al.,* 2007). Lee et al reported that preoperative osteophyte height (not width) and plate thickness were not a risk factor for developing postoperative dysphagia. Although surrounding soft tissue swelling may have a prominent role in causing dysphagia. Study by Kepler et al reported that prevertebral soft tissue swelling has no contribution to the development of postoperative dysphagia for 1-2 cervical levels at 2 or 6 weeks after surgery (Kepler *et al.,*

2012). The potential complications associated with anterior approach and technique are listed in Table 3.

CLINICAL SIGNS AND SYMPTOMS

Patients developing dysphagia after anterior cervical spine surgery demonstrate significant impairments in swallowing mechanism including prolonged chewing time, poor bolus control, swallowing, apraxia, poor oral sensation, drooling, frequent aspiration, choking, spluttering, nasal regurgitation, delayed oral transit time, dehydration, malnutrition, weaker pharyngeal constriction and peristalsis, decreased hyoid displacement, impaired upper oesophageal sphincter opening, and reduced laryngeal closure (Kang *et al.,* 2016). Common clinical signs of dysphgia may represent as reflexive cough or wet voice before/during/after swallowing; inability to handle secretions, extra time/effort needing for chewing; drooling of saliva or sticking sensation; and aspiration pneumonia or chest congestion. Prolonged dysphagia may cause nutritional compromise including dehydration and weight loss from insufficient food intake; whereas risk of increased aspiration can cause respiratory complications and aspiration pneumonia. Fear or embarrassment about symptoms such as choking, coughing, or spluttering while eating and longer meal times can also lead to psychological and social difficulties for those living with dysphagia (American Speech-Language-Hearing Association, 2013).

Table 4. The Bazaz Dysphagia Scoring System

Score	Severity	Liquid	Solid
0	None	None	None
1	Mild	None	Rare
2	Moderate	None or rare	Occasionally
3	Severe	None or rare	Frequent

CLINICAL EVALUATION

Dysphagia is a common postoperative complaint following anterior cervical spine surgery (ACSS). Prompt recognition of dysphgia and early diagnosis can often be accomplished through a systematic clinical history and examination. The patient's subjective history, onset of symptoms, duration and its severity may give clue for its progression (Nanda *et al.,* 2006; Cook, 2008). Instrumental evaluation like lateral X-ray radiographs may help to find structurally induced dysphagia caused by postoperative hematoma or edema, soft tissue swelling, bone graft dislodgement, retropharyngeal abscess (Hartig *et al.,* 2015). The physical examination should be assessed for oral reflexes, oral sensation, motor evaluation of face, lips, tongue, palate and larynx, and saliva management (Flanagan, 2012). Neurologic evaluation should be done for cranial nerves associated with swallowing mechanism (the motor components of cranial nerves V, VII, X, XI, and XII and the sensory components of cranial nerves V, IX, and X).Clinical laboratory tests exclude an underlying systemic and neurogenic causes of the dysphagia that have specific therapies (Cook, 2008; Jones *et al.,* 2016). The clinicians should also differentiate the following conditions during dysphagia investigation: (1) true dysphagia, odynophagia or xerostomia, from the globus sensation, and the origin of dysphagia(esophageal or pharyngeal) (2) motor disorders from the structural abnormalities (3) any underlying systemic and neurogenic conditions ,which are treatable (4) the swallowing dysfunction mechanism (performed with a modified barium swallow); and (5) the VSE examination for the accurate detection of aspiration. The videoradiographic swallowing evaluation (VSE) is considered the gold standard for dysphagia examination. VSE is performed to find the aspiration and to find functional abnormality of the swallowing mechanism by providing direct visualization of the oral cavity, pharynx, and esophagus (Cook, 2008). Despite all the assessment available, there is still lack of universally accepted objective methods for evaluating dysphagia (Riley *et al.,* 2010). There are several objective instruments which have been applied in recent studies including the Bazaz Dysphagia Score system[15,24]; Modified Bazaz Dysphagia Score (Papavero *et al.,* 2007), Modified Dysphagia Scoring System, World Health Organization Dysphagia Grade (Lee *et al.,* 2011), Cervical Spine Outcomes Questionnaire (Riley *et al.,* 2005), modified Japanese Orthopaedic Association (mJOA) score (Fehlings *et al.,* 2012), Dysphagia Numeric Rating Scale (Kepler *et al.,* 2012), and plain lateral cervical radiographs (Chin *et al.,* 2007; Yue *et al.,* 2005). The Neck Disability Index(NDI) (Lee *et al.,* 2011), Oswestry Neck Disability Questionnaire (Riley *et al.,* 2005), Oswestry Disability Index (Buttermann, 2008), are the useful functional outcome measures for assessing the effects of neck pain on movement.

The most popular objective assessment tool used for dysphagia is the Bazaz Dysphagia Score (Table 4); its wide application ;based on telephonic interview, allows for the comparison of results at different follow-up intervals (Table 1) (Lee *et al.,* 2005). According to Bazaz grading system, the patients' dysphagic symptoms are graded as none "0", mild "1", moderate "2", and severe"3". Patients with no any episodes of swallowing difficulty/problems with liquids/solids were graded as "none" whereas patients with no difficulty with liquids and only rare difficulty with solids were graded as "mild". Rare or no difficulty with liquids and occasional difficulty with certain solid foods was regarded as "moderate" whereas difficulty with all liquids and frequent swallowing difficulty with majority of solid foods was regarded as "severe". However, the Bazaz dysphagia score has several drawbacks from different aspects: (1) Firstly, it is not self-administrated, that is, it represents an interpretatation of the patients's dysphagia symptoms by the therapist, which may introducea bias. (2) a much simplified score and its few clinical categories may not result in enough discrepancy between patients; (3) yet another problem is that difficulties swallowing solids always score worse than liquids, while patients often actually experience quite the opposite; (4) its scoring scale has never been universally validated despite its wide clinical use in literatures (Skeppholm *et al.,* 2012). The objective evaluation of swallowing function, however, are often unsatisfactory for complete diagnosis. Although objective assessment such as the barium swallow are useful for analyzing the degree of swallowing disruption, their results closely do not correspond with patient's dysphagic symptoms (Riley *et al.,* 2010). Patient self-reported problems are considered to be more clinically applicable and effective in determining swallowing disruptions (Kepler *et al.,* 2012).

REHABILITATION AND TREATMENT

The goal of dysphgia treatment is to reduce the risk of aspiration, enhance the ability to eat and drink by mouth, and maximize nutritional status and hydration, as well as improve or maintain quality of life and maximize the airway protection (Cook,. 2008; Jones *et al.,* 2016). Swallowing disorders are usually amenable to rehabilitation, including dietary

modification and training in swallowing techniques and maneuvers. The primary treatment options for dysphagia should include behavioral treatments, which contains postural adjustments, sensory enhancements, swallowing maneuvers, strengthening exercises, voluntary controls while eating, and dietary modifications (Rommel and Hamdy, 2016). The prognosis of dysphagia after ACSS is influenced by the complications including pneumonia, dehydration, and malnutrition. Dysphagic patients can practice various compensatory treatments requiring minimal effort by facilitating the effective passage of bolus material including (1) dietary modification: thickened liquids and softer diet to eliminate aspiration, avoiding harder foods; (2) increased sensory input by taste enhancement prior to swallowing ; (3) voluntary control to the swallow by breath holding (4) postural adjustments enabling airway protection to minimize the aspiration(chin tuck position, head tilting to the strong side, head rotation to the affected side, head lift exercises, lying down); and (5) isometric neck and range of motion(ROM) exercises to increase muscle tone and augment pharyngeal swallow, and to improve swallowing performance. If the patients still unable to improve swallowing function from these rehabilitation methods, then further medical and surgical treatments may be required. A vocal fold injection of short lasting augmentation material provides immediate rehabilitation with increased function and better swallowing during recovery from the RLN injury (Ali Zafar *et al.,* 2012). A temporary nasogastric tube may be the feeding option in cases where aspiration risk cannot be minimized and/ or nutritional demand cannot be fulfilled.

PREVENTION

Certain preoperative maneuver like preoperative tracheal traction exercise, intraoperative (use of steroids), improving surgical techniques and decreasing operative time and perioperative management may help in decreasing the incidence and severity of postoperative dysphagia after ACSS.

Implications for practice

Despite considerable clinical research efforts, conventional diagnostic methods and lack of universally validated assessment methods for evaluating dysphagia have limited proven accuracy in predicting the accurate incidence and prevalence. We contend that incorporation of universally measurable objective assessments into clinical diagnosis of dysphagia is needed and might be key in developing novel therapeutic modalities.

Implications for research

Further research is needed to confirm the incidence, prevalence, risk factors,causes, pathomechanisms, and long-term follow-up of dysphagia after ACSS, and also to identify the measures for prevention of dysphagia. Well designed, prospective randomized large studies may specify more elucidation on local inflammation, edema formation, hemorrhage, and other traumatic events during surgery; as well as the width or area of the space occupied by the osteophytes; examining the effect of diminished mucosal perfusion; studying the correlation between retraction time and the development of dysphagia; and analyzing whether mechanical retraction induces an esophageal dysmotility or interrupts the esophageal innervations. Further investigations on the prevention of dysphagia after ACSS comprise: determining the appropriate local steroid use; quantifying the optimal amount and length of retraction pressure; intraoperative EMG monitoring of laryngeal nerves injuries due to stretch injury; analyzing the effect of intermittent versus static retraction on the dysphagia. Results of these large standardized studies can be implemented to further improvement in surgical technique, perioperative care and a better knowledge of the effectof dysphagia symptoms on outcomes and effective treatment options, which may minimize the incidence rate of dysphagia after ACSS.

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