■ INSTRUCTIONAL REVIEW: SPINE

Dysphagia following anterior cervical spinal surgery

A SYSTEMATIC REVIEW

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Dysphagia is a common complication of anterior surgery of the cervical spine. The incidence of post-operative dysphagia may be as high as 71% within the first two weeks after surgery, but gradually decreases during the following months. However, 12% to 14% of patients may have some persistent dysphagia one year after the procedure. It has been shown that female gender, advanced age, multilevel surgery, longer operating time and severe pre-operative neck pain may be risk factors. Although the aetiology remains unclear and is probably multifactorial, proposed causes include oesophageal retraction, prominence of the cervical plate and prevertebral swelling. Recently, pre-operative tracheal traction exercises and the use of retropharyngeal steroids have been proposed as methods of reducing post-operative dysphagia.

We performed a systematic review to assess the incidence, aetiology, risk factors, methods of assessment and management of dysphagia following anterior cervical spinal surgery.

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The anterior approach to the cervical spine is commonly used in the surgical treatment of disc herniation and spondylosis.[1] The Smith–Robinson approach is the most widely used in anterior cervical procedures between C3 and T1.[1]

Dysphagia is a common complication of anterior cervical spine surgery. The pathophysiology of post-operative dysphagia is poorly understood, and few authors have described ways of avoiding it or of treating it.[2-4]

Materials and Methods

On 31 May 2012 we searched the databases PubMed, EMBASE and the Cochrane Central Register of Controlled Trials (CENTRAL) using the terms 'dysphagia', 'swallowing disorders' and 'anterior cervical spine surgery', looking for papers published in English that reported the aetiology, incidence, risk factors and management of dysphagia following anterior cervical surgery. Reviews, commentaries, case reports, case series and papers duplicated in several databases were excluded. The search was performed in duplicate and any disagreements were resolved by the senior author (DHL).

The papers were examined for the level of evidence using previously published guidelines.[5] The search yielded 260 papers in PubMed, 46 in EMBASE and seven from CENTRAL. Of these, 22 were included in this systematic review. There were 17 prospective and five retrospective studies. None had level I evidence; 16 were level II studies, three were level III studies and three were level IV studies (Table I).[2-4,6-24]

Results

Incidence. We reviewed one retrospective, one prospective comparative and two prospective longitudinal cohort studies for the incidence of post-operative dysphagia.[2-4,18] Edwards et al[3] assessed the accuracy of identification of dysphagia and dysphonia after anterior cervical surgery and found a poor correlation between patient surveys and the medical records, suggesting that the rate of post-operative dysphagia was significantly under-reported.

Results from prospective studies suggested that dysphagia is a common complication, particularly in the immediate post-operative period. Rihn et al[18] identified an incidence of dysphagia of 71% two weeks post-operatively and Bazaz et al[2] found that the incidence decreased to 50.2% at one month post-operatively, and decreased further to 32.2%, 17.8% and 12.5% by two, six and 12 months post-operatively, respectively. A prospective study by Lee et al[4] found a similar decreasing incidence of 54.2%, 33.6%, 18.6%, 15.2% and 13.6% at one, two, six and 12 months post-operatively, respectively. These studies suggest a high incidence of dysphagia in the first few weeks following surgery that decreases, reaching a plateau of between 12% and 14% one year post-operatively.[2,4,18]

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Table I. Studies included in the systematic review

Author(s)	Study type	Sample size (n)	Level of evidence
Bazaz et al[2]	Prospective longitudinal cohort	224	II
Buttermann[6]	Prospective non-randomised controlled	66	III
Chen et al[7]	Prospective randomised controlled trial	102	II
Chin et al[8]	Prospective comparative cohort	63	II
Edwards et al[3]	Retrospective survey	187	II
Frempong-Boadu et al[9]	Prospective longitudinal	23	II
Kang et al[10]	Retrospective longitudinal	45	IV
Kepler et al[11]	Prospective longitudinal cohort	43	II
Lee et al[4]	Prospective longitudinal cohort	348	II
Lee et al[12]	Prospective comparative	156	II
Lee et al[13]	Prospective randomised controlled trial	50	II
Mendoza-Lattes et al[14]	Prospective longitudinal cohort	17	II
Papavero et al[15]	Prospective longitudinal cohort	92	II
Pedram et al[16]	Prospective non-randomised controlled trial	236	II
Ratnaraj et al[17]	Prospective randomised controlled	51	II
Rihn et al[18]	Prospective comparative	94	II
Riley et al[19]	Retrospective longitudinal	454	III
Scholz et al[20]	Prospective longitudinal cohort	38	IV
Shields et al[21]	Retrospective longitudinal	151	III
Siska et al[22]	Prospective comparative	29	II
Smith-Hammond et al[23]	Prospective comparative	83	II
Vaidya et al[24]	Retrospective comparative	46	IV

Aetiology. Seven studies (one retrospective, four prospective longitudinal, two prospective comparative) investigated the aetiology of post-operative dysphagia,[8,10,11,12,14,15,20] suggesting prevertebral swelling, prominence of the cervical plate and oesophageal retraction as possible causes.

Prevertebral soft-tissue swelling. One retrospective and one prospective longitudinal study investigated the role of prevertebral swelling in the pathogenesis of post-operative dysphagia.[10,11] Prevertebral swelling as a result of haemorrhage or intra-operative soft-tissue trauma may impair oesophageal motility. However, a retrospective study by Kang et al[10] failed to find a significant correlation between the thickness of prevertebral tissue following anterior cervical surgery and the incidence of dysphagia. Similar findings were also reported by Kepler et al.[11]

Cervical plate prominence. Anterior cervical osteophytes secondary to arthritic changes, diffuse idiopathic skeletal hyperostosis or anterior cervical hyperosteophytosis can lead to dysphagia, through mechanical impingement on the oesophagus or inflammation causing fibrosis and adhesions.[8,12,20,25,26] Removal of anterior osteophytes at operation significantly reduces the incidence of dysphagia.[25,26]

Two prospective comparative and one prospective longitudinal study investigated whether prominence of the plate can induce dysphagia through similar mechanisms.[8,12,20] One non-randomised prospective study showed that the use of thicker plates was significantly associated with dysphagia,[12] and another found that the use of a non-protruding zero-profile plate was associated with a lower incidence of dysphagia.[20] A prospective study by Chin et al[8] failed to find a significant difference in the incidence of dysphagia between patients in whom the cervical plate protruded beyond the osteophytes and those in whom it did not. Thus the role of the cervical plate in the pathogenesis of post-operative dysphagia remains unclear.

Oesophageal retraction. Oesophageal retraction is another possible cause of post-operative dysphagia. Two prospective longitudinal studies investigated oesophageal retraction[14,15] and found that retraction of the oesophagus may produce ischaemia, and its release may lead to a reperfusion injury compromising oesophageal motility. Mendoza-Lattes et al[14] found that patients with dysphagia after anterior cervical surgery had significantly higher oesophageal intraluminal pressures, suggesting more oesophageal retraction and lower oesophageal perfusion than those without dysphagia. However, Papavero et al[15] failed to detect a significant correlation between the intra-operative pressure of oesophageal retraction and the incidence of post-operative dysphagia. Thus, these two studies of similar design and level of evidence reached differing conclusions regarding the relationship between oesophageal retraction and post-operative dysphagia.

Risk factors. A total of 11 studies (one prospective non-randomised controlled, four prospective comparative, three prospective longitudinal and three retrospective) attempted to identify risk factors for the development of post-operative dysphagia.[2,4,6,8,12,18-21,23,24] The factors that were analysed included patient demographics, surgical characteristics, the profile of the cervical plate and the use of recombinant human bone morphogenetic protein-2 (rhBMP-2) (Table II).

Patient characteristics. Four prospective studies (two longitudinal and two comparative) and one retrospective study investigated correlations between the pre-operative

Table II. Significant risk factors for dysphagia following anterior cervical spine surgery (rhBMP-2, recombinant human bone morphogenetic protein-2)

Risk factor	Supporting study (study design, number of subjects)
Female gender	Lee et al[4] (prospective, n = 348) Bazaz et al[2] (prospective, n = 249)
Multiple level procedures	Lee et al[4] (prospective, n = 348) Bazaz et al[2] (prospective, n = 249) Riley et al[19] (retrospective, n = 454)
Revision procedures	Lee et al[4] (prospective, n = 348)
Duration of procedure	Riley et al[19] (retrospective, n = 454) Rihn et al[18] (prospective, n = 94)
Older age	Smith-Hammond et al[23] (prospective, n = 83)
Prominent plate profile	Lee et al[12] (prospective, n = 156)
rhBMP-2	Buttermann et al[6] (prospective, n = 66) Vaidya et al[24] (retrospective, n = 46) Shields et al[21] (retrospective, n = 151)
Neck pain	Riley et al[19] (retrospective, n = 454)

characteristics of the patients and the incidence of dysphagia post-operatively.[2,4,18,19,23] Prospective cohort studies by Lee et al[4] and Bazaz et al[2] identified female gender as a significant risk factor for the development of dysphagia, starting six months after the procedure. A smaller prospective comparative study by Rihn et al[18] and a retrospective study by Riley et al[19] failed to find that gender was a significant risk factor. Whereas Lee et al[4] and Bazaz et al[2] found no correlation between age and the incidence of post-operative dysphagia, a prospective cohort study conducted by Smith-Hammond et al[23] found older age to be a significant risk factor. Riley et al also found severe neck pain to be a significant risk factor.[19]

Surgical characteristics. Three prospective cohort studies (two comparative and one longitudinal) and one retrospective study investigated whether certain surgical characteristics were risk factors for post-operative dysphagia.[2,4,18,19] Whereas the two larger prospective studies and one retrospective study found multilevel procedures to be a significant risk factor,[2,4,19] Rihn et al[18] did not find a significant correlation between the number of levels involved in the surgery and the incidence of dysphagia. Lee et al[4] also found revision surgery to be a significant risk factor. Longer duration of surgery was anecdotally believed to be a risk factor for post-operative dysphagia, perhaps owing to oesophageal retraction for a longer period of time. Retrospective and prospective studies found that longer operations were associated with a higher incidence of dysphagia.[18,19] However, it is possible that this followed multilevel operations, which usually take longer.[19] Furthermore, other studies failed to find duration of surgery to be a significant risk factor.[2,4,10]

Cervical plate prominence. Two prospective comparative studies and one prospective longitudinal study investigated prominence of the cervical plate as a possible risk factor.[8,12,20] Prospective studies by Lee et al[12] and Scholz et al[20] suggested that the use of larger, bulkier plates that protruded beyond the vertebral bodies was a significant risk factor for dysphagia. However, a prospective study by Chin et al[8] failed to find a correlation between protrusion of the plate and an increased incidence of post-operative dysphagia. It remains unclear whether prominence of the plate is actually a significant risk factor.

Bone morphogenetic protein. Two retrospective studies and one prospective non-randomised controlled study investigated the use of rhBMP-2 as a risk factor for post-operative dysphagia[6,21,24]; it can induce inflammation and oedema in the oesophagus and surrounding soft tissues resulting in reduced oesophageal motility and dysphagia.[6] A non-randomised study found that the use of rhBMP-2 was associated with an almost fourfold increase in the incidence of post-operative dysphagia compared with those who were treated with autograft.[25] Similar studies also found the incidence of dysphagia in patients receiving rhBMP-2 to be significantly higher than those treated with allograft, especially when the dose of rhBMP-2 exceeded the recommended amount.[21,24] Most importantly, the oedema associated with rhBMP-2 can lead to more serious complications such as airway or nerve compression; as a result, the United Stated Food and Drug Administration (FDA) has advised against its use in anterior cervical surgery.[27]

Review of these studies suggests that female gender, revision and multilevel procedures are risk factors for the development of dysphagia post-operatively.[2,4,18] It is still

Table III. Bazaz dysphagia scoring system[2]

Severity of dysphagia	Difficulty swallowing liquids	Difficulty swallowing solids
None	None	None
Mild	None	Rare
Moderate	None or rare	Occasionally (only with specific foods)
Severe	None or rare	Frequent (majority of solids)

Table IV. Modified Bazaz dysphagia scoring system.[15] Assessment is undertaken on the day of operation and on the first, third and fifth post-operative days; the scores are added together, with dysphagia defined as a cumulative score of ≥ 12

Points	Severity of dysphagia	Definition
0	None	No episodes of difficulty swallowing
1 to 3	Mild	Only rare episodes of difficulty swallowing
4 to 6	Moderate	Occasional swallowing difficulty with solid foods
7 to 10	Severe	Swallowing difficulty with solids and liquids

not clear whether the severity of pre-operative neck pain and the prominence of the plate are true risk factors.[8,12,19,20] Although the studies on rhBMP-2 were either retrospective or non-randomised prospective, the FDA warning suggests that its use should be considered as a significant risk factor for dysphagia.[6,21,24,27]

Assessment of post-operative dysphagia. Three prospective longitudinal and two prospective comparative studies described methods of diagnosing and assessing the severity of post-operative dysphagia.[2,9,15,18,22] These included videofluoroscopy, the Bazaz dysphagia questionnaire[2] and its modified form,[15] the Dysphagia Numerical Rating Scale,[11] the Dysphagia Disability Index[18] and the Swallowing-Quality of Life (SWAL-QOL) questionnaire.[22]

The gold standard for the assessment of dysphagia is videofluoroscopic swallow evaluation (VSE). A prospective study by Frempong-Boadu et al[9] compared pre- and post-operative VSE results with clinical findings in patients undergoing anterior cervical surgery, and found a poor correlation between the objective and subjective findings of dysphagia. Four prospective studies (two comparative and two longitudinal) reported the use of patient-reported dysphagia questionnaires to assess the incidence and severity of dysphagia.[2,15,18,22] A commonly used questionnaire is the Bazaz dysphagia score,[2] which grades patients as 'none', 'mild', 'moderate' or 'severe', based on the frequency of dysphagia and the types of foods that lead to dysphagia (Table III). It was subsequently modified to a ten-point scale recorded daily for four days (Table IV),[15] with dysphagia being defined as a cumulative four-day score of ≥ 12. The Dysphagia Disability Index[18] includes physical function and emotional domains. None of these questionnaires have been validated or shown to be significantly reliable, and therefore the accuracy of their results is not known.[2,15,18]

The SWAL-QOL survey is a validated 93-item questionnaire that quantifies dysphagia on the basis of severity and duration as well as its psychological impact.[22] Although it has been shown to be valid and reliable, its length and complexity make it less practical in the clinical setting.[22]

Although the objective VSE findings may be important, patient-reported questionnaires may provide more useful information when assessing post-operative dysphagia.[9]

Clinical recommendations. Eight prospective studies (three randomised controlled, two comparative, two longitudinal and one non-randomised controlled) evaluated methods of reducing post-operative dysphagia, including the use of intravenous methylprednisolone, maintaining a baseline endotracheal tube cuff pressure, using different types of cervical plates and tracheal traction exercises.[7,8,12,13,16,17,20,23]

Steroid therapy. One prospective non-randomised controlled study and one randomised prospective study investigated the use of steroids in the treatment of post-operative dysphagia.[13,16] It was thought that steroids might reduce prevertebral swelling.[13,16] A prospective study by Pedram et al,[16] however, failed to find a significant difference in the incidence of dysphagia between patients who received three post-operative intravenous injections of methylprednisolone and those who did not. However, as this study failed to randomise patients into control and treatment groups, it is unclear whether intravenous steroids can alleviate post-operative dysphagia.[16] A prospective randomised study by Lee et al[13] found that the intra-operative application of triamcinolone into the retropharyngeal space significantly reduced prevertebral swelling, in addition to reducing the incidence of painful swallowing post-operatively (Table V).

Endotracheal tube cuff pressure. One prospective randomised study evaluated whether controlling the endotracheal tube cuff pressure during retraction can reduce the incidence of dysphagia.[17] The hypothesis was that increased cuff pressure may induce injury to the oesophagus. The study failed to detect a significant difference in the incidence of dysphagia between the control and intervention groups. The mean retraction time, however,

Table V. Proposed methods of reducing dysphagia following anterior cervical spine surgery

Suggested intervention	Evaluating studies (design, number of subjects)	Study conclusions
Intravenous methylprednisolone	Pedram et al[16] (prospective non-randomised, n = 236)	No significant difference between intervention and control groups
Retropharyngeal steroids	Lee et al[13] (prospective randomised, n = 50)	Retropharyngeal steroids significantly reduced incidence of odynophagia
Reduction/control of endotracheal tube cuff pressure	Ratnaraj et al[17] (prospective randomised, n = 51)	No significant difference between intervention and control groups
Reducing cervical plate profile	Lee et al[12] (prospective, n = 156)	Smaller and smoother plates significantly reduced incidence of post-operative dysphagia
Zero-profile implant	Scholz et al[20] (prospective, n = 38)	Zero-profile implants significantly reduced incidence of post-operative chronic dysphagia
Tracheal traction exercises (TTEs)	Chen et al[7] (prospective randomised, n = 102)	TTEs significantly reduced incidence of post-operative dysphagia

was significantly higher in the treatment group than in the controls, suggesting that reduction of cuff pressure may make the procedure more technically difficult.[17]

Cervical plate design. Two prospective comparative studies and one prospective longitudinal study investigated whether using cervical plates with a different profile can lower the incidence of dysphagia.[8,12,20]

As plates were hypothesised to produce dysphagia through the effect of mass and inflammation of the oesophagus, several studies investigated whether changing the design of the plate could reduce the incidence of dysphagia. Lee et al[12] conducted a prospective study comparing the incidence of dysphagia between patients who were treated with the larger and more bulky Atlantis plate (Medtronic, Memphis, Tennessee) and those treated with the smaller and smoother Zephir (Medtronic). Patients receiving the Zephir plate had a significantly lower incidence of dysphagia only at six and 12 months post-operatively.[12]

Another recent study on 38 patients evaluated the incidence of dysphagia in patients who were treated with the Zero-P plate (Synthes, West Chester, Pennsylvania), which is radiolucent and does not protrude beyond the anterior vertebral bodies.[20] Patients with this plate had almost complete resolution of dysphagia (2.9%) three months after the procedure.[20]

Although these studies suggest that the use of a thinner, smoother plate is associated with a lower incidence of dysphagia, Chin et al[8] in a prospective study failed to find a difference in the incidence of dysphagia between patients whose cervical plates were more prominent than their osteophytes and those whose plates were less prominent. Thus, the relationship between post-operative dysphagia and different designs of cervical plate remains unclear.

Tracheal traction exercises. A prospective randomised controlled study by Chen et al[7] involving 102 patients evaluated whether pre-operative tracheal traction exercises can reduce the incidence of post-operative dysphagia. The authors assumed that oesophageal retraction induces post-operative dysphagia through ischaemia and reperfusion injury. In turn, tracheal traction exercises, which include gentle manoeuvring of the thyroid cartilage from side to side, may increase the compliance of the oesophagus and thereby reduce the pressure required by retraction to maintain an adequate operative field. Thus, tracheal traction exercises were hypothesised to reduce the risk of ischaemic injury without making the procedure longer or more technically difficult.[7]

The exercises were performed twice daily (15 times each time) for three days, starting four days before the operation. The authors found that patients undertaking the exercises had a significantly lower incidence of dysphagia at one and three weeks post-operatively. However, there was no significant difference in the incidence of dysphagia between the treatment and control groups at six weeks, three months or six months post-operatively. Although this study does offer a possible method for reducing the incidence of dysphagia, it was not blinded and lacked placebo controls.[7]

Posterior approach. A prospective study by Smith-Hammond et al[23] showed that the incidence of post-operative dysphagia is significantly lower in patients who have undergone posterior cervical surgery than in those who have undergone anterior surgery. Currently, the posterior approach is recommended when the procedure involves many cervical levels, when there is ankylosis of the spine or ossification of the posterior longitudinal ligaments and when cervical lordosis is preserved.[1,28] It is important to assess the cervical kyphosis pre-operatively because posterior decompression may not allow the spinal cord to move posteriorly, and so further kyphosis may worsen the spinal cord compression.[1,28]

Discussion

In conclusion, dysphagia is a common but poorly understood complication of anterior cervical spine surgery.[2,4,18] Although its aetiology is most likely to be multifactorial, several risk factors have been identified: female gender, revision, multilevel procedures, longer operating time, older age, pre-existing severe neck pain, the use of rhBMP-2 and the use of large or bulky plates.[8,10,11,12,14,15,20] Although none of the studies investigated the role of post-

operative adjacent-level degeneration in the development of post-operative dysphagia, adjacent-level ossification may result in delayed dysphagia.[29-31]

Forms of treatment such as intravenous steroid, strict control of endotracheal cuff pressure and the use of lower-profile implants have not been consistently shown to reduce the incidence of post-operative dysphagia significantly.[8,12,13,16,17,20s] Intra-operative retropharyngeal steroids may facilitate swallowing in the immediate post-operative period.[13] Pre-operative tracheal traction exercises and the use of a posterior approach to the cervical spine are associated with a significantly lower incidence of post-operative dysphagia.[7,23]

Supplementary material

A table detailing the component questions and scoring of the Dysphagia Disability Index is available with the electronic version of this article on our website www.bjj.boneandjoint.org.uk

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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