The Journal of Laryngology & Otology (2014), ***128***, *1105–1110.*
© JLO (1984) Limited, 2014
doi:10.1017/S0022215114002692

SHORT COMMUNICATION

Targeted use of endoscopic CO_2 laser cricopharyngeal myotomy for improving swallowing function following head and neck cancer treatment

N DAWE[1], J PATTERSON[2], D HAMILTON[1], C HARTLEY[1]

[1]*ENT Department and* [2]*Speech and Language Therapy Department, Sunderland Royal Hospital, UK*

Abstract

Background: Cricopharyngeal dysfunction following head and neck cancer treatment may lead to a significant reduction in oral intake. Carbon dioxide laser is an established procedure for the treatment of non-malignant cricopharyngeal disorders. We report our experience of laser cricopharyngeal myotomy with objective swallowing outcome measures, before and after treatment.

Methods: We identified 11 patients who had undergone carbon dioxide laser cricopharyngeal myotomy for dysphagia following radiotherapy, with or without chemotheraphy between January 2006 and July 2011. We analysed the swallowing outcomes following carbon dioxide laser cricopharyngeal myotomy by retrospective grading of pre- and post-procedure videofluoroscopic swallowing study of liquids, using the validated Modified Barium Swallow Impairment Profile.

Results: The median Modified Barium Swallow Impairment Profile score was 13 pre-myotomy and 10 post-myotomy. This difference between scores was non-significant ($p = 0.41$). The median, cricopharyngeal-specific Modified Barium Swallow Impairment Profile variables (14 and 17) improved from 3 to 2, but were similarly non-significant ($p = 0.16$). We observed the improved Modified Barium Swallow Impairment Profile scores post-procedure in the majority of patients.

Conclusion: Endoscopic carbon dioxide laser cricopharyngeal myotomy remains a viable option in treatment-related cricopharyngeal dysfunction; its targeted role requires further prospective study. Objective analysis of the technique can be reported using the validated Modified Barium Swallow Impairment Profile.

Key words: Esophageal Sphincter, Upper; Pharyngeal Muscles; Head and Neck Neoplasms; Deglutition Disorders; Radiotherapy; Chemoradiotherapy

Introduction

Dysphagia following head and neck cancer treatment is common, multifactorial and has a significant impact on quality of life.[1] Some degree of post-treatment dysphagia is reported in up to 50 per cent of head and neck cancer patients.[2] Post-treatment swallowing disorders include weakness of posterior motion of the tongue base, incoordination of swallow phases, reduced laryngeal elevation and closure, and reduced epiglottic inversion. Cricopharyngeal muscle relaxation at the end of the pharyngeal phase of a normal swallow, assisted by the anterior–superior displacement of the larynx, allows the passage of the food bolus. Poor cricopharyngeal opening, confirmed during videofluoroscopic swallowing study, is a major factor contributing to a significant reduction in oral intake following cancer treatment.[3] Cricopharyngeal dysfunction incorporates several pathologies that include failure of muscle relaxation, fibrosis, hypertrophy and incoordination between pharyngeal constriction and cricopharyngeal opening.

Wang *et al*.[4] reported an overall risk of 7.2 per cent for pharyngoesophageal stricture formation following radiotherapy (RT) with or without chemotherapy ((chemo)RT), confirmed at barium swallow or direct endoscopy. In their meta-analysis of 26 published studies, the authors reported late dysphagia as correlating with: (1) radiation technique (conventional *vs* intensity-modulated RT, with increased dysphagia in intensity-modulated RT); (2) radiation dose to the cervical oesophagus and pharyngeal constrictors; and (3) chemotherapy use. Specifically, intensity-modulated RT to the lower neck exposes the inferior pharyngeal constrictor muscles to a greater radiation dose and is associated with increased pharyngoesophageal stricture rates compared with conventional RT (16.7 per cent *vs* 5.7 per cent; odds ratio = 3.3).[4] Cricopharyngeal fibrosis presents in a varied and non-specific manner that may include a globus sensation, progressive dysphagia and, ultimately, gross aspiration.

Several management options exist for benign upper oesophageal sphincter pathologies including bougienage, botulinum toxin injection and open cricopharyngeal

Presented as a poster at the 14th British Academic Conference in Otolaryngology, 4–7 July 2012, Glasgow, United Kingdom
Accepted for publication 16 January 2014 First published online 11 November 2014

myotomy. Carbon dioxide (CO_2) laser is an established procedure for the treatment of non-malignant cricopharyngeal disorders, and specifically for cases in which there may be uncoordinated cricopharyngeal muscle relaxation or a prominent cricopharyngeal bar.[5] One published abstract presented CO_2 laser cricopharyngeal myotomy following RT alongside barium swallow and subjective swallow outcome measures in 12 patients, and reported no complications.[6] To date, no published series has reported its use, together with objective outcome measures, in the context of cricopharyngeal-related dysphagia following treatment for head and neck cancer. We sought to report our experience of laser cricopharyngeal myotomy with objective swallowing outcome measures, before and after treatment.

Methods

We performed a retrospective analysis of patients undergoing CO_2 laser cricopharyngeal myotomy for post-treatment, cricopharyngeal fibrosis-related dysphagia. At our hospital in Sunderland, UK, swallowing function is jointly assessed as part of the first combined head and neck cancer clinic review, following (chemo)RT for head and neck cancer. In the first instance, the assessment usually consists of a clinical examination and a fibreoptic endoscopic evaluation of swallowing. If the patient is not following the expected trajectory as their acute (chemo)RT side effects resolve, we proceed to a videofluoroscopic swallowing study or examination under anaesthesia. We review patients regularly thereafter as swallowing function can deteriorate over time. This complement of tests gives a fuller picture of all the various components of the swallowing mechanism. Findings are jointly discussed and an individual management plan is devised to maximise swallowing safety and efficiency. Management techniques include specific swallowing exercises, postures, manoeuvres, diet modification or surgical procedures. Patients with cricopharyngeal opening problems confirmed by videofluoroscopic swallowing study would be considered for a CO_2 laser cricopharyngeal myotomy as a component of their treatment plan.

We rated the videofluoroscopic swallowing studies performed before and after cricopharyngeal myotomy on the Modified Barium Swallow Impairment Profile.[7] The Modified Barium Swallow Impairment Profile is a validated, standardised rating scale of the Modified Barium Swallow Study with 17 components and 3–5 associated scores describing progressive levels of oral, pharyngeal and oesophageal impairment (Table I). Ratings in our analysis were based on the first 'cup sip' of the videofluoroscopic swallowing study examination: a speech and language therapist and ENT specialist trainee independently reviewed the videofluoroscopic swallowing study with results correlated to achieve a consensus score. We analysed the differences in Modified Barium Swallow Impairment Profile scores using a Wilcoxon signed-ranks test for paired, non-parametric, ordinal data, with a two-tailed p value of < 0.05 considered significant.[8]

The normalcy of diet subsection of the Performance Status Scale is a well-validated, clinician-rated measurement of food textures designed for head and neck cancer patients (Table II).[9] We recorded this scale pre- and post-laser treatment.

To perform the cricopharyngeal myotomy, we inserted a bivalve Weerda diverticuloscope (KARL STORZ GmbH & Co. KG, Tuttlingen, Germany) into the post-cricoid space, with the anterior blade towards the oesophageal lumen and the posterior blade placed at the base of the cricopharyngeal muscle on the posterior pharyngeal wall. We incised the cricopharyngeal mucosa using a CO_2 laser (Lumenis UK Ltd, London, UK) set on continuous delivery at a power of 2 W. If the cricopharyngeal muscle could be mobilised or placed under some lateral tension, the lead author (CH) aimed to resect a portion of the muscle to prevent fibrosis and restenosis. The dissection proceeded until it was either apparent that the muscle was divided and the underlying fascia visualised, or we

TABLE II
NORMALCY OF DIET SUBSECTION OF THE PERFORMANCE STATUS SCALE[9]*

Full diet with no restrictions	100
Full diet with liquid assistance	90
All meats	80
Carrots, celery (crunchy food items)	70
Dry bread and crackers	60
Soft, chewable foods (pasta)	50
Soft foods requiring no chewing	40
Purée	30
Warm liquids	20
Cold liquids	10
Non-oral	0

*Patients are asked what type of textures they are eating at present and they are then scored on the scale; they end up with a single score according to the most difficult texture they can manage.

TABLE I
MODIFIED BARIUM SWALLOW IMPAIRMENT PROFILE[7]

Oral impairment domain	Pharyngeal impairment domain	Oesophageal impairment domain
1. Lip closure	7. Soft palate elevation	17. Oesophageal clearance*
2. Tongue control during bolus hold	8. Laryngeal elevation	
3. Bolus preparation/mastication	9. Anterior hyoid excursion	
4. Bolus transport/lingual motion	10. Epiglottic movement	
5. Oral residue	11. Laryngeal vestibule closure	
6. Initiation of the pharyngeal swallow	12. Pharyngeal stripping wave	
	13. Pharyngeal contraction	
	14. Pharyngoesophageal segment opening*	
	15. Tongue-base retraction	
	16. Pharyngeal residue (amount of bolus material remaining in the pharynx after the initial swallow)	

*The variables numbered 14 and 17 are specific to cricopharyngeal muscle function.

https://doi.org/10.1017/S0022215114002692 Published online by Cambridge University Press

deemed it unsafe to progress. We did not close the mucosal incision.

We achieved haemostasis by a diffused laser beam or adrenaline-soaked pledgets. If this approach was inadequate, we used endoscopic diathermy, though this could cause a greater degree of post-operative fibrosis and subsequent scarring, and thus we kept its use to a minimum. Many patients experienced some degree of trismus following RT treatment. Although this may have led to poor operative access, no patients in our series were excluded due to failed insertion of the diverticuloscope.

Results

We identified 13 patients who experienced dysphagia, and they successfully underwent cricopharyngeal myotomy for cricopharyngeal fibrosis-related symptoms. No cases were excluded in which the procedure was abandoned due to limitations in operative access or co-morbidities. We did not record any procedure-related complications. All patients had undergone RT with or without chemotherapy for a variety of head and neck cancers between January 2006 and July 2011. We excluded two patients for having insufficient videofluoroscopic swallowing study data available: the image quality for one post-cricopharyngeal myotomy videofluoroscopic swallowing study was insufficient for analysis and another patient had significant fibrosis, which necessitated a tracheostomy and ultimately pharyngolaryngectomy for a dysfunctional larynx. This meant that complete pre- and post-procedure videofluoroscopic swallowing studies were available for interpretation in 11 patients (Table III).

Pre- and post-laser cricopharyngeal myotomy, and median Modified Barium Swallow Impairment Profile scores showed improvements, with a lower score signifying a better swallowing performance. Individual scores are presented in a radar plot for the total Modified Barium Swallow Impairment Profile (Figure 1) and cricopharyngeal-specific variables (Figure 2).

These overall differences, however, were not significant for either the total or the cricopharyngeal-specific (variables 14 and 17) Modified Barium Swallow Impairment Profile scores (Figure 3). The median total Modified Barium Swallow Impairment Profile score improved from a pre-myotomy score of 13 (95 per cent confidence interval (CI); 8.21, 17.79) to a post-myotomy score of 10 (95 per cent CI; 4.15, 15.85), with a lower score signifying a better swallowing performance. This difference in median Modified Barium Swallow Impairment Profile scores was non-significant ($p = 0.41$, 95 per cent CI; −4.56, 10.56). The median Modified Barium Swallow Impairment Profile score of the cricopharyngeal-specific function (variables 14 and 17) improved from 3 (95 per cent CI; −0.19, 6.19) to 2 (95 per cent CI; 0.4, 3.6), but was also non-significant ($p = 0.16$, 95 per cent CI; −2.57, 4.57). A score of 0 or 1 on each parameter of the Modified Barium Swallow Impairment Profile is considered within the normal range, and thus a move of greater than one point on each parameter may be considered meaningful as a measure of swallowing impairment (B Martin-Harris, personal communication).[10]

Patients with the greatest overall swallowing impairment (i.e. higher Modified Barium Swallow Impairment Profile scores; cases 1, 2 and 9) demonstrated improvement post-intervention. Of particular note, case 9 presented with a high pre-intervention Modified Barium Swallow Impairment Profile score, which dropped by 17 points post-intervention. For the remaining eight patients assessed, four out of eight had worse overall Modified Barium Swallow Impairment Profile scores post-intervention. Notably, 2 out of 8 patients (cases 3 and 6) had worse cricopharyngeal-specific variables post-intervention, measured at 5 and 25 months respectively. These four patients with a worse overall Modified Barium Swallow Impairment Profile score (particularly case 6) presented with multiple problems with bolus propulsion, in combination with poor cricopharyngeal opening. They developed progressive fibrosis accounting for their worsening swallowing performance. This fibrosis was so significant in one patient that they were excluded from analysis, and as previously mentioned ultimately they went on to have a pharyngolaryngectomy due to an incompetent fibrotic larynx.

Clinical aspiration or radiological penetration was evident in 8 out of 11 patients pre-cricopharyngeal myotomy, and this remained in 4 of these patients post-cricopharyngeal myotomy. Normalcy of diet data were available for 10 out of 11 patients (Table IV). The median score improved from 20 out of 100 pre-cricopharyngeal myotomy to 30 out of 100 post-cricopharyngeal myotomy.

Discussion

In this study, we have demonstrated a trend for improved median Modified Barium Swallow Impairment Profile swallowing scores following CO_2 laser cricopharyngeal

TABLE III
PATIENT CHARACTERISTICS AND TIMINGS OF INTERVENTIONS

Case No.	Age/sex	Primary disease	RT	CRT	RT/CRT to laser CPM (months)	RT/CRT to pre-op VFSS (months)	Laser CPM to post-op VFSS (months)
1	88M	T_{1b} larynx	Y	N	102	102	5
2	56M	T_4 N_{2c} tonsil	Y	Y	18	15	0
3	54M	T_4 N_{2c} piriform fossa	Y	Y	5	4	0
4	50M	T_3 N_{2a} tongue base	Y	Y	6	12	11
5	63M	T_2 oropharynx	Y	N	70	60	0
6	59M	T_3 N_{2b} tongue base	Y	Y	22	7	3
7	64F	T_4 N_1 maxilla	Y	N	30	6	4
8	65F	T_3 N_0 hypopharynx	Y	Y	12	12	9
9	71M	T_2 N_1 supraglottis	Y	Y	4	2	1
10	47M	T_3 N_1 soft palate	Y	N	25	11	2
11	64F	T_4 N_0 tonsil	Y	Y	6	3	3

RT = radiotherapy; CRT = chemoradiotherapy; CPM = cricopharyngeal myotomy; VFSS = videofluoroscopic swallowing study

https://doi.org/10.1017/S0022215114002692 Published online by Cambridge University Press

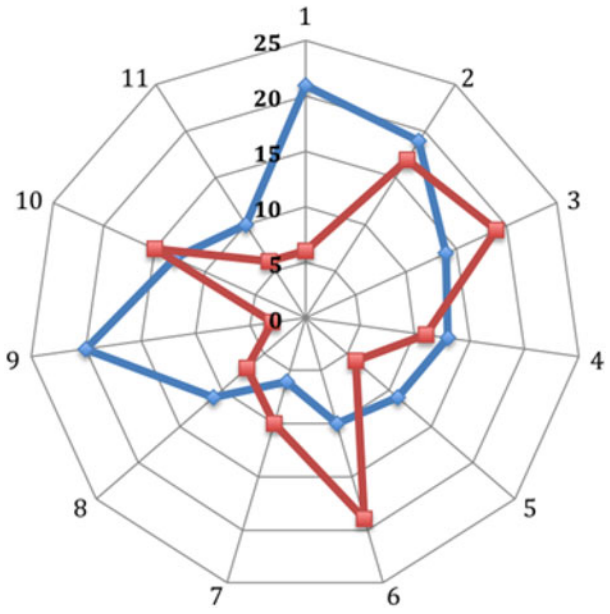

FIG. 1

Individual patients' total MBSImP scores pre- (blue line) and post-CO_2 laser cricopharyngeal myotomy (red line). CO_2=carbon dioxide; MBSImP = Modified Barium Swallow Impairment Profile

myotomy in patients previously treated with (chemo)RT for head and neck cancer. Although this finding did not achieve statistical significance, this is the first description of the use of this technique in the management of patients following non-surgical treatment for cancer. The Performance Status Scale normalcy of diet scores provided a further descriptive report of the type of oral diet patients were able to achieve, and showed variation across cases.

Our mixed results in this case series reflect the complexity of post-(chemo)RT dysphagia. When considering

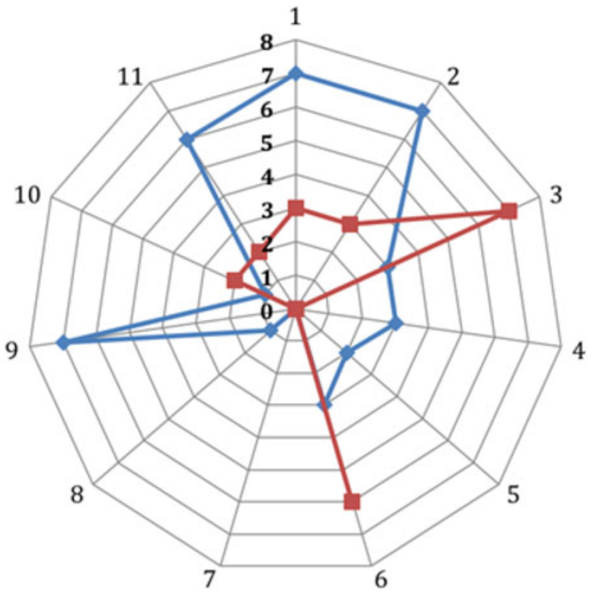

FIG. 2

Individual patients' cricopharyngeal function-specific MBSImP scores (variables 14 and 17) pre- (blue line) and post-CO_2 laser cricopharyngeal myotomy (red line). CO_2 = carbon dioxide; MBSImP = Modified Barium Swallow Impairment Profile

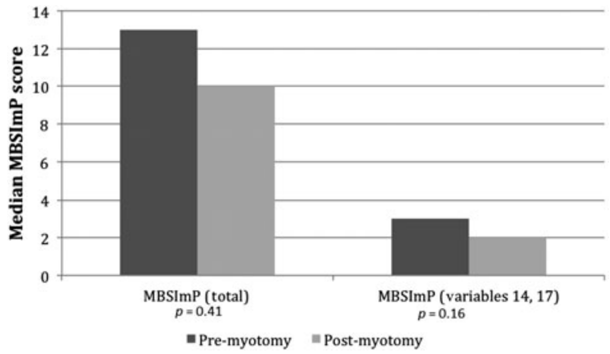

FIG. 3

Graph showing the improved median total and cricopharyngeal-specific (variables 14 and 17) MBSImP scores following CO_2 laser cricopharyngeal myotomy. MBSImP = Modified Barium Swallow Impairment Profile

the remarkable improvement in swallowing described by the Modified Barium Swallow Impairment Profile for case 9 (Figures 1 and 2), this was reflected in the eating habits of the patient as recorded by the Performance Status Scale normalcy of diet scale; the patient progressed from having no oral intake to managing a puréed diet (Table IV). One possible explanation for this is a 'use it or lose it' theory, with the best exercise for swallowing, being swallowing itself.[11] Patient number 11 experienced major diet changes, but relatively small changes in Modified Barium Swallow Impairment Profile scores following the intervention. This patient had a focal problem with cricopharyngeal opening, thus the procedure led to a dramatic change in the ability to eat and drink. In our analysis of the heterogeneous response to cricopharyngeal myotomy reported in our series, we have acknowledged that several patients presented with complex swallowing problems. It is this complexity that likely accounts for the relative mix of outcomes following cricopharyngeal myotomy.

Cricopharyngeal myotomy has been recommended and widely used to improve swallowing both alongside, and following surgical treatment of head and neck cancer.[12] One prospective study examined the role of external approach cricopharyngeal myotomy in those undergoing surgical management of tongue-base and supraglottic laryngeal cancer.[13] The authors concluded that the procedure failed to provide any benefit and criticised purported widespread reporting of its application for dysphagia in the literature despite a lack of evidence.

TABLE IV
NORMALCY OF DIET SUBSECTION OF THE PERFORMANCE STATUS SCALE

Case No.	Pre-procedure	Post-procedure
1	50	100
2	0	0
3	0	30
4	10	30
5	40	40
6	20	20
7	10	NA
8	40	90
9	0	30
10	30	30
11	20	80

The applications of laser cricopharyngeal myotomy for cricopharyngeal dysfunction following non-surgical head and neck cancer treatment are less clearly documented. Small, uncontrolled case series routinely present endoscopic cricopharyngeal myotomy data for a heterogeneous mix of benign and malignant cricopharyngeal pathologies, limiting direct comparison with our series. Methods of swallowing assessment pre- and post-cricopharyngeal myotomy are equally heterogeneous and apply non-objective outcome measures.

Dauer *et al.*[14] performed a retrospective review of CO_2 laser cricopharyngeal myotomy ($n = 14$) versus an external approach ($n = 8$), using pre-operative manofluorography and a functional outcome swallowing scale, concluding that the technique was safe and effective. Brøndbo[15] presented 17 cases with pre-operative videofluoroscopic swallowing study and manometry, reporting subjective improvement in the majority of cases using a swallowing questionnaire.

Lawson and Remacle[16] retrospectively analysed 29 patients undergoing CO_2 laser cricopharyngeal myotomy for a multitude of underlying pathologies. They were assessed pre- and post-operatively by videofluoroscopic swallowing study, flexible nasendoscopy and a subjective patient score for dysphagia and aspiration, each graded 0–4, and reported an improvement in each score. Similarly, several further key studies have reported mixed pathologies and pre-operative assessments.[5,17–19]

This paper demonstrates the feasibility of the laser cricopharyngeal myotomy procedure and highlights the need to report valid, objective outcome data for comparison with other techniques.

Dysphagia following (chemo)RT is usually multifactorial, may deteriorate over time and typically requires a combined approach to rehabilitation. There is substantial diversity in the reported methods of measuring swallowing before and after laser cricopharyngeal myotomy. The variety of pre-procedure measurement scales applied in the literature presents clinicians with considerable difficulty in effective patient selection. No effective methods exist to predict success prior to cricopharyngeal myotomy; the use of manometry and intrabolus pressures to measure pharyngoesophageal pressures is considered unreliable; however, it may well have an adjunctive role alongside dynamic swallow examinations.[20] In our study, we selected patients for the procedure following multidisciplinary team discussion, clinical assessment and videofluoroscopic swallowing study findings, which allowed an objective measure of the swallowing impairment. It appears that laser cricopharyngeal myotomy is ideal for patients presenting with a focal cricopharyngeal opening problem. This procedure may also have a role in managing patients with oropharyngeal dysphagia in addition to cricopharyngeal opening dysfunction. However, we feel it is not indicated in patients where progressive fibrosis is identified.

Halvorson and Kuhn[21] first described endoscopic cricopharyngeal myotomy using a potassium titanyl phosphate laser. The CO_2 laser is advantageous as it delivers a more localised thermal injury and improved haemostasis. The advantages of endoscopic approaches over open cricopharyngeal myotomy include reduced anaesthesia time and the avoidance of potential complications, including pharyngocutaneous fistula, recurrent laryngeal nerve injury, haematoma, seroma and infection. Based on cadaveric studies in benign disease, the procedure is theorised to preserve the integrity of the buccopharyngeal fascia – the visceral layer of the middle layer of the deep cervical fascia – which maintains a protective layer and isolates the transmucosal myotomy site from the retropharyngeal space.[22]

Laser cricopharyngeal myotomy following head and neck cancer treatment presents an additional challenge when these fascial planes may be disrupted by tissue fibrosis. Chitose *et al.*[23] emphasised the need to ensure myotomy of both horizontal and oblique parts of the cricopharyngeal muscle and suggested the technique may be developed further to limit post-operative stenosis arising from adhesion of the cricopharyngeal muscle and mucosal scarring through resection of the cricopharyngeal muscle and horizontal suturing of the mucosa. In our series, we aimed to resect muscle whenever feasible, however, the nature of irradiated tissues limited this in most cases and we were unable to draw conclusions between the technique and outcomes in individual cases.

- **Dysphagia following head and neck cancer treatment is common, multifactorial and has a significant impact on quality of life; cricopharyngeal dysfunction is one of the causes, reflected by the small number of cases presented here**
- **Symptoms of cricopharyngeal fibrosis occurring after radiotherapy and chemotherapy treatment are varied and relatively non-specific, but may include a globus sensation, progressive dysphagia to solids and subsequently liquids, and ultimately gross aspiration**
- **Dysphagia assessment may include clinical examination, videofluoroscopy and examination under anaesthetic, to identify all components contributing to the impairment**
- **Where cricopharyngeal dysfunction is identified, carbon dioxide (CO_2) laser cricopharyngeal myotomy remains a viable option in carefully selected patients, in the absence of signs of progressive fibrosis**
- **In this case series, we observed a trend for improved Modified Barium Swallow Impairment Profile swallowing scores following CO_2 laser cricopharyngeal myotomy in 7 out of 11 patients, but this was not statistically significant**

This study is limited by a small sample size. We did not undertake videofluoroscopic swallowing studies at set time points as we used them solely for clinical (non-research) purposes in patients complaining of dysphagia, which itself may continue to evolve following the completion of (chemo)RT.[24] Nevertheless, the results provide an encouraging account of the application of this technique in patients following head and neck cancer treatment. The data supports the case for further investigation of this technique in the form of an adequately powered prospective study.

Conclusion

Our data suggest cricopharyngeal myotomy is effective in selected patients experiencing dysphagia following non-surgical treatment for head and neck cancer. The Modified

https://doi.org/10.1017/S0022215114002692 Published online by Cambridge University Press

Barium Swallow Impairment Profile also provides a clinically accessible, standardised measure of oropharyngeal impairment.[7] A sensitive method of identifying those at risk of cricopharyngeal dysfunction, either based on treatment protocols or using the Modified Barium Swallow Impairment Profile, may permit a more effective and targeted role of CO_2 laser cricopharyngeal myotomy.

References

1 Gillespie MB, Brodsky MB, Day TA, Lee FS, Martin-Harris B. Swallowing-related quality of life after head and neck cancer treatment. *Laryngoscope* 2004;**114**:1362–7
2 Nguyen NP, Sallah S, Karlsson U, Antoine JE. Combined chemotherapy and radiation therapy for head and neck malignancies: quality of life issues. *Cancer* 2002;**94**:1131–41
3 Pauloski BR, Rademaker AW, Logemann JA, Newman L, MacCracken E, Gaziano J *et al*. Relationship between swallow motility disorders on videofluorography and oral intake in patients treated for head and neck cancer with radiotherapy with or without chemotherapy. *Head Neck* 2006;**28**:1069–76
4 Wang JJ, Goldsmith TA, Holman AS, Cianchetti M, Chan AW. Pharyngoesophageal stricture after treatment for head and neck cancer. *Head Neck* 2012;**34**:967–73
5 Pitman M, Weissbrod P. Endoscopic CO2 laser cricopharyngeal myotomy. *Laryngoscope* 2009;**119**:45–53
6 Silver N. Endoscopic cricopharyngeal myotomy for stenosis after XRT. *Otolaryngol Head Neck Surg* 2010;**143**(suppl): 183–4
7 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**: 392–405
8 Bonett DG, Price RM. Statistical inference for a linear function of medians: confidence intervals, hypothesis testing, and sample size requirements. *Psychol Methods* 2002;**7**:370–83
9 List MA, Ritter-Sterr C, Lansky SB. A performance status scale for head and neck cancer patients. *Cancer* 1990;**66**:564–9
10 Sandidge J. The Modified Barium Swallow Impairment Profile (MBSImP): a new standard physiologic approach to swallowing assessment and targeted treatment. *Perspectives on Swallowing and Swallowing Disorders (Dysphagia)* 2009;**18**:117–22
11 Rosenthal DI, Lewin JS, Eisbruch A. Prevention and treatment of dysphagia and aspiration after chemoradiation for head and neck cancer. *J Clin Oncol* 2006;**24**:2636–43
12 Horowitz JB, Sasaki CT. Effect of cricopharyngeus myotomy on postlaryngectomy pharyngeal contraction pressures. *Laryngoscope* 1993;**103**:138–40
13 Jacobs JR, Logemann J, Pajak TF, Pauloski BR, Collins S, Casiano RR *et al.* Failure of cricopharyngeal myotomy to improve dysphagia following head and neck cancer surgery. *Arch Otolaryngol Head Neck Surg* 1999;**125**:942–6
14 Dauer E, Salassa J, Iuga L, Kasperbauer J. Endoscopic laser *vs* open approach for cricopharyngeal myotomy. *Otolaryngol Head Neck Surg* 2006;**134**:830–5
15 Brøndbo K. Treatment of cricopharyngeal dysfunction by endoscopic laser myotomy. *Acta Otolaryngol Suppl* 2000;**543**:222–4
16 Lawson G, Remacle M. Endoscopic cricopharyngeal myotomy: indications and technique. *Curr Opin Otolaryngol Head Neck Surg* 2006;**14**:437–41
17 Herberhold C, Walther EK. Endoscopic laser myotomy in cricopharyngeal achalasia. *Adv Otorhinolaryngol* 1995;**49**:144–7
18 Lim RY. Endoscopic CO2 laser cricopharyngeal myotomy. *J Clin Laser Med Surg* 1995;**13**:241–7
19 Takes RP, van den Hoogen FJ, Marres HA. Endoscopic myotomy of the cricopharyngeal muscle with CO2 laser surgery. *Head Neck* 2005;**27**:703–9
20 Bammer T, Salassa JR, Klingler PJ. Comparison of methods for determining cricopharyngeal intrabolus pressure in normal patients as possible indicator for cricopharyngeal myotomy. *Otolaryngol Head Neck Surg* 2002;**127**:299–308
21 Halvorson DJ, Kuhn FA. Transmucosal cricopharyngeal myotomy with the potassium-titanyl-phosphate laser in the treatment of cricopharyngeal dysmotility. *Ann Otol Rhinol Laryngol* 1994;**103**:173–7
22 Chang CW, Liou SS, Netterville JL. Anatomic study of laser-assisted endoscopic cricopharyngeus myotomy. *Ann Otol Rhinol Laryngol* 2005;**114**:897–901
23 Chitose S, Sato K, Hamakawa S, Umeno H, Nakashima T. A new paradigm of endoscopic cricopharyngeal myotomy with CO_2 laser. *Laryngoscope* 2011;**121**:567–70
24 Logemann JA, Pauloski BR, Rademaker AW, Lazarus CL, Gaziano J, Stachowiak L *et al*. Swallowing disorders in the first year after radiation and chemoradiation. *Head Neck* 2008; **30**:148–58

Address for correspondence:
Mr Nicholas Dawe,
ENT Department,
Sunderland Royal Hospital,
Kayll Road,
Sunderland,
SR4 7TP United Kingdom

E-mail: N.DAWE@NHS.NET

Mr N Dawe takes responsibility for the integrity of the content of the paper
Competing interests: None declared