The Journal of Laryngology & Otology (2010), ***124***, *886–891.*

doi:10.1017/S0022215110000253

Main Article

Selective lateral laser thyroarytenoid myotomy for adductor spasmodic dysphonia

A Hussain, M Shakeel

Abstract

Objective: Selective lateral laser thyroarytenoid myotomy is a conceptually sound, simple, minimally invasive, repeatable and predictable new surgical procedure for treating adductor spasmodic dysphonia. This paper aims to introduce and describe the surgical technique, and to present a clinical case series and its outcomes.

Study design: A prospective, clinical case series treated with selective lateral laser thyroarytenoid myotomy, with follow up of 2.5 years.

Method: Pre- and post-operative data were collected prospectively for patients undergoing selective lateral laser thyroarytenoid myotomy. These data included patient demographics, previous interventions for adductor spasmodic dysphonia, technical aspects of surgery and clinical outcome. Outcome data included clinical assessment, voice handicap index, need for further intervention, and patient satisfaction assessed by subjective improvement (detailed subjectively by the patients themselves and objectively using the Glasgow benefit inventory).

Results: Four patients (two men and two women; mean age 65 years; age range 41–80 years) were included. The mean duration of adductor spasmodic dysphonia was 11 years. All patients had previously been treated with botulinum toxin A. All patients reported improvement in voice quality, fluency, sustainability and elimination of voice breaks over 2.5 years' follow up. Clinical assessment revealed no alteration in mucosal wave, and complete relief of hyperadduction was observed on phonation. No patients required supplementary botulinum toxin treatment during follow up.

Conclusion: Selective lateral laser thyroarytenoid myotomy seems to represent a curative procedure for adductor spasmodic dysphonia, a chronic, debilitating condition. This procedure is conceptually simple, minimally invasive and repeatable. It also seems to offer a safe and lasting alternative to botulinum toxin therapy.

Key words: Vocal Cords; Spasmodic Dysphonia; Laser Surgery; Thyroarytenoid

Introduction

Adductor spasmodic dysphonia is a central neurological disorder of the basal ganglia, of undetermined aetiology. It is a focal laryngeal dystonia which is task-specific and leads to spasm of laryngeal adductors on phonation, with resultant strangled, strained, short-lived speech with frequent voice breaks. Repeated, effortful phonation leads to fatigue and a resultant breathy voice quality. There is no curative treatment. The available medical and surgical treatments target the end organs.

The vast majority of focal laryngeal dystonia cases are of the adductor spasmodic variety. The standard treatment is chemo-denervation of the thyroarytenoid muscle with botulinum toxin A, with or without supplementary voice therapy, as supported by the American Academy of Otolaryngology, Head and Neck Surgery. The advantages of botulinum toxin treatment include reversibility, repeatability and adjustability of dosage. However, there are significant limitations, including short duration of efficacy, life-long need for repeated injections, breathy voice quality, unpredictable dose–response relationship, cost, inconvenience, discomfort and the possibility of resistance over a long period of time. A meta-analysis of botulinum toxin treatment suggested a moderate resulting improvement, amounting to one standard deviation, across the dependent variables studied.[1] Specifically,

From the Department of Otolaryngology Head and Neck surgery, University of Aberdeen Hospitals, Aberdeen Royal Infirmary, Scotland, UK.
Presented at the Winter Meeting of the Scottish Otolaryngological Society, 21 November 2008, Aberdeen, Scotland, UK.
Presented at the 6th European Congress of Oto-Rhino-Laryngology Head and Neck Surgery, 30 June to 4 July 2007, Vienna, Austria.
Accepted for publication: 17 November 2009. First published online 29 April 2010.

both the quantitative and qualitative analyses suggested that the treatment effect measured from acoustic and perceptual indexes was smaller than that measured from physiological indexes from patient self-rating. The meta-analysis also suggested that the amount of post-treatment speech and voice improvement perceived by listeners was not as large as the effort reduction perceived by the patient. Following botulinum toxin treatment, breathy dysphonia was variable and of considerable duration. Also, botulinum toxin treatments were not uniform and could be sex- and age-dependent (i.e. males might experience vocal breathiness for longer, and older patients might not respond as well). In addition, botulinum toxin did not seem to affect the abnormal behaviour of the false vocal folds.

An appreciation of the well recognised and established limitations of botulinum toxin therapy of adductor spasmodic dysphonia has led to the development of various surgical procedures aiming to effect permanent cure. During the last 25 years, reported surgical techniques have included: recurrent laryngeal nerve resection, crush or avulsion; selective denervation-reinnervation of the adductor branch of the recurrent laryngeal nerve; superior laryngeal nerve section; thyroarytenoid thinning and myectomy; anterior commissure release; midline lateral thyroplasty; and autologous replacement of vocal folds with fascia.[2,3] Most of these surgical procedures are aggressive, ablative and non-physiological, and some are irreversible. Even so, initial results have been encouraging; however, long term outcomes have not been worthwhile.

Any surgical treatment of adductor spasmodic dysphonia aims to be curative and safe, with minimal complications. We have attempted to achieve these goals with selective lateral laser thyroarytenoid myotomy.

Methods and materials

Design

We collected a prospective, clinical case series treated with selective lateral laser thyroarytenoid myotomy, with a follow up of 2.5 years. Patients included in the study had all previously been treated with botulinum toxin for up to 11 years with upper limit of 17 years, within the department of otolaryngology voice clinic, University of Aberdeen, Scotland.

Method

Pre- and post-operative data were collected prospectively for patients undergoing selective lateral laser thyroarytenoid myotomy. Data included patient demographics, previous interventions for adductor spasmodic dysphonia, technical aspects of surgical procedure and clinical outcome.

Outcome data also included clinical assessment (i.e. video strobolaryngoscopy), voice handicap index, need for further intervention, and patient satisfaction (primarily assessed by subjective reporting of improvement by patients themselves). Objective patient satisfaction was assessed using the Glasgow benefit inventory.

In 1996, Robinson and colleagues devised the Glasgow benefit inventory.[4] This is a validated, 18-item, post-intervention questionnaire developed especially for otolaryngological interventions, and is a measure of patient benefit resulting from healthcare intervention. Glasgow benefit inventory scores range from -100 to $+100$, with any positive score indicating an improvement in general health status.

The Statistical Package for the Social Sciences version 15 software was used for data collection and analysis.

Surgical technique

Written informed consent was obtained, and pre-operative assessment and preparation were carried out in the standard manner for microlaryngoscopy.

All procedures were carried out under general anaesthetic, by the primary author (AH). Standard neck flexion with head extension was used for positioning. A Hunsaker Mon-Jet tube (Xomed Surgical Products, Jacksonville, Florida, USA), an endolaryngeal tube, was employed for administration of general anaesthesia. A large, saline-soaked neuropatty was placed immediately below the target vocal fold on one side only. A microscopic magnification of $\times 16$ was used. The choice of incision side was determined by ease of exposure. With the CO_2 laser set at 10 W, a spot size of 1 mm with a depth of 2 mm in a pulsed mode was selected. One to three transverse cuts were made in the lateral thyroarytenoid muscle to achieve a segmental myotomy, with preservation of the intervening lateral thyroarytenoid muscle. The precise placement of laser incisions under magnification enabled preservation of the vibratory segment of the lamina propria, the vocalis and the intervening lateral thyroarytenoid muscle. Also, the attachment of the vocalis and the remaining lateral thyroarytenoid muscles to the arytenoid cartilage and the thyroid lamina could be preserved (Figures 1 and 2). The

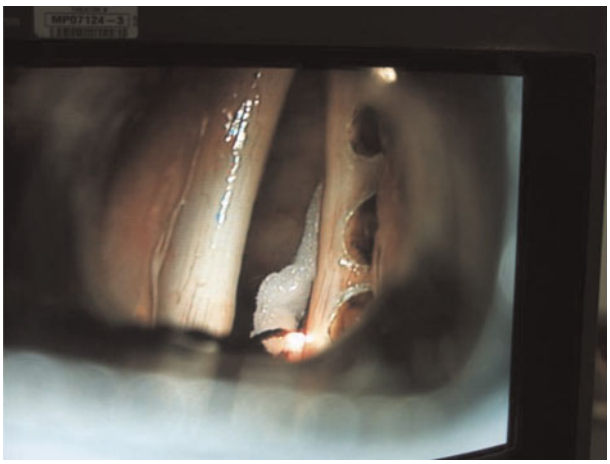

FIG. 1
Intra-operative view of selective lateral laser thyroarytenoid myotomy – right vocal fold.

https://doi.org/10.1017/S0022215110000253 Published online by Cambridge University Press

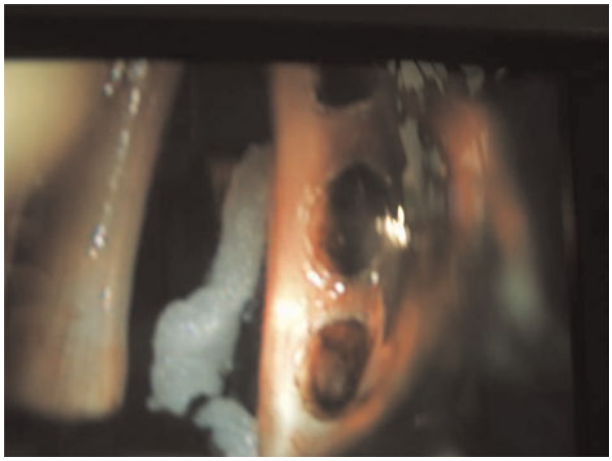

FIG. 2
Intra-operative view of selective lateral laser thyroarytenoid myotomy – right vocal fold (greater magnification).

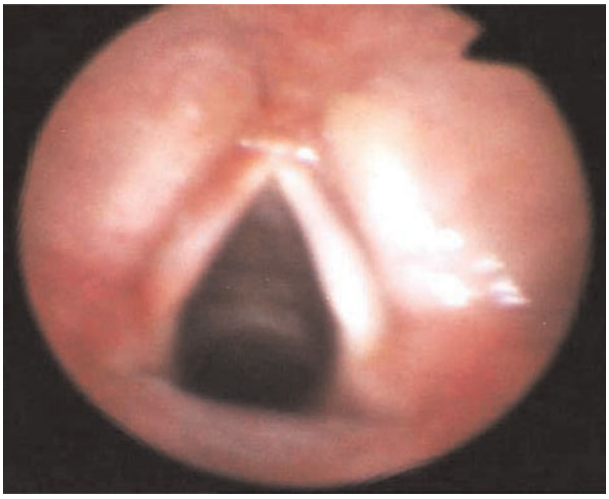

FIG. 3
Endoscopic appearance of left, operated vocal fold at six weeks post-operatively.

delivery direction of laser cuts was from superior to inferior, and the depth of myotomy was dependent upon spot depth and wattage.

Patients stayed in hospital overnight and were advised to undertake absolute voice rest for two days and relative voice rest for two weeks. Patients were reviewed at one, six, 12 and 24 weeks. Further follow up was conducted at six-monthly intervals.

Results

Four patients (two men and two women) with a mean age of 65 years (range 41–80 years) were included. The mean duration of adductor spasmodic dysphonia was 11 years. All patients had previously been treated with botulinum toxin A (Botox; Allergan, Irvine, CA, USA); the number of treatments ranged from six to 27 injection episodes (mean = 17). No complications were observed during follow up (Table I). All patients reported improvement in voice quality, fluency and sustainability, and elimination of voice breaks, over the 2.5 year follow-up period. Patients also reported a reduction in the effort required to vocalise. Clinical assessment revealed no alteration in the mucosal wave or the volume of the vocal folds. No obvious scarring was noted (Figures 3, 4 and 5). Complete relief of hyperadduction was observed, with normal approximation of vocal folds on phonation, and without any residual glottic gap on video strobolaryngoscopy (Appendix 1). None of our patients required supplementary botulinum toxin A treatment during the follow-up period.

Discussion

Adductor spasmodic dysphonia remains a challenging problem despite many available medical and surgical treatments. All such treatments have proved to be less than ideal, with good short term results but disappointing long term outcomes.

Botulinum toxin chemo-denervation remains a widely practised, standard medical treatment. Recognition of the well established limitations of botulinum toxin chemo-denervation has led to the introduction of a variety of surgical procedures, in an attempt to provide a lasting solution. Most of these procedures require a neck incision and are aggressive and destructive in nature, with a significant cost and variable long term results. More recently, radiofrequency treatment has also been employed.[5,6]

TABLE I
CHARACTERISTICS OF PATIENTS UNDERGOING SELECTIVE LATERAL LASER THYROARYTENOID MYOTOMY

Parameter	Patient 1	Patient 2	Patient 3	Patient 4
Age (y), sex	80, F	73, M	68, F	41, F
ASD duration (y)	7	6	17	3
Bot tox (*n*)	18	14	27	6
SLLTM side, cuts (*n*)	L, 2	R, 3	L, 2	L, 2
Wound healing	Excellent	Excellent	Excellent	Excellent
Further therapy	None	None	None	None
Pre-op VHI	53/120	67/120	103/120	78/120
Post-op VHI	22/120	29/120	39/120	7/120
GBI	5.6	2.8	11	75

Y = years; F = female; M = male; ASD = adductor spasmodic dysphonia; Box tox = botulinum toxin injection sessions; SLLTM = selective lateral laser thyroarytenoid myotomy; pre-op = pre-operative; post-op = post-operative; VHI = voice handicap index; GBI = Glasgow benefit inventory

https://doi.org/10.1017/S0022215110000253 Published online by Cambridge University Press

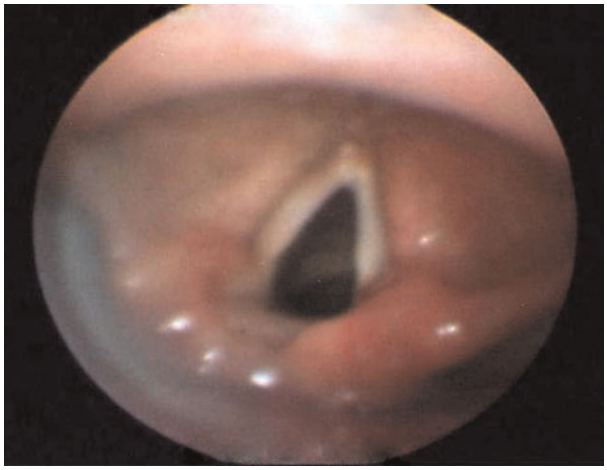

FIG. 4
Endoscopic appearance of left, operated vocal fold at nine months post-operatively.

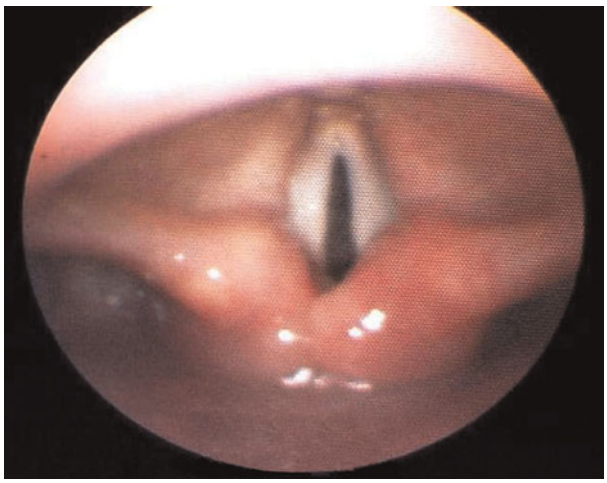

FIG. 5
Endoscopic appearance of left, operated vocal fold at 18 months post-operatively.

We have attempted, successfully in our view, to overcome the limitations of the previously recognised medical and surgical treatments for adductor spasmodic dysphonia, in a minimally invasive fashion, with a satisfactory outcome and without any harm to patients.

Dedo introduced recurrent laryngeal nerve section as a curative surgical procedure in 1976.[7] However, this procedure has not stood the test of time, with reports of recurrence of adductor spasmodic dysphonia over time. Due to its overly aggressive and destructive nature, this procedure has fallen from grace and is no longer practised to any significant extent.

Berke and colleagues introduced selective laryngeal adductor denervation-reinnervation as an alternative surgical procedure, and concluded that this technique provided an alternative to botulinum toxin, with sustained beneficial effects.[8] Chhetri *et al.* reviewed this technique's long term results, and concluded that it provided long-lasting relief in a majority of patients.[9] They also acknowledged the occurrence of post-operative breathiness, and reported that vocal spasm returned in 26 per cent of their patients. Five out of 12 patients with recurrence continued to require botulinum toxin chemo-denervation. Chhetri and colleagues acknowledged a failure rate of 11 per cent. In our view, selective laryngeal adductor denervation-reinnervation has similar limitations to recurrent laryngeal nerve section, as the reinnervation is often variable and does not lead to normal movement of the vocal fold.

Isshiki *et al.* introduced midline thyroplasty for adductor spasmodic dysphonia.[10] The overall effectiveness of type II thyroplasty was assessed by Sanuki and Isshiki, who concluded that type II thyroplasty with titanium was effective and that 70 per cent of patients were happy with the outcome.[11] However, in the remaining patients voice strangulation, interruption and tremor persisted.

Netterville *et al.* introduced recurrent laryngeal nerve avulsion in 1991, and found a high recurrence rate of adductor spasmodic dysphonia by the third post-operative year.[12] Long term follow-up results for this procedure were also reported by Weed *et al.* in 1996.[13] Seventy-eight per cent of their patients reported no recurrence of spasm at three years; however, the remaining patients did suffer recurrence and required additional treatment.[13]

Remacle *et al.* reported radiofrequency-induced thermotherapy for adductor spasmodic dysphonia.[5] A similar study was published by Kim *et al.* in 2008, which reported persistence of a glottic gap on phonation and attributed this to atrophy or fibrosis of the thyroarytenoid muscle.[6] These authors also reported deterioration in voice quality after six months.

Selective lateral laser thyroarytenoid myotomy is conceptually very sound, yet simple. It is based on the principle of selective adductor muscle weakening in order to counter the hyperadduction seen in adductor spasmodic dysphonia. The procedure is highly selective, as it involves myotomy of the lateral thyroarytenoid muscle with preservation of the vibratory segment and of all its attachment to the surrounding cartilaginous framework. No direct or permanent neural ablation is involved. Reduced hyperadduction of the thyroarytenoid muscle is achieved by a segmental, horizontal myotomy of the lateral portion of the thyroarytenoid muscle, progressing from superior to inferior, without any post-operative glottic gap.

Selective lateral laser thyroarytenoid myotomy avoids all the problems associated with other reported surgical procedures. It avoids the need for a skin incision, as it is carried out endoscopically, and theoretically could be repeated over a longer period in cases of recurrence (although we did not encounter the need for this during follow up). No additional training is required to carry out the procedure safely, as microlaryngoscopy and CO_2 laser use are commonly practised by most laryngologists.

The procedure is reproducible and appears to be entirely safe; no adverse effects were observed in

https://doi.org/10.1017/S0022215110000253 Published online by Cambridge University Press

our patients. There was no apparent loss of thyroarytenoid muscle volume. The procedure resulted in relief of hyperadduction, observed clinically, without any glottic gap or scarring. The mucosal wave appears to be preserved. The procedure can be carried out on the opposite side if required, in case of less than complete response or recurrence. However, we have not been required to do this, as we observed no recurrence over the 2.5 year follow-up period. We are unable to explain the response on the opposite side.

We acknowledge the limitations of this study: a limited number of patients, relatively short follow-up period, and lack of sophisticated objective means of outcome assessment. We primarily relied on patients' self-assessment and satisfaction with their voice, and on clinicians' and speech therapists' assessment of voice and of laryngeal appearance and mobility. All our patients reported relief from voice breaks and strangulated voice, enhanced ease of voice production, and increased fluency. Our patients also reported significant gains in their self-confidence because of the overall improvement in their post-surgical voice.

- **Adductor spasmodic dysphonia is a central, neurological disorder of the basal ganglia, of undetermined aetiology, and is a chronic, debilitating condition**
- **Selective lateral laser thyroarytenoid myotomy is based on the principle of selective adductor muscle weakening, in order to counter hyperadduction**
- **This procedure seems to represent a curative treatment for adductor spasmodic dysphonia**

Conclusion

Selective lateral laser thyroarytenoid myotomy would appear to offer a curative treatment for adductor spasmodic dysphonia. It is conceptually simple, minimally invasive, repeatable and reproducible. No special training is required, and the procedure utilises the CO_2 laser, a readily available, common tool in laryngological surgery. The procedure also avoids the problems associated with previously reported, more aggressive, ablative surgical procedures. In our experience, selective lateral laser thyroarytenoid myotomy is very effective and free of complications, with long-lasting results. It also seems to offer a safe and lasting alternative to botulinum toxin chemodenervation. We observed no adverse effects in any of our patients, and consider it very unlikely that any harm would occur with such a minimally invasive procedure.

Therefore, we believe that selective lateral laser thyroarytenoid myotomy warrants further investigation in a larger number of patients, involving more objective voice assessment and longer follow up.

Acknowledgement

We thank our speech and language therapists Margaret Singer and Claire Tarr for their help in data collection.

References

1 Boutsen F, Cannito MP, Taylor M, Bender B. Botox treatment in adductor spasmodic dysphonia: a meta-analysis. *J Speech Lang Hear Res* 2002;**45**:469–81
2 Sulica L, Blitzer A, Brin MF, Stewart CF. Botulinum toxin management of adductor spasmodic dysphonia after failed recurrent laryngeal nerve section. *Ann Otol Rhinol Laryngol* 2003;**112**:499–505
3 Tsunoda K, Amagai N, Kondou K, Baer T, Kaga K, Niimi S. Autologous replacement of the vocal fold: a new surgical approach for adduction-type spasmodic dysphonia. *J Laryngol Otol* 2005;**119**:222–5
4 Robinson K, Gatehouse S, Browning GG. Measuring patient benefit from otorhinolaryngological surgery and therapy. *Ann Otol Rhinol Laryngol* 1996;**105**:415–22
5 Remacle M, Plouin-Gaudon I, Lawson G, Abitbol J. Bipolar radiofrequency-induced thermotherapy (RFITT) for the treatment of spasmodic dysphonia. A report of three cases. *Eur Arch Otorhinolaryngol* 2005;**262**:871–4
6 Kim HS, Choi HS, Lim JY, Choi YL, Lim SE. Radiofrequency thyroarytenoid myothermy for treatment of adductor spasmodic dysphonia: how we do it. *Clin Otolaryngol* 2008;**33**:621–5
7 Dedo HH. Recurrent laryngeal nerve section for spastic dysphonia. *Ann Otol Rhinol Laryngol* 1976;**85**:451–9
8 Berke GS, Blackwell KE, Gerratt BR, Verneil A, Jackson KS, Sercarz JA. Selective laryngeal adductor denervation-reinnervation: a new surgical treatment for adductor spasmodic dysphonia. *Ann Otol Rhinol Laryngol* 1999;**108**:227–31
9 Chhetri DK, Mendelsohn AH, Blumin JH, Berke GS. Long-term follow-up results of selective laryngeal adductor denervation-reinnervation surgery for adductor spasmodic dysphonia. *Laryngoscope* 2006;**116**:635–42
10 Isshiki N, Tsuji DH, Yamamoto Y, Iizuka Y. Midline lateralization thyroplasty for adductor spasmodic dysphonia. *Ann Otol Rhinol Laryngol* 2000;**109**:187–93
11 Sanuki T, Isshiki N. Overall evaluation of effectiveness of type II thyroplasty for adductor spasmodic dysphonia. *Laryngoscope* 2007;**117**:2255–9
12 Netterville JL, Stone RE, Rainey C, Zealear DL, Ossoff RH. Recurrent laryngeal nerve avulsion for treatment of spastic dysphonia. *Ann Otol Rhinol Laryngol* 1991;**100**:10–14
13 Weed DT, Jewett BS, Rainey C, Zealear DL, Stone RE, Ossoff RH *et al*. Long-term follow-up of recurrent laryngeal nerve avulsion for the treatment of spastic dysphonia. *Ann Otol Rhinol Laryngol* 1996;**105**:592–601

Appendix 1. Supplementary video material

The following video clips are available online on *The Journal of Laryngology & Otology* website, at the web addresses indicated.

Video clip one shows selective lateral laser thyroarytenoid myotomy of the left vocal fold at six weeks post-operatively: http://journals.cambridge.org/jlo2010001

Video clip two shows selective lateral laser thyroarytenoid myotomy of the left vocal fold at nine months post-operatively: http://journals.cambridge.org/jlo2010002

Video clip three shows selective lateral laser thyroarytenoid myotomy of the left vocal fold at 18

months post-operatively: http://journals.cambridge.org/jlo2010003

Video clip four shows patient 2.5 years after selective lateral laser thyroarytenoid myotomy of the left vocal fold: http://journals.cambridge.org/jlo2010004

Address for correspondence:
Mr Akhtar Hussain,
Consultant Otolaryngologist Head and Neck Surgeon,
Department of Otolaryngology
Head and Neck Surgery (Ward 45),
University of Aberdeen Hospitals,
Aberdeen Royal Infirmary,
Foresterhill Road,
Aberdeen AB25 2ZN, Scotland, UK.

Fax:+44 1224 554569
E-mail: drakhtarhussain93@yahoo.co.uk

Mr A Hussain takes responsibility for the integrity of the content of the paper.
Competing interests: None declared

https://doi.org/10.1017/S0022215110000253 Published online by Cambridge University Press