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LARYNGOLOGY

European consensus on endoscopic surgery for bilateral vocal fold immobility: classification and nomenclature

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Abstract

Introduction There are inconsistencies in how different endoscopic procedures to manage Bilateral Vocal Fold Immobility (BVFI) have been described in the literature. This limits our ability to compare functional outcomes. There is no unifying international terminology available that precisely describes the anatomical boundaries and extent of the different types of treatment. A pan-European consensus regarding terminology of different endoscopic surgical procedures to manage BVFI in adults was developed.

Methods Thirty-one expert laryngologists and phoniatricians of the European Laryngological Society (ELS) or Union of the European Phoniatricians (UEP), participated in a modified Delphi process. They voted on an initial series of 13 proposed statements, including graphical visualization of different endoscopic surgical techniques for BVFI. Statements reaching > 70% of agreement in the first voting round were accepted. In the second voting round, eight revised and newly proposed statements were accepted with an increased threshold of > 80%.

Results Fourteen statements were anonymously validated through two voting rounds. The following categories of endoscopic arytenoid and vocal fold surgery were defined: total arytenoidectomy, partial arytenoidectomy (subclassified into subtotal, anteromedial, posteromedial and superomedial), posterior cordectomy (subclassified into ligamental, transmuscular and ventriculocordectomy) and transverse cordotomy (subclassified into posterior cordotomy and ventriculocordotomy). The suffixes 'with mucosal preservation', 'with laterofixation' and 'combined procedure' were defined too.

Conclusion This ELS-UEP consensus on endoscopic arytenoid and vocal fold surgery for BVFI provides a practical nomenclature and classification to improve reporting in literature and clinical practice and to allow comparison of functional outcomes.

Keywords Otolaryngology · Otorhinolaryngology · Posterior glottic stenosis · Bilateral · Immobility · Vocal fold palsy · Arytenoidectomy · Cordotomy · Cordectomy

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Introduction

Bilateral vocal fold immobility (BVFI) refers to the restricted movement of both vocal folds secondary to mechanical fixation or neurological involvement, and is considered a challenging condition to manage.

For a very long time, tracheostomy has been the only treatment routinely applied for non-reversible symptomatic bilateral vocal fold immobility. Arytenoidectomy for vocal cord paralysis was first performed in 1836 by veterinary surgeons in horses for the relief of laryngeal stridor (roaring) due to paralysis of the vocal cord [1]. In 1908, Citelli introduced the so called cordectomy externa through a thyrofissure [2]. Ivanoff first performed a total ayrtenoidectomy on a tracheotomised patient in 1911, and Baker presented the first successful thyrotomy with cordectomy and arytenoidectomy in 1916 [3, 4]. However, Chevalier Jackson was the first to introduce the ventriculocordectomy, where he removed the entire vocal cord and ventricle endoscopically, to create an excellent airway but breathy voice in 1922 [5]. Several extralaryngeal approaches has been described since by King and Kelly including the first external arytenoidopexy in 1939 and first open lateralisation procedure in 1940 [6, 7]. In 1946 Woodman presented the extralaryngeal arytenoidectomy, excising most of the arytenoid but preserving the vocal process by suturing it to the inferior cornu of the thyroid cartilage, which became a popular technique at that time [8]. After the first endoscopic technique being described in 1922, it was not until 1948 that an endolaryngeal total arytenoidectomy was proposed by Thornell [5, 9]. In 1976 Strong et al. were the first to mention the use of CO_2 laser for endoscopic arytenoidectomy, but their actual technique was not described [10]. In 1979, Kirchner described a technique for endoscopic lateralisation of the vocal cord [11]. Kleinsasser and Nolten improved the endoscopic total arytenoidectomy by Thornell with a partial cordectomy in 1981 [12]. Ossoff described the first large series of CO2 laser endoscopic arytenoidectomies in 1983, resecting the main part of the arytenoid down to cricoid cartilage, while remaining vocal and muscular processes [13]. Also in 1983, Lichtenberger further refined the technique using a special endo-extralaryngeal needle carrier, and Ejnell presented the breathing and voice outcomes of this technique in 1984 [14, 15]. In 1989, Dennis and Kashima introduced their technique of endoscopic laser posterior cordectomy, which has become very popular since [16]. Crumley introduced the medial bilateral partial arytenoidectomy in 1993 and the endoscopic subtotal arytenoidectomy with CO_2 laser has been proposed by Remacle et al. in 1996 [17, 18].

Various techniques of endoscopic surgical treatment for BVFI have been proposed and modified by various surgeons, ranging from (sub)total to partial arytenoidectomies, transverse cordotomies and laterofixation [19, 20]. However, the definition of these surgical procedures lacks consensus. This specifically holds true for the 'partial arytenoidectomy' procedure, which has been referred to in literature varying from removing just the vocal process to an almost total resection of the arytenoid body [21–23]. The frequent use of author names to refer to certain surgical procedures contributes to the confusion regarding the extent of resection of the arytenoid and vocal folds. As an example, the endoscopic posterior partial cordectomy, often referred to as 'Kashima' in clinical practice, was originally described as the resection of a 4 mm C-shaped wedge of posterior vocal cord just anterior to the vocal process [16]. Many articles have referred to this technique since, but some cite it as being a cordotomy, with just a transverse incision in the posterior vocal cord, and others as a cordectomy with resection of a significant larger part of the vocal cord [24–27].

Recently, three different systematic reviews have tried to compare the effectiveness and functional outcomes of the different surgical techniques to manage bilateral vocal cord paralysis [21–23]. This is of importance as many publications have highlighted the risks of adverse effects on swallowing, voice and need for recurrent procedures following different types and extent of endoscopic procedures [19–23, 28]. All three reviews concluded it is very difficult to compare functional outcomes, due to heterogeneity of publications and a lack of a clear homogenous definition of the extent of surgery.

To date, there is no unifying international terminology available that precisely describes the anatomical boundaries and extent of the different types of treatment. The aim of the present paper was to develop international expert consensus, supported by the European Laryngological Society (ELS) and Union of the European Phoniatricians (UEP), regarding the terminology of different endoscopic surgical procedures for the treatment of acquired BVFI affecting breathing in adults. More specifically, anatomical boundaries and the exact extent of the different endoscopic surgical procedures will be defined.

Methods

A modified Delphi Consensus study based on evidence from systematic reviews and expert opinions was designed. International experts were invited to vote anonymously on a series of proposed statements, including graphical visualisation of different endoscopic surgical techniques, through SurveyMonkey® (San Mateo, California, USA), allowing each participant to complete the survey only once.

Consensus committee, voting panel, and design of statements

A Consensus Committee (CC) was composed of five European experts (EACD, CAY, JRL, CS, AG), all board-certified laryngologists, and active members of ELS and/or UEP. The CC developed an initial list of 13 statements, which covered different endoscopic surgical management options to either arytenoid cartilages or vocal folds to manage BVFI in adults. Statements were designed using accurate anatomical descriptions of surgical techniques, rather than names of surgeons that invented or first published on the technique, to come to a clear and homogenous definition. The statements were based on selected relevant papers in the literature [16–24, 26, 29–39]. A PubMed, Cochrane Library, and Scopus database literature search from 1980 to 2024 was conducted by two authors (EACD and JRL) for relevant peer-reviewed publications in English-language using relevant keywords (MeSH: Bilateral Vocal Fold/Cord Immobility, Paralysis, Paresis, Posterior Glottic stenosis) to identify publications dedicated to the surgical management of acquired BVFI in adults. The literature search was conducted according to the PRISMA Statements [40]. Relevant publications, focusing on systematic reviews and meta-analyses, were identified for the development of initial statements. References of the included papers were further screened for additional relevant studies. Two authors (EACD and AG) reviewed each of the abstracts and selected articles for the development of statements. The full texts of selected papers were available to the expert panel during all rounds of the Delphi process.

Anatomical illustrations including sagittal and superior views were used to graphically visualize the incisions and resections being used in each procedure. In practice, the result of a procedure might look different than the illustrations, due to the natural retraction of tissue when an incision is being made in tissue that is under tension.

Of the 40 experts (24 countries) invited to participate, 31 experts participated in the study (18 countries). There were 8 females and 23 males, all international experts of high calibre, known for their expertise or with multiple published articles on this topic. Nine experts did not participate due to lack of time. There was a representative geographical distribution with participants from: Belgium, Czech Republic, France, Germany, Greece, Hungary, Italy, Luxemburg, Netherlands, Norway, Poland, Romania, Spain, Sweden, Switzerland, Türkiye, United Kingdom, and the United States of America. All experts are members of one or more of the following scientific societies: European Laryngological Society (ELS), Union of the European Phoniatricians (UEP), British Laryngological Association (BLA), American Laryngological Association (ALA), American Broncho-Esophagological Association (ABEA).

Delphi methodology

The methodology of the Delphi process was documented before starting the study. The CC agreed to organize the Delphi process through a maximum of three voting rounds. Experts needed to either agree or disagree with the statements and provide comments. During the first voting round, there was an opportunity to propose new statements too. The independent CC members were not allowed to vote. Statements reaching 70% of agreement were accepted and statements reaching 70% of disagreement were rejected. Statements that returned with 30–70% agreement were revised by the CC, based on feedback and comments provided by the voting panel. The results of the voting rounds were analyzed by the first author of the study (EACD) and presented to the CC for discussion and revision of statements for quality improvement. Accepted statements (above 70% agreement threshold) with comments were reviewed by the CC, and revised if the quality of the statements and the final consensus were deemed to improve by revision of the statements. All revised statements were then subjected to an additional voting in round 2. An increased acceptance threshold of 80% was deemed necessary for revised statements in round 2. In the second voting round, there was no room for suggestions for additional items by the expert panel. However, it was still possible to comment or provide feedback on the current statements. After the second voting round, the same procedure as in the first round was done regarding consensus acceptance. A third round of online meeting between the CC and the experts panel was held to further improve the accepted statements with meaningful comments and the statements that remained in the 30–80% agreement level.

Results

Voting rounds and discussion

The Delphi process lasted five months and included two voting rounds, separated by a period for revision and discussion. After the first voting round, the initial 13 statements received > 70% consensus agreement. Following comments by the expert voting panel in the first round, eight statements were revised for quality improvement. Semantic corrections of two statements were done, correction of the anatomical description of the resection was done in four statements, one statement was merged with another statement, and one new statement was proposed. In the second round, the eight revised and newly proposed statements were accepted by > 90% of the expert voting panel. A third online round was organized with CC members and experts to further improve the quality and practical application of the final product of the Delphi process. Supplementary material 1

Table 1 Categories of endoscopic arytenoid and vocal fold surgery for treatment of bilateral vocal fold immobility

Main procedure	Sub classification
Total arytenoidectomy	
Partial arytenoidectomy	Subtotal arytenoidectomy Anteromedial arytenoidectomy Posteromedial arytenoidectomy Superomedial arytenoidectomy
Posterior cordectomy	Ligamental posterior cordectomy Transmuscular posterior cordectomy Posterior ventriculocordectomy
Transverse cordotomy	Posterior cordotomy Posterior ventriculocordotomy
Suffix	'&' (combined procedure) With mucosal preservation With laterofixation

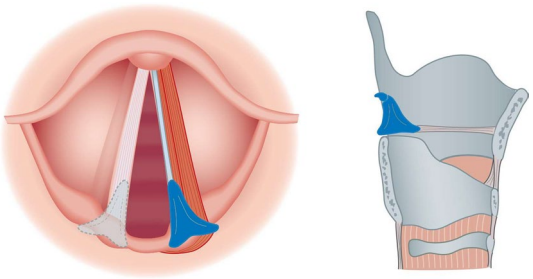

Fig. 1 Total arytenoidectomy. Resection of the whole arytenoid cartilage, including vocal and muscular process and dislocation of cricoarytenoid joint

provides in-depth insight in the full Delphi process and revision of statements. Table 1 shows the categories of endoscopic arytenoid and vocal fold surgery that were defined during the Delphi process.

Arytenoid surgery

Two categories of arytenoid surgery have been defined: total arytenoidectomy (93% acceptance) and partial arytenoidectomy. Within the partial arytenoidectomy, four different subgroups are being recognized: subtotal (93% acceptance), anteromedial (90% acceptance), posteromedial (74% acceptance) and superomedial arytenoidectomy (90% acceptance). Figure 1 shows the graphical visualisation and description of total arytenoidectomy. Figure 2a–d show the graphical visualisation and description of procedures in the partial arytenoidectomy category.

Vocal fold surgery

Two categories of vocal fold surgery have been defined: posterior cordectomy and transverse cordotomy. Within the posterior cordectomy group, three subgroups are being distinguished regarding the lateral extent of the resection: ligamental (83% acceptance) or transmuscular (97% acceptance) cordectomy, and posterior ventriculocordectomy (94% acceptance). In the transverse cordotomy category, the lateral extent has been defined as either posterior cordotomy (93% acceptance) or posterior ventriculocordotomy (93% acceptance). Figure 3a–c show the graphical visualisation and description of procedures in the posterior cordectomy category. Figure 4a, b show the graphical visualisation and description of procedures in the transverse cordotomy category.

Suffixes

Three different suffixes can be added to all arytenoid and vocal fold procedures: '&' for a combined procedure (97% acceptance), 'with mucosal preservation' (100% acceptance) or 'with laterofixation' (100% acceptance). Figure 5 shows the description of the different suffixes that can be used with the abovementioned endoscopic techniques.

Discussion

The results of this modified Delphi Consensus study among 31 international BVFI experts, based on evidence from systematic reviews and expert opinions, has led to the development of the first ELS-UEP consensus classification and nomenclature of endoscopic arytenoid and vocal fold surgery for acquired BVFI in adults.

Though many retrospective, studies have described the outcomes of endoscopic arytenoid or vocal fold surgery, it has proven quite difficult to compare those outcomes [21–23]. Part of the problem originates in the correct use of the suffix 'otomy' *versus* 'ectomy', which is quite often interchangeably used in clinical practice and literature regarding endoscopic laryngeal procedures to enlarge the glottis. Anatomically the suffix 'otomy' refers to the incision in an anatomical structure, where 'ectomy' refers to the actual removal of the anatomical structure [41]. Essentially, the suffixes are often used as a metonymy, but to fully understand the extent of surgery it is important to use the correct suffix, or have a graphical visualization available to describe the procedure done [42]. The classification as described in this paper helps overcome this problem, especially regarding the cordectomy and cordotomy procedures for BVFI. Another problem lies in the frequent use of author names to refer to certain surgical procedures. With Crumley's endoscopic medial arytenoidectomy the medial body of the arytenoid is removed but the vocal process is preserved [18]. However, many papers incorrectly refer to this technique as including the resection of the vocal process [21]. With our

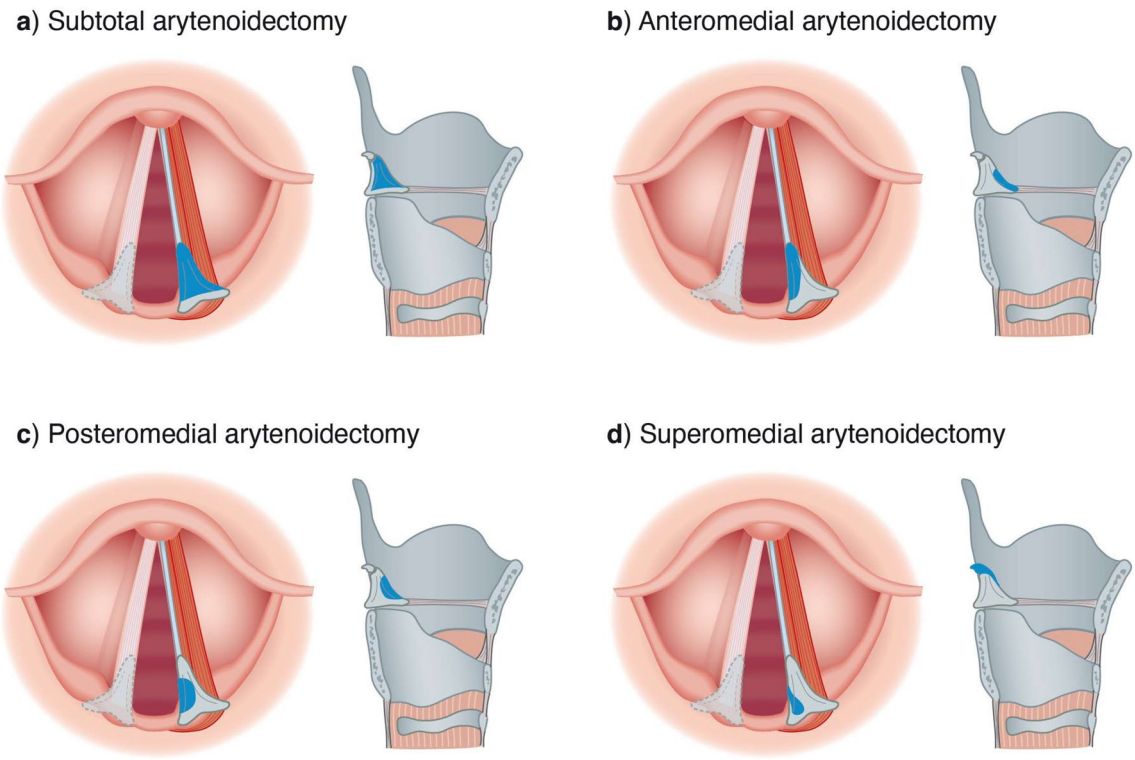

Fig. 2 Partial arytenoidectomy. **a**) Subtotal arytenoidectomy: resection of major parts of the arytenoid, including vocal process and central arytenoid,preserving the posterior border of arytenoid, cricoarytenoid joint and most of the muscular process.**b**) Anteromedial arytenoidectomy: resection of the medial part of the main body of the arytenoid, including the vocal process. The muscular process, the corniculate and cuneiform cartilages and crico-arytenoid joint are preserved.**c**) Posteromedial arytenoidectomy: resection of the medial part of the arytenoid posterior to the vocal process,resulting in concavity along the glottic edge of the arytenoid body. The vocal process, the muscular process, the corniculate and cuneiform cartilages and crico-arytenoid joint are preserved.**d**) Superomedial arytenoidectomy: resection of the superomedial part of the arytenoid posterior to the vocal process, including corniculate and cuneiform cartilages. The vocal process, the muscular process and crico-arytenoid joint are preserved

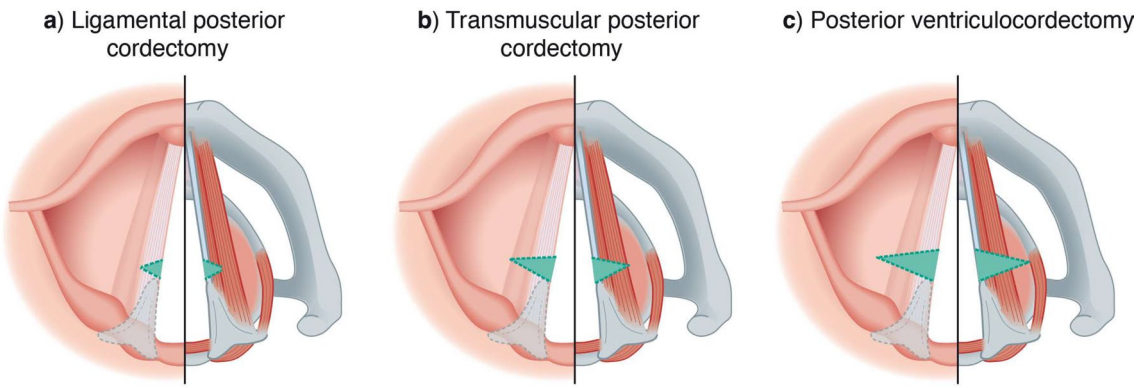

Fig. 3 Posterior cordectomy. **a**) Ligamental posterior cordectomy: wedge resection of a posterior segment of the free border of the true vocal fold,excluding the vocal process. The thyroarytenoid muscle is preserved.**b**) Transmuscular posterior cordectomy: wedge resection of a posterior segment of the true vocal fold, including a segment of the thyroarytenoid muscle and through elastic cone, but excluding the vocal process.**c**) Posterior ventriculocordectomy: wedge resection of a posterior segment of the true and false cord, including a portion of the thyroarytenoid muscle and through elastic cone, excluding resection of any cartilaginous structures.

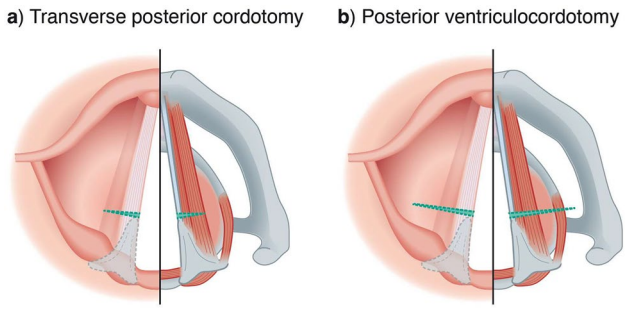

Fig. 4 Transverse cordotomy.**a**) Posterior cordotomy: transverse incision of the posterior vocal fold anterior to the vocal process and through the elastic cone, without resecting any tissue.**b**) Transmuscular ventriculocordectomy: transverse incision of the posterior vocal fold anterior to the vocal process and through the elastic cone, and extending into the false cord laterally, without resecting any tissue.

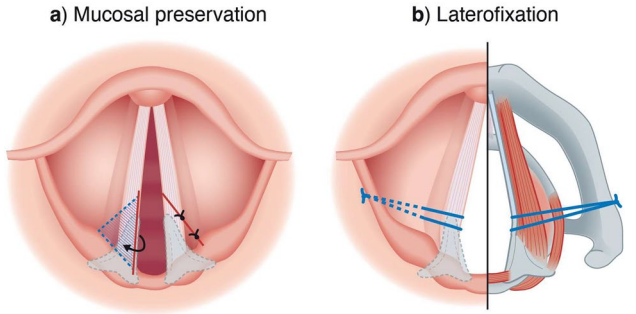

Fig. 5 Suffix. **a**) Mucosal preservation: preservation of the medial mucosa covering the arytenoid cartilage or vocal fold. The suffix 'with mucosal preservation' should be added to the procedure title. For example, 'subtotal arytenoidectomy with mucosal preservation'.**b**) Laterofixation: a thread looped around the vocal process to lateralis it. The suffix 'with laterofixation' should be added to the procedure when used. For example, 'subtotal arytenoidectomy with laterofixation'.**c**) Combined procedure: combination of a form of arytenoidectomy with a form of cordectomy or cordotomy.The procedure title should include both terms, combined with '&'. For example, 'anteromedial partial arytenoidectomy & posterior transverse cordotomy'.

classification, this procedure would classify as 'posteromedial arytenoidectomy'—which emphasizes the preservation of the vocal process by the anatomical description in the name of the procedure—in contrast to the 'anteromedial arytenoidectomy' where the vocal process is resected.

The presented ELS-UEP classification that uses anatomical descriptions of the exact extent of surgery, including graphical visualization and the correct use of suffixes, rather than referring to the names of surgeons that invented or first published on the technique, will help overcome these problems.

With this consensus on the classification and nomenclature of arytenoid and vocal fold surgery for BVFI we aimed primarily to define a unifying international terminology that can be used in research, to increase our ability to compare functional outcomes of different procedures. This is of importance as there is still no consensus on the risks and adverse effects on swallowing, voice, and the need for recurrent procedures following different types and extent of endoscopic procedures [19–23, 28]. The available studies are often small retrospective case series, which provide less reliable evidence [21–23]. However, when counselling patients with a rare and complex condition as BVFI, most physicians cannot rely on personal experience alone, and consistent reporting in literature is key. The classification presented in this paper even allows to retrospectively categorize cases from published papers, as long as the exact incisions and resections have been described in the material and methods section. For this purpose, an easy grading form is available in Supplementary material 2.

Secondly, the classification and visualizations can be used in theatre for more consistent reporting on the exact procedure that has been performed for the individual patient. The form in Supplementary material 2 can be used. Consistent reporting will help with future prospective international multi-center data collection to improve patient selection criteria for surgical procedures, (long-term) functional outcomes, quality of life, and cost-effectiveness, as one group in Germany and Austria has already started [43].

Thirdly, this terminology can serve an educational purpose as the graphical visualizations will help less experienced colleagues and those in training understand what the anatomical boundaries of the different procedures are. Especially the partial arytenoidectomy is a category that can be quite difficult to understand with the different anatomical structures that can be preserved or resected. With the presented classification, that is based on anatomical descriptions, teaching and distinguishing the different techniques will be more simplified.

It is difficult to design a classification that can be used both for scientific purposes and is thus very detailed and precise, and for clinical purposes, and would ideally be concise and easy to use. The classification as presented in this paper is quite extensive and is more suited to use in research, although the graphical visualisations make it quite easy to use in clinical practice too. This paper also does not define the best equipment or tools to use for the described endoscopic surgical techniques as it does not serve as a surgical guideline.

This paper has not defined the indications or timing to use these different endoscopic surgical procedures. These will be

addressed in a subsequent modified Delphi Consensus study, among other statements regarding diagnosis, management, and follow-up for acquired BVFI in adults.

Conclusion

This ELS-UEP consensus on endoscopic arytenoid and vocal fold surgery for BVFI provides a practical nomenclature and classification to improve reporting in literature and clinical practice and to allow for comparison of functional outcomes. The classification can be used to retrospectively categorize previously published cases and cohorts and can also be used prospectively in a theatre setting to enable prospective data collection. The graphical visualizations are helpful for educational purposes too.

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Data availability The data that support the findings of this study are openly available in Supplementary Material 1.

Declarations

Conflict of interest The authors have no competing interests. No funds, grants, or other support was received.

Competing interest The author Jerome R. Lechien was not involved with the peer review process of this article.

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