

ORIGINAL ARTICLE

Open Access



Etiology and presenting features of vocal cord paralysis: changing trends over the last two decades

Subash Bhatta^{1*} , Sachin Gandhi², Asheesh Dora Ghanpur² and Dushyanth Ganesuni²

Abstract

Background: The study was performed to evaluate the changing trends in etiology and presenting features of vocal cord paralysis (VCP) from March 1998 to March 2020.

Methods: Patient's record collected from hospital database and divided into two groups, from March 1998 to March 2009 and from April 2009 to March 2020, to evaluate the changing trends in etiology and presenting features.

Results: Total of 711 VCP patients, 80.3% with unilateral (UVCP) and 19.7% with bilateral vocal cord paralysis (BVCP) included. The commonest etiology was non-surgical (57.1%) for UVCP and surgical (55.7%) for BVCP. The commonest surgical etiology was thyroid and parathyroid surgery for both UVCP (16.6%) and BVCP (38.5%). The commonest non-surgical etiology was idiopathic for UVCP (23.1%) and malignancies for BVCP (13.6%). There was increase in surgical etiology for both UVCP (39.3 to 45.3%) and BVCP (51.2 to 57.7%), and decrease in non-surgical etiology for both UVCP (60.7 to 54.6%) and BVCP (48.8 to 42.3%). The change in voice was most common presenting features for both UVCP (69.2%) and BVCP (92.8%). The frequency of the presenting features was comparable, with decrease in the duration of symptom onset over the time period.

Conclusion: The most common etiology for UVCP was idiopathic, and for BVCP was thyroid and parathyroid surgery. For both, UVCP and BVCP there was increasing trend for surgical and decreasing trend for non-surgical etiology. The change in voice was the most common presenting complain, with decrease in duration of symptom onset over time period.

Keywords: Unilateral vocal cord paralysis, Bilateral vocal cord paralysis, Etiology, Presenting features

Background

Vocal cord paralysis (VCP) is the manifestation of the disease rather than a disease in itself, characterized by the loss of the movement of one or both of the vocal cords. The restriction in the movement of vocal cords can be unilateral (UVCP) or bilateral (BVCP). The presenting features and the management protocol of the patients are different for UVCP and BVCP. The UVCP patients may be asymptomatic or can present with the varying

degree of dysphonia (breathy voice, vocal fatigue to complete aphonia), dysphagia and aspiration [1–3]. Similarly, the patients with BVCP may present with stridor, snoring, difficulty in swallowing and aspiration in addition to the dysphonia as present in UVCP [4–6]. The presence of stridor and need for immediate intervention has made BVCP as one of the emergencies in the Laryngology practice. The presence of recurrent cough, fever and pneumonia can also sometimes be the presenting features of the VCP [3, 7–9].

The etiology of the VCP has a very important role to play in the management process for both UVCP or BVCP [4, 5, 10, 11]. Hence, detail evaluation has to be done for

*Correspondence: 2042subase@gmail.com

¹ Indira Gandhi Memorial Hospital, Male, Maldives
Full list of author information is available at the end of the article

any case of VCP to find out the definitive etiology responsible. The management of the etiological factors, causing VCP, alone may sometimes be the complete treatment for VCP. The imaging modalities like computed tomography (CT) scan, magnetic resonance imaging (MRI) and modified barium swallow (MBS), in addition to consultation with various other specialties such as neurology, gastroenterology, pulmonology, cardio vascular surgery, or spine surgery are required most of the times to ascertain the main cause responsible for VCP [1, 5, 11–13].

The VCP results primarily due to the neurological or the mechanical cause. Any type of trauma (iatrogenic or non-iatrogenic) or pathology in the motor cortex, skull base, neck, and mediastinum that leads to the disruption of the function of recurrent laryngeal nerve (RLN), constitute the neurological etiology. Similarly, the mechanical etiology incorporates the loss of movement of the vocal cords as a result of infiltration of the muscle of the vocal cords or ankyloses of the cricoarytenoid joint. The type of the vocal cord paralysis, whether it is due mechanical fixation of the vocal cords (for example, cricoarytenoid joint fixation or muscle infiltration) or due to the neurological cause, is evaluated with the detailed study of the characteristics of vocal cord vibration during the videolaryngostroboscopy (VLS). There have been multiple studies suggesting various etiological factors responsible for VCP, often without proper agreement on the most common etiology [1, 3, 4, 10, 14–17]. There also are studies that have evaluated the changing trend in the etiology of VCP over the time period [1, 12, 13, 16, 18]. The present study evaluates the etiology and presenting features of the UVCP and BVCP patients over the 22 years at a single institute. The study also explores the change in the trend over the 22 years in the etiology and presenting features of the VCP patients.

Methods

This was a retrospective study conducted at the Laryngology department of the Deenanath Mangeshkar Hospital and Research Center, Pune, India (referred as 'hospital' from here on). It is a review article which studied the etiology and presenting features of vocal cord paralysis from March 1998 to March 2020. Approval for the study was granted by the Institutional Ethics Committee of the hospital. The primary objective of the study was to analyze the etiology and presenting features of VCP and to look into the changing trend of etiology and presenting features over the above-mentioned time frame.

Adhering to the objectives, details of the VCP patients were retrieved from the hospital database. Patients of all ages and genders with VCP who underwent evaluation at the hospital from March 1998 to March 2020 were included in the study. The detailed history taking and

examination was done for all the patients of VCP. The VLS was routinely performed for every VCP patient. The imaging modality like CT scan, MRI, and MBS along with the necessary blood investigations were performed in the VCP patients in order to find out the etiology. Consultations were done with other departments such as neurology, pulmonology, cardiovascular surgery, spine surgery, and gastro enterology for evaluating the VCP patients. The combined team approach was utilized to evaluate the etiology for VCP.

The records of 711 patients were included in the study. The patients were divided into 2 groups for studying the change in the trends in etiology and presenting complaints of VCP. The first group consisted of 272 (38.3%) patients from March 1998 to March 2009 and second group consisted 439 (61.7%) patients from April 2009 to March 2020. The history and examination sheet, the investigation profile and all the imaging of patients were reviewed. The reference note from other concerned departments were also reviewed. The demographic details, gender, presenting complain, age at the presentation, diagnosis, type of paralysis (unilateral or bilateral), and side of paralysis for unilateral paralysis were documented. For every VCP patients, the VLS was studied and the vocal cords vibratory patterns were evaluated in the presence of consultant laryngology surgeon in order to differentiate between the mechanical and neural cause of VCP. The etiology of the VCP was documented under two broad headings such as surgical and non-surgical etiology separately for UVCP and BVCP respectively. The etiology was defined as idiopathic, if after the complete evaluation and consultation with other departments, there was no established cause identified. The collected information was analyzed between the first and second groups to evaluate the changing trend in the etiology and presenting complaint of the VCP patients.

Results

The mean age of the patients included in the study was 47 ± 9.2 (range 2 months to 91 years, median 45 years). There were 451/711 (63.4%) males and 260/711 (36.6%) females. The first group consisted of 229 (84.2%) with UVCP and 43 (15.8%) with BVCP. Similarly, the second group consisted of 342 (77.9%) patients with UVCP and 97 (22.1%) patients with BVCP. Out of the total 571 patients with UVCP, the left sided paralysis was present in 343 (60.1%). The presenting features and their duration of onset in the patients with UVCP and BVCP are as shown in Figs. 1 and 2 respectively. The surgical and non-surgical etiologies of UVCP and BVCP are as shown in Tables 1 and 2 respectively.

The dysphonia was most common presenting feature in UVCP and BVCP with 67.2% in first and 70.5% in second

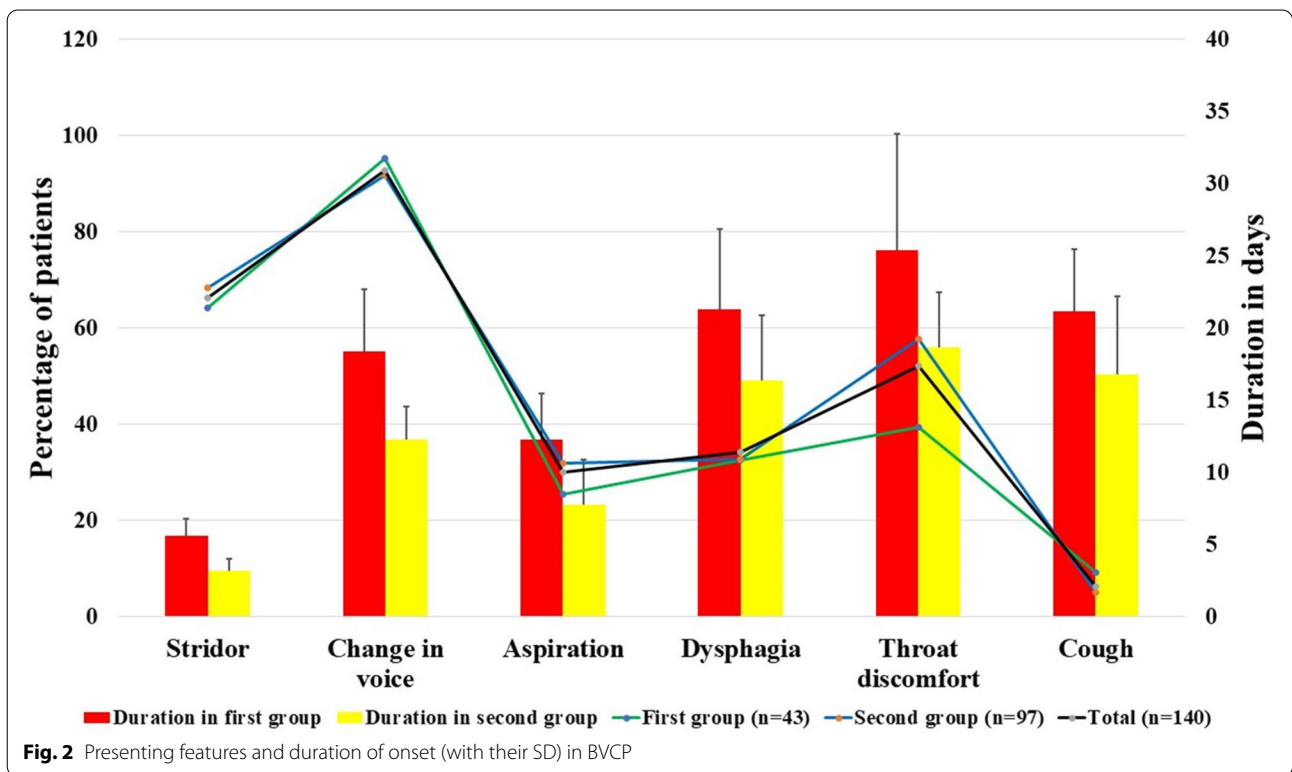
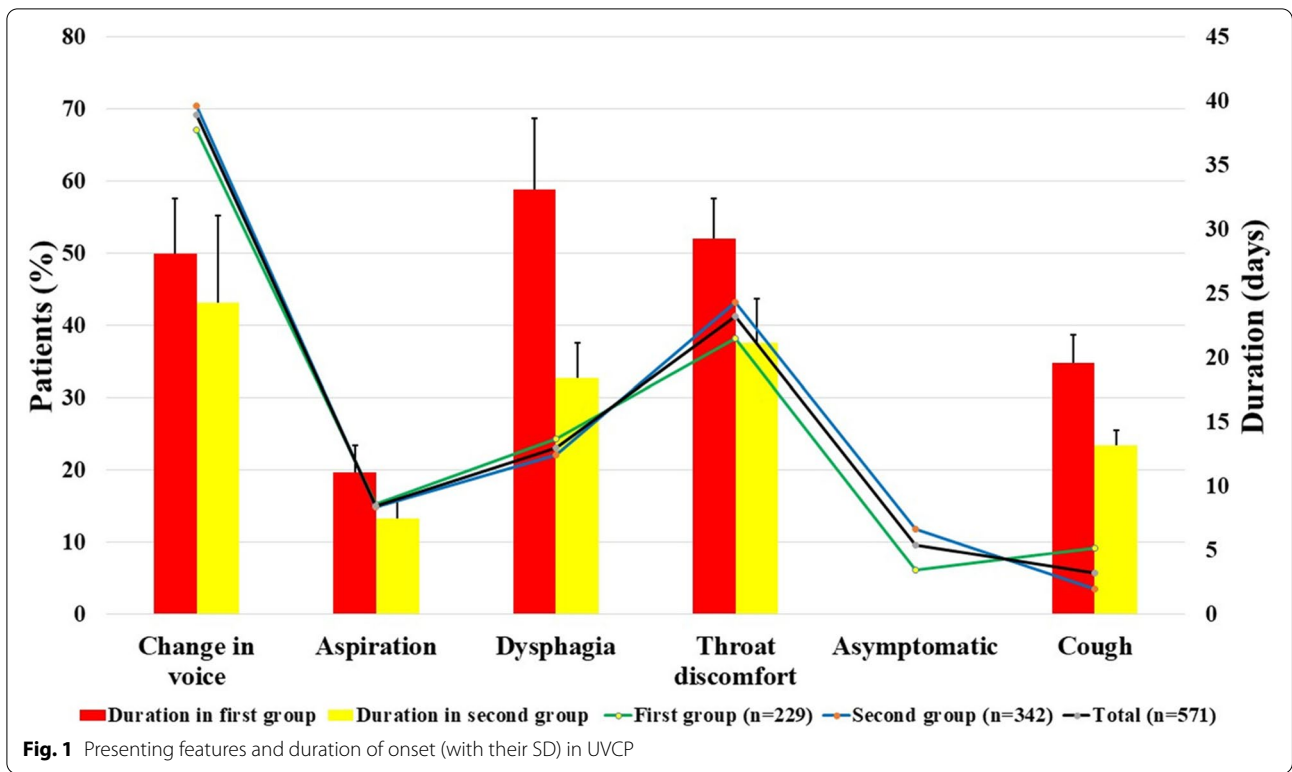


Table 1 Surgical and non-surgical etiology of UVCP

Surgical etiology		First group (n = 229)	Second group (n = 342)	Total (n = 571)	
Thyroid and parathyroid surgery	Thyroid surgery only	27 (11.8%)	53 (15.5%)	80 (14%)	
	Parathyroid surgery only	1 (0.4%)	5 (1.5%)	6 (1%)	
	Both thyroid and parathyroid surgery	3 (1.3%)	6 (1.7%)	9 (1.6%)	
	Sub-total	31 (13.5%)	64 (18.7%)	95 (16.6%)	
Intracranial surgery		2 (0.8%)	5 (1.5%)	7 (1.2%)	
Skull base surgery		3 (1.4%)	2 (0.6%)	5 (0.9%)	
Neck surgery (other than thyroid and parathyroid surgery)	Neck dissection	7 (3%)	10 (2.9%)	17 (3%)	
	Parapharyngeal tumor excision	9 (3.9%)	14 (4.1%)	23 (4%)	
	Carotid endarterectomy	3 (1.3%)	0	3 (0.5%)	
	Branchial cyst excision	2 (0.8%)	3 (0.9%)	5 (0.9%)	
	Tracheal resection and anastomosis	0	2 (0.6%)	2 (0.4%)	
	Sub-total	21 (9.3%)	29 (8.5%)	50 (8.8%)	
Spine surgery		17 (7.4%)	24 (7%)	41 (7.2%)	
Thoracic surgery		16 (6.9%)	31 (9%)	47 (8.2%)	
Total		90 (39.3%)	155 (45.3%)	245 (42.9%)	
Non-surgical etiology					
Idiopathic		64 (27.9%)	68 (19.9%)	132 (23.1%)	
Trauma		10 (4.4%)	16 (4.8%)	26 (4.6%)	
Intubation		3 (1.3%)	4 (1.1%)	7 (1.2%)	
Malignancy	Laryngeal malignancy	10 (4.4%)	14 (4%)	24 (4.2%)	
	Thyroid malignancy	5 (2.2%)	6 (1.8%)	11 (1.9%)	
	Non-larynx and non-thyroid malignancy	Esophageal carcinoma	5 (2.2%)	7 (2%)	12 (2.1%)
		Lung cancer	4 (1.8%)	5 (1.5%)	9 (1.6%)
		Metastatic nodes	5 (2.2%)	7 (2%)	12 (2.1%)
		Non-Hodgkin's lymphoma	1 (0.4%)	2 (0.6%)	3 (0.5%)
	Hodgkin's lymphoma	1 (0.4%)	2 (0.6%)	3 (0.5%)	
	Sub-total	16 (7%)	23 (6.7%)	39 (6.8%)	
CNS pathology		7 (3%)	14 (4%)	21 (3.8%)	
Infectious diseases	Pulmonary tuberculosis	9 (3.9%)	13 (3.8%)	22 (3.9%)	
	Tuberculous lymph node neck	5 (2.2%)	7 (2%)	12 (2.1%)	
	Other infections	2 (0.9%)	4 (1.2%)	6 (1%)	
	Sub-total	16 (7%)	24 (7%)	40 (7%)	
Radiotherapy		6 (2.6%)	13 (3.8%)	19 (3.3%)	
Miscellaneous		2 (0.9%)	5 (1.5%)	7 (1.2%)	
Total		139 (60.7%)	187 (54.6%)	326 (57.1%)	

Abbreviations: UVCP unilateral vocal cord paralysis, CNS central nervous system

group for UVCP and 95.3% in first and 91.7% in second group for BVCP. The frequency of all the presenting features in both the groups were comparable for both UVCP and BVCP. However, the duration of symptoms onset at the time of presentation, for all the symptoms, was less for second group in comparison to first group for both the UVCP and BVCP respectively.

In surgical etiology, the thoracic surgery included surgeries such as pneumonectomy (1.7% in the first and 2% in the second group), thoracotomy and pericardiocentesis (0.4% and 1.7%), mediastinal mass excision

(1.3% and 1.7%), esophagectomy and gastric pull up (1.7% and 2.3%), aortic aneurysm repair (1.3% and 1.2%), and implantation of vagal nerve simulator (0.4% and 0). CNS pathology included conditions such as motor neuron disease (0 and 0.3%), myasthenia gravis (0.8% and 1.4%), post-viral neuritis (1.7% and 1.7%), cerebrovascular accident (CVA) (0.4% and 0.3%), and pontomedullary glioma (0 and 0.3%). The miscellaneous in non-surgical etiology included conditions such as coarctation of aorta (0.4% and 0.6%), pulmonary hypertension leading to right ventricular hypertrophy

Table 2 Surgical and non-surgical etiology of BVCP

Surgical etiology		First group (n = 43)	Second group (n = 97)	Total (n = 140)
Thyroid and parathyroid surgery	Thyroid surgery only	9 (20.9%)	22 (22.7%)	31 (22.1%)
	Parathyroid surgery only	3 (7%)	6 (6.2%)	9 (6.4%)
	Both thyroid and parathyroid surgery	4 (9.4%)	10 (10.3%)	14 (10%)
	Sub-total	16 (37.3%)	38 (39.2%)	54 (38.5%)
Non-thyroid and parathyroid surgery	Neck dissection	2 (4.6%)	4 (4.1%)	6 (4.3%)
	Esophagectomy and gastric pull up	2 (4.6%)	5 (5.1%)	7 (5%)
	Carotid endarterectomy	1 (2.3%)	2 (2.1%)	3 (2.1%)
	Esophageal stent placement	0	3 (3.1%)	3 (2.1%)
	Tracheal resection and anastomosis	1 (2.3%)	4 (4.1%)	5 (3.6%)
	Sub-total	6 (13.8%)	18 (18.5%)	24 (17.2%)
Total	22 (51.2%)	56 (57.7%)	78 (55.7%)	
Non-surgical etiology				
Idiopathic		5 (11.7%)	10 (10.3%)	15 (10.7%)
Trauma		1 (2.3%)	2 (2.1%)	3 (2.1%)
Intubation		2 (4.6%)	3 (3.1%)	5 (3.6%)
Malignancy	Laryngeal malignancy	3 (7%)	7 (7.2%)	10 (7.1%)
	Thyroid malignancy	2 (4.6%)	2 (2.1%)	4 (2.9%)
	Esophageal	2 (4.6%)	3 (3.1%)	5 (3.6%)
	Sub-total	7 (16.2%)	12 (12.5%)	19 (13.6%)
CNS pathology		1 (2.3%)	3 (3.1%)	4 (2.9%)
Pulmonary tuberculosis		2 (4.7%)	3 (3.1%)	5 (3.6%)
Radiotherapy		3 (7%)	8 (8.2%)	11 (7.8%)
Total		21 (48.8%)	41 (42.3%)	62 (44.3%)

Abbreviations: BVCP bilateral vocal cord paralysis, CNS central nervous system

(0.4% and 0.3%), aberrant azygous vein (0 and 0.3%), and aortic aneurysm (0 and 0.3%).

Discussion

The VCP is not an infrequent condition encountered during the laryngology practice with study suggesting 0.42% of total new patients [11]. The age and gender of the VCP patients as shown in the current study are comparable as shown by other researches [10–14, 19, 20]. Our study showed 19.7% of the VCP patients were having BVCP, similarly Laura H. Swibel Rosenthal et al. [13], Albert L Merati et al. [12], and Hsin Chien Chen et al. [20] reported BVCP in 17%, 11%, and 11% of VCP patients respectively. The left VCP was more common than right VCP as shown by the current, and other studies [11, 15, 16, 21]. The reason for this could be the longer course of left RLN which leads to more probability of it getting injured during any pathology in the lower neck and mediastinum. The course of right RLN such as, making angle of around 45 degree while entering the tracheo-esophageal groove and the variation in the branching pattern in relation to the inferior thyroid

artery often renders it more vulnerable to injury during the neck surgeries [22–24].

The dysphonia was the most common presenting complain in both the UVCP and BVCP. David M. Simpson et al. [25], Brian C Spector et al. [26], and Jaya Gupta et al. [10] in their study have reported dysphonia to be the most common presenting feature of UVCP. In contrast to the current study, John M. Feehery et al. [18] and Jaya Gupta et al. [10] have reported difficulty in breathing to be the most common presenting complaint in BVCP. For both the first and second group the frequency of the presenting complaints was comparable in our study. However, the duration of onset of the symptoms was less for the second group as compared to the first group. The reason for this was felt to be increased awareness among the patients about the condition and also the increased accessibility of the hospitals to the patients. Vague symptoms such as dysphagia, aspiration and cough had maximum duration of onset for both UVCP and BVCP. The alarming symptoms such as stridor and aspiration as expected were the ones with shortest duration of onset.

Table 3 Etiology of UVCP and BVCP by various studies over the different time period

UVCP etiology/study	Francis W. Parnell et al. (n = 86, 1970) [28]	Harvey M. Tucker (n = 210, 1975–1978) [3]	Laura H. Swibel Rosenthal et al. (n = 363, 1996–2005) [13]	Shingo Takano et al. (n = 466, 1990–2005) [29]	Vyas M. N. Prasad et al. (n = 140, 2010–2014) [19]	Seyed Javad Seyed Toutounchi et al. (n = 45, 2010–2011) [2]
Surgical etiology						
Thyroid	5	8.2	19.2	18.6	8.8	18.6
Non-thyroid	37	15.7	37.1	37.1	53.3	37.1
Non-surgical etiology						
Idiopathic	34	19.6	16.8	10.7	–	10.7
Trauma	–	11.1	2.5	1.4	–	1.4
Intubation	–	7.5	7.3	7.1	20	7.1
Malignancy	22	24.7	12.9	1.4	31.1	1.4
CNS	2	7.9	3	10	–	10
Infectious disease	–	–	0.8	7.9	–	7.9
BVCP etiology/study	Paul C. Holinger et al. (n = 389, 1976) [4]	John M. Feehery et al. (n = 75, 1982–1997) [18]	Michael S. Benninger et al. (n = 117, 1985–1995) [5]	Laura H. Swibel Rosenthal et al. (n = 72, 1996–2005) [13]	Hsin-Chien Chen et al. (n = 32, 2000–2004) [20]	Jaya Gupta et al. (n = 8, 2008–2009) [10]
Surgical etiology						
Thyroid	17	11.8	18	48.6	37.5	25
Non-thyroid	8	8	7.7	6.9	9.3	–
Non-surgical etiology						
Idiopathic	13	13.3	12.8	8.3	9.3	25
Malignancy	21	21.4	17	9.7	18.7	25
Trauma	27	9.3	11.1	1.4	9.3	12.5
CNS	19	18.7	12.8	6.9	6.2	12.5
Intubation	–	9.3	15.4	9.7	–	–

Note: All the figure mentioned in percentage

Abbreviations: UVCP Unilateral vocal cord paralysis, BVCP Bilateral vocal cord paralysis, CNS Central nervous system

The patients of VCP were routinely investigated using various imaging modalities such as CT scan, MRI and MBS in order to find out the etiology behind the VCP. The imaging modalities helped to search for any pathology, responsible for causing VCP. The electromyography as used by Vyas M. N. Prasad et al. [19] in their study was not used in current study. There was increase in the surgical etiology for UVCP and BVCP in second group when compared to the first group. Our study demonstrated increase in the total number of thyroid and parathyroid surgery (31 vs 64) resulting in UVCP in second group compared to the first group. The number of the thyroid surgery causing UVCP was almost increased by twice (27 vs 53), however the percentage of thyroid surgeries causing UVCP only increased by 3.7%. Similarly, the number of thyroid and parathyroid surgeries causing BVCP was also increased by more than double in second group (16 vs 38), though the percentage increment was mere 1.9%. The reason for the relatively less increment in percentage could be increase in total number of VCP (272 vs 439) alongside the individual etiology in the second group. There was also increase in number of patients with parathyroid surgery as etiological factor for VCP in second group. Laura H. Swibel Rosenthal et al. [13], in their study, have shown the doubling in the number of surgical

etiologies for UVCP during the year 1996 to 2005 when compared to 1985 to 1995. This was thought to be due to the increase in the number of the surgeries performed during this time period.

The total number of non-surgical etiology were decreased, as shown by our study, in second group when compared to the first group for both UVCP and BVCP. There was decrease in the idiopathic cases in the second group UVCP (from 27.9% in first group to 19.9% in the second group) and BVCP (from 11.7 to 10.3%). The improved diagnostic modalities in the recent times were the reason for this decrease in the number. There was an increase in the number of UVCP due to trauma, which can be attributed to increased road traffic accident in the recent times [27]. The decrease in the number of laryngeal malignancy cases causing UVCP and BVCP was thought to be due to the early diagnosis and treatment of laryngeal malignancy. There was also an increment in the number of patients with UVCP and BVCP in second group following radiotherapy. This was due to the shifting paradigm of malignancy management towards, conservative and organ preservation approach in the recent times. The better community level management of pulmonary tuberculosis (TB) was the reason behind the decreased pulmonary TB etiology in

the second group. As most of the TB cases in the recent times are treated at very early stage unlike the scenario in the past. The similar findings were also demonstrated by Laura H. Swibel Rosenthal et al. [13] in their study, however there was decrease in number of trauma cases as the etiological factor of UVCP during the time period 1996 to 2005. The trend of changes in the etiology of UVCP and BVCP over the time period by various study is as shown in Table 3.

There was increase in the number of thyroid surgeries as the etiological factor for UCVP and BVCP over the time period as shown in the Table 3. The non-thyroid surgeries have been seen to have constant variation throughout the mentioned time frame. The idiopathic cause shows the decreasing trend in UVCP as shown by various studies. In case of BVCP, the idiopathic causes have shown constant variation over the time period.

The present study was the largest study found in the literature that has shown the changing trend of etiology and presenting features of UVCP and BVCP, over the time duration of 22 years. This study also had the largest sample size of the VCP patients in comparison to other similar studies found in the literature. The retrospective nature of the data collection and lack of the follow up data was felt to be the limiting factor of the present study. Hence, the recommendation has been put forward in the future, for a prospective research with proper long-term follow-up for better understanding of the subject matter.

Conclusions

The most frequent etiological factor for UVCP was non-surgical, with idiopathic being the commonest, in the surgical etiology thyroid and parathyroid surgery were the commonest. The BVCP was most often caused by surgical etiology, with thyroid and parathyroid surgery being the commonest and malignancy being the commonest non-surgical etiology. For both the UVCP and BVCP, there was increasing trend for surgical and decreasing trend for non-surgical etiology over the time period. The VCP was found to be detected earlier than before with dysphonia being the commonest presenting complain. The prospective research with increased sample size has been suggested in the future for better understanding the changing trend of etiology and presenting complain.

Acknowledgements

This research was fully supported by Laryngology Department of Deenanath Mangeshkar Hospital and Research Center. We would like to extend our heartfelt thanks to all our colleagues from ENT Department of Deenanath Mangeshkar Hospital and Research Center who provided insight and expertise that greatly assisted the research. We would like to thank Dr. Gauri Oak, Head of department, Research Department, Deenanath Mangeshkar

Hospital and Research Center and Deevika Joshi, Research Assistant, Research Department, Deenanath Mangeshkar Hospital and Research Center for their assistance in the biostatistics, language correction, and technical issues.

Authors' contributions

SB, ADG, and DG helped in data collection, data analyzing, result analysis and manuscript writing. SG helped in methodology, and editing. All authors read and approved the final manuscript.

Funding

From voice clinic Deenanath Mangeshkar Hospital and Research Center.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval obtained from the ethical committee of the Deenanath Mangeshkar Hospital and Research Center. Consent to participate is not applicable as it is a retrospective study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

¹Indira Gandhi Memorial Hospital, Male, Maldives. ²Deenanath Mangeshkar Hospital and Research Centre, Pune, India.

Received: 10 June 2022 Accepted: 2 October 2022

Published online: 12 October 2022

References

- Ramadan HH, Wax MK, Avery S (1998) Outcome and changing cause of unilateral vocal cord paralysis. *Otolaryngol Head Neck Surg* 118:199–202. [https://doi.org/10.1016/S0194-5998\(98\)80014-4](https://doi.org/10.1016/S0194-5998(98)80014-4)
- Seyed Toutouchi SJ, Eydi M, Golzari SE et al (2014) Vocal cord paralysis and its etiologies: a prospective study. *J Cardiovasc Thorac Res* 6:47–50. <https://doi.org/10.5681/jcvtr.2014.009>
- Tucker HM (1980) Vocal cord paralysis ??? 1979. *Laryngoscope* 90:585–590. <https://doi.org/10.1288/00005537-198004000-00004>
- Holinger LD, Holinger PC, Holinger PH (1976) Etiology of bilateral abductor vocal cord paralysis: a review of 389 cases. *Ann Otol Rhinol Laryngol* 85:428–436. <https://doi.org/10.1177/000348947608500402>
- Hillel AD, Benninger M, Blitzer A et al (1999) Evaluation and management of bilateral vocal cord immobility. *Otolaryngol Head Neck Surg* 121:760–765. <https://doi.org/10.1053/hn.1999.v121.a98733>
- Fukae J, Kubo SI, Hattori N et al (2005) Hoarseness due to bilateral vocal cord paralysis as an initial manifestation of familial amyotrophic lateral sclerosis. *Amyotroph Lateral Scler Other Motor Neuron Disord* 6:122–124. <https://doi.org/10.1080/14660820510034451>
- Murty GE, Lancaster P, Kelly PJ (2009) Cough intensity in patients with a vocal cord palsy*. *Clin Otolaryngol Allied Sci* 16:248–251. <https://doi.org/10.1111/j.1365-2273.1991.tb02044.x>
- Evans & William JM, Schucany GG (2004) Hoarseness and cough in a 67-year-old woman. 17:469–472. <https://doi.org/10.1080/08998280.2004.11928015>
- Lewy RB (1964) Glottic rehabilitation with teflon injection - the return of voice, cough and laughter. *Acta Otolaryngol* 58:214–220. <https://doi.org/10.3109/00016486409121378>
- Gupta J, Varshney S, Bist SS, Bhagat S (2013) Clinico-etiological study of vocal cord paralysis. *Indian J Otolaryngol Head Neck Surg* 65:16–19. <https://doi.org/10.1007/s12070-012-0574-x>

11. Ahmad S, Muzamil A, Lateef M (2002) A study of incidence and etiopathology of vocal cord paralysis. *Indian J Otolaryngol Head Neck Surg* 54:294–296. <https://doi.org/10.1007/BF02993746>
12. Merati AL, Shemirani N, Smith TL, Toohill RJ (2006) Changing trends in the nature of vocal fold motion impairment. *Am J Otolaryngol* 27:106–108. <https://doi.org/10.1016/j.amjoto.2005.07.020>
13. Rosenthal LHS, Benninger MS, Deeb RH (2007) Vocal fold immobility: a longitudinal analysis of etiology over 20 years. *Laryngoscope* 117:1864–1870. <https://doi.org/10.1097/MLG.0b013e3180de4d49>
14. Yumoto E, Minoda R, Hyodo M, Yamagata T (2002) Causes of recurrent laryngeal nerve paralysis. *Auris Nasus Larynx* 29:41–45. [https://doi.org/10.1016/S0385-8146\(01\)00122-5](https://doi.org/10.1016/S0385-8146(01)00122-5)
15. Srirompotong S, Sae-Seow P, Srirompotong S (2001) The cause and evaluation of unilateral vocal cord paralysis. *J Med Assoc Thai* 84:855–858
16. Benninger MS, Gillen JB, Altman JS (1998) Changing etiology of vocal fold immobility. *Laryngoscope* 108:1346–1350. <https://doi.org/10.1097/00005537-199809000-00016>
17. Myssiorek D (2004) Recurrent laryngeal nerve paralysis: anatomy and etiology. *Otolaryngol Clin North Am* 37:25–44. [https://doi.org/10.1016/S0030-6665\(03\)00172-5](https://doi.org/10.1016/S0030-6665(03)00172-5)
18. Feehery JM, Pribitkin EA, Heffelfinger RN et al (2003) The evolving etiology of bilateral vocal fold immobility. *J Voice* 17:76–81. [https://doi.org/10.1016/S0892-1997\(03\)00030-4](https://doi.org/10.1016/S0892-1997(03)00030-4)
19. Prasad VMN, Fakhoury R, Helou D et al (2017) Unilateral vocal fold immobility: a tertiary hospital's experience over 5 years. *Eur Arch Otorhinolaryngol* 274:2855–2859. <https://doi.org/10.1007/s00405-017-4528-5>
20. Chen HC, Jen YM, Wang CH et al (2007) Etiology of vocal cord paralysis. *ORL* 69:167–171. <https://doi.org/10.1159/000099226>
21. Havas T, Lowinger D, Priestley J (1999) Unilateral vocal fold paralysis: causes, options and outcomes. *Aust N Z J Surg* 69:509–513. <https://doi.org/10.1046/j.1440-1622.1999.01613.x>
22. Kaisha W, Wobenjo A, Saidi H (2011) Topography of the recurrent laryngeal nerve in relation to the thyroid artery, Zuckerkandl tubercle, and Berry ligament in Kenyans. *Clin Anat* 24:853–857. <https://doi.org/10.1002/ca.21192>
23. Haller JM, Iwanik M, Shen FH (2012) Clinically relevant anatomy of recurrent laryngeal nerve. *Spine (Phila Pa 1976)* 37:97–100. <https://doi.org/10.1097/BRS.0b013e31821f3e86>
24. Shindo ML, Wu JC, Park EE (2005) Surgical anatomy of the recurrent laryngeal nerve revisited. *Otolaryngol Head Neck Surg* 133:514–519. <https://doi.org/10.1016/j.otohns.2005.07.010>
25. Simpson DM, Sternman D, Graves-Wright J, Sanders I (1993) Vocal cord paralysis: clinical and electrophysiologic features. *Muscle Nerve* 16:952–957. <https://doi.org/10.1002/mus.880160911>
26. Spector BC, Nettekville JL, Billante C et al (2001) Quality-of-life assessment in patients with unilateral vocal cord paralysis. *Otolaryngol Head Neck Surg* 125:176–182. <https://doi.org/10.1067/mhn.2001.117714>
27. Ruikar M (2013) National statistics of road traffic accidents in India. *J Orthop Trauma Rehabil* 6:1. <https://doi.org/10.4103/0975-7341.118718>
28. Parnell FW, Brandenburg JH (1970) Vocal cord paralysis. A Review Of 100 Cases. *Laryngoscope* 80:1036–1045. <https://doi.org/10.1288/00005537-197007000-00002>
29. Takano S, Nito T, Tamaruya N, Kimura M, Tayama N. Single institutional analysis of trends over 45 years in etiology of vocal fold paralysis. *Auris Nasus Larynx*. 2012;39(6):597–600. <https://doi.org/10.1016/j.anl.2012.02.001>. Epub 2012 Mar 6.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Submit your manuscript to a SpringerOpen® journal and benefit from:

- Convenient online submission
- Rigorous peer review
- Open access: articles freely available online
- High visibility within the field
- Retaining the copyright to your article

Submit your next manuscript at ► [springeropen.com](https://www.springeropen.com)
