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ORIGINAL RESEARCH

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A comparative analysis of laryngeal nerve damage in patients with idiopathic vocal cord paralysis exhibiting different paralytic sides

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Abstract

Objective: To assess the extent of recurrent laryngeal nerve (RLN) and superior laryngeal nerve (SLN) damage in patients with idiopathic vocal cord paralysis (IVCP) exhibiting different paralytic sides.

Methods: A total of 84 IVCP cases were evaluated using stroboscopic laryngoscopy, voice analysis, and laryngeal electromyography (LEMG). The results were compared between patients with left-sided paralysis and right-sided paralysis based on different disease courses (less than or more than 3 months).

Results: Initially, the average age and disease progression of IVCP patients were found to be similar regardless of the side of paralysis ($p > .05$). Additionally, there were no significant variations in voice indicators, such as MPT, DSI, and VHI, between IVCP patients with left and right vocal cord paralysis ($p > .05$). Furthermore, no disparities were detected in the latencies and amplitudes of the paralyzed RLN and SLN, as well as the durations and amplitudes of the action potentials in the paralyzed TM and PCM, among IVCP patients with left and right vocal cord paralysis ($p > .05$). Notably, the amplitudes of the left paralytic CM were significantly lower than those of the right paralytic CM (0.45 vs. 0.53, $Z = -2.013$, $p = .044$). In addition, no disparities were observed in APDs and amplitudes between the ipsilateral PCM and TM, either for patients with left or right vocal fold paralysis ($p > .05$). Finally, all the IVCP patients were subdivided into two subgroups according to different disease course (less than or more than 3 months), and in each subgroup, the comparison of voice indicators and LEMG results in IVCP patients with left or right vocal fold paralysis were similar with the above findings ($p > .05$).

Conclusion: Overall, the degree of RLN and SLN damage appeared to be similar in IVCP patients with left and right vocal cord paralysis, provided that the disease course was comparable.

Level of Evidence: 4.

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KEYWORDS
damage, disease course, IVCP, laryngeal electromyography, RLN, side, SLN

1 | INTRODUCTION

Despite the lack of significant differences in the anatomical courses of the left and right recurrent laryngeal nerves (RLN) along the trachea, a higher prevalence of left vocal fold paralysis is observed in patients with idiopathic vocal cord paralysis (IVCP).[1,2] This observation aligns with the pathogenic neuropathy associated with IVCP, which specifically affects the left RLN.[3] Consequently, it is not surprising that the incidence of left-sided paralysis is greater in IVCP patients compared to those with other known causes of vocal cord paralysis.[4] Some scholars posit that this asymmetrical distribution may be attributed to the left RLN's heightened vulnerability to injury when compared to the right RLN, which may be related to the elongated and convoluted path of the left RLN around mediastinal structures.[5] Moreover, the left RLN's smaller diameter and vulnerability to traction make it more susceptible to injury.[6] Additionally, the right RLN is characterized by a greater presence of protective epineurium and adipose tissues compared to the left RLN in all segments.[7]

Considering the phenomenon of retrograde degeneration, it is expected that the recovery of paralysis on the left and right sides would exhibit differences in IVCP. Husain et al. discovered that the duration of restored vocal function in cases of left-sided IVCP exceeded that of right-sided IVCP (179.8 vs. 111.3 days).[6] In addition, the incidence of left vocal cord paralysis was higher among IVCP patients who did not regain their voice compared to those with right vocal cord paralysis (58.8% vs. 41.2%).[8] Nevertheless, the extent of injury to the RLN and SLN in IVCP patients remains uncertain. It should be noted that the left RLN's susceptibility to damage does not necessarily imply a more severe degree of impairment.

Laryngeal electromyography (LEMG) is considered as the gold standard for diagnosing vocal cord paralysis, which holds significant importance in determining injury to the RLN.[9] However, the extent of vocal parameter differences and LEMG results in cases of IVCP on different sides remains unknown. Therefore, we propose the hypothesis that IVCP patients with left vocal cord paralysis may exhibit more severe damage to the left RLN compared to IVCP patients with right vocal cord paralysis and their right RLN. Hence, the objective of this study is to analyze the extent of RLN and SLN injury in IVCP patients with varying paralytic sides, even distinguishing different disease courses, aiming to provide a theoretical foundation for a deeper understanding of IVCP.

2 | METHODS

2.1 | Subjects

The patients with IVCP were diagnosed using stroboscopic laryngoscope, computer voice analysis, and LEMG during their initial visit to the Department of Otolaryngology-Head and Neck Surgery in the Second Affiliated Hospital of Xi'an Jiaotong University between March 2018 and December 2022. The inclusion criteria for this study were as follows: (1) presence of unilateral vocal cord paralysis without an identifiable cause; (2) absence of abnormalities detected by thyroid and cervical lymph node ultrasound, chest CT, cranial MRI, barium esophagography, or electronic gastroscopy; (3) availability of complete clinical results, including stroboscopic laryngoscope, computer voice analysis, LEMG and Voice Handicap Index (VHI) scale. The exclusion criteria for this study included individuals with bilateral vocal cord paralysis, a history of neck, chest, or craniocerebral operations, and confirmed destruction or compression of the RLN by a tumor in various anatomical locations as determined by the aforementioned methods. The medical records of consecutive patients diagnosed with IVCP, aged over 14 years, were reviewed. The records included information on gender, affected side, age at diagnosis, etiology, and the time interval between symptom onset and medical visit (disease course). Finally, all the IVCP patients were subdivided into two subgroups according to different disease course (less than 3 months and more than 3 months), and in each subgroup, the results of voice indicators and LEMG were compared, respectively.

2.2 | VHI

The Chinese version of Voice Handicap Index (VHI) was utilized to assess self-reported voice disorders in IVCP patients.[10] The participants were instructed to evaluate their function (F), physiology (P), and emotion (E) scores, with a higher cumulative score indicating a more severe subjective assessment of voice disorder for individuals with IVCP.

2.3 | Assessment of objective acoustic voice parameters in IVCP patient

The assessment was conducted using the DiVAS Voice Analysis Software from X10N, a German company, in an environment with ambient noise levels below 40 dB sound pressure level. The participants were asked to wear a headset microphone positioned 30 centimeters away from their mouth and were instructed to relax and breathe calmly. The vowel "a" was pronounced for a duration of 2 s, repeated 3 times, and the best sound quality was subsequently chosen. The extracted parameters encompassed stable segment parameter fundamental frequency (F0) and fundamental frequency perturbation (Jitter), the maximum pronunciation time (MPT), the highest fundamental frequency (F0-High), and the lowest sound intensity (I-Low). The Dysphonia Severity Index (DSI) score was automatically computed using the DiVAS voice analysis software, employing the following formula:

DSI = 0.13 × MPT (s) + 0.0053 × F0-high (Hz) − 0.26 × I-Low (dB) − 1.18 × Jitter (%) + 12.4. A more negative DSI value indicates a higher degree of hoarseness, while a more positive value suggests a lesser degree of hoarseness.

2.4 | Stroboscopic laryngoscope

The stroboscopic laryngoscope (EndoSTROB, Berlin, Germany) was used to observe various changes in the hypopharyngeal, supraglottic, glottic, and subglottic structures, as well as the vibration mode, fundamental frequency, vibration amplitude, features of the mucosal wave, symmetry and periodicity of vibration, characteristics of closure phase, and vertical heights of vocal cord on both sides.

2.5 | LEMG

LEMG Technique. The LEMG was conducted by two physicians who are board-certified in electrodiagnostic medicine (MCM). In this study, a 37 mm concentric needle electrode was employed in conjunction with a surface ground electrode positioned on the forehead. The Synergy EMG system (CareFusion, Middleton, WI) was utilized, with filter settings ranging from 20 Hz to 10 kHz. MU recruitment tracings were captured at sweep speeds of 10 ms per division, employing a gain of 200 IV per division. The data were digitally recorded for subsequent offline analysis.

Needle electromyography for laryngeal muscles. For the purpose of laryngeal muscle needle electromyography, the patient's neck was extended, and the skin was disinfected and anesthetized using 2 g of 5% compound lidocaine cream. In the case of the cricothyroid muscle (CM), the muscle is identified at a distance of 1 cm from the midline. The needle is then angled laterally towards the cricoid cartilage, and the position is confirmed by conducting a sustained vowel phonation from low to high pitch. As for the thyroarytenoid muscle (TM), the electrode is inserted at a superior angle of 45° and a lateral angle of 20° through the cricothyroid membrane.[11] The TM is typically situated at a depth of 2 cm. The patient is instructed to produce a sustained /i/ sound at three graded levels of intensity, corresponding to "mild," "moderate," and "loud" phonation. The maximal sustained /i/ sound is used to represent a contraction of the TM at its highest intensity. Multiple fields were documented for each muscle, with a minimum of three fields recorded. Subsequently, the patient's neck was rotated by ninety degrees, and a concentric needle electrode was inserted through the posterior aspect of the lamina in the cricoid cartilage. The patient was then instructed to inhale deeply to verify the accurate placement of the concentric needle electrode in the posterior cricoarytenoid muscle (PCM).

Needle electromyography for laryngeal nerves. Needle electromyography was performed to assess the laryngeal nerves, with the concentric needle electrodes positioned in the CM and TM serving as recording electrodes. An additional concentric needle electrode was employed as stimulating electrode, which was inserted through the thyrohyoid membrane. It was then directed downwards along the path of SLN until reaching the level above the cricothyroid membrane for SLN evaluation. Alternatively, it was inserted 1 cm below the lateral aspect of cricothyroid membrane and directed upwards along tracheoesophageal groove until reaching the level of cricothyroid membrane for RLN evaluation. The stable compound muscle action potential was obtained by the recording electrode when electric stimulation was administered through the stimulating electrode, regardless of the intensity of stimulation for SLN and RLN. Subsequently, the latencies and amplitudes of the recording electrodes on both the left and right sides were compared to determine the affected side of the RLN and SLN. Furthermore, the electromyographic characteristics of patients with IVCP were analyzed and compared.

2.6 | Ethical statement

All patients provided written informed consent. The study was performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Second Affiliated Hospital of Xi'an Jiaotong University (No. 2022031).

2.7 | Statistical analysis

Statistical analysis was performed using SPSS 23.0 software (International Business Machines Corporation, USA). The data were analyzed using appropriate statistical tests based on the distribution and variance of the data. If the data followed a normal distribution with homogeneous variance, mean ± standard deviation was used, and a *t*-test was employed for comparison. Alternatively, if the data did not meet these assumptions, median and interquartile spacing were used, and a rank-sum test was conducted for comparison. A significance level of $p < .05$ was considered statistically significant.

3 | RESULTS

3.1 | The clinical characteristics of IVCP patients

In this study, a total of 84 cases of IVCP patients were included, consisting of 43 males and 41 females. The mean age of male patients (56.24 ± 14.12 years) was found to be similar to that of female patients (57.33 ± 13.02 years) ($t = -0.354$, $p = .724$). No statistically significant disparities were observed in discomfort symptoms such as pharyngoxerosis among the entire cohort of patients with IVCP ($p > .05$). Notably, the prevalence of left vocal fold paralysis (52 cases, 61.9%) was found to be higher compared to right vocal fold paralysis (32 cases, 38.1%) ($X^2 = 9.524$, $p = .002$). Furthermore, the median age (59 years vs. 59 years, $Z = -0.366$, $p > .05$) and duration of illness (40 days vs. 45 days, $Z = -0.248$, $p > .05$) were nearly identical for IVCP patients with left and right vocal fold paralysis, suggesting that

TABLE 1 The voice characteristics of IVCP patients with different paralytic sides.

Indices	Paralytic side		Z/t	p
	Left ($n = 52$)	Right ($n = 32$)		
MPT (s)	4.30 (3.15, 8.28)	5.10 (2.70, 12.20)	−0.320	.749
DSI	−0.55 ± 2.65	−0.83 ± 2.28	0.446	.657
F0max (Hz)	370.75 ± 139.60	286.80 ± 97.53	2.657	.010*
Male	272.61 ± 94.34	264.11 ± 89.58	0.277	.783
Female	438.69 ± 125.43	345.14 ± 98.95	1.819	.079
F0min (Hz)	120.98 ± 48.04	112.30 ± 37.59	−0.506	.613
Male	98.58 ± 19.44	103.40 ± 27.82	−0.624	.536
Female	137.35 ± 55.94	137.71 ± 51.53	−0.016	.988
SPLmax [dB (A)]	88.00 (82.00, 94.00)	92.00 (83.00, 99.00)	−1.462	.114
SPLmin [dB (A)]	55.00 (52.00, 56.50)	55.00 (52.00, 60.00)	−0.616	.538
VHI score	50.82 ± 28.42	50.04 ± 29.90	0.107	.915

Note: *t test.
Abbreviations: DSI, dysphonia severity index; F0max and F0min, maximal and minimal fundamental frequencies; IVCP, idiopathic vocal cord paralysis; MPT, maximal phonation time; SPLmax and SPLmin, maximal and minimal sound pressure level; VHI, voice handicap index.

the demographic attributes of patients with different paralytic sides were comparable and analogous.

In addition, the mean age, and the discomfort symptoms such as pharyngoxerosis, were almost the same as each other for patients with left or right vocal fold paralysis, no matter the disease course of which was less than 3 months (left paralysis, $n = 32$; right paralysis, $n = 24$) or more than 3 months (left paralysis, $n = 20$; right paralysis, $n = 8$) ($p > .05$).

3.2 | Comparison of the voice outcomes in IVCP patients with different paralytic sides

The study examined the voice outcomes in patients with IVCP who had varying degrees of paralysis on each side. The results indicated that, with the exception of the highest fundamental frequency (370.75 ± 139.60 for the left side vs. 286.80 ± 97.53 for the right side, $t = 2.657$, $p = .010$), there were no statistically significant differences observed in measures such as MPT (4.30 vs. 5.10, $Z = -0.320$, $p = .749$), DSI (−0.55 ± 2.65 vs. −0.83 ± 2.28, $t = 0.446$, $p = .657$), maximum and minimum sound pressure levels (88.00 vs. 92.00, $Z = -1.462$, $p = .114$; 55.00 vs. 55.00, $Z = -0.616$, $p = .538$), VHI (50.82 ± 28.42 vs. 50.04 ± 29.90, $t = 0.107$, $p = .915$), and other voice indicators among IVCP patients with different degrees of paralysis on each side ($p > .05$) (**Table 1**).

Furthermore, all the IVCP patients were subdivided into two subgroups according to different disease course (less than 3 months and more than 3 months), and in each subgroup, there were also no statistically significant differences observed in measures such as MPT (4.30 vs. 3.70, $Z = -0.117$, $p = .907$ for disease course < 3 months; 4.70 vs. 11.90, $Z = -1.322$, $p = .186$ for disease course ≥ 3 months), DSI (−0.43 ± 1.80 vs. −1.21 ± 2.33, $t = 1.254$, $p = .217$ for disease course < 3 months;−0.26 ± 3.12 vs. 0.60 ± 1.48, $t = -0.591$, $p = .561$ for disease course ≥ 3 months), and VHI (50.96 ± 27.96 vs. 52.67 ± 30.33, $t = -0.202$, $p = .841$ for disease course < 3 months; 50.59 ± 30.00 vs. 36.25 ± 26.81, $t = 0.874$, $p = .393$ for disease course ≥ 3 months), and other voice indicators among IVCP patients with left or right vocal fold paralysis ($p > .05$).

3.3 | Comparison of the LEMG results in IVCP patients with different paralytic sides

The present study aimed to compare the results of LEMG in patients with IVCP who exhibited paralysis on either the left or right side. The findings revealed no significant differences in terms of latencies and amplitudes of the RLN on the paralytic left and right sides (1.40 vs. 1.50, $Z = -0.097$, $p = .923$ for latencies, 1.40 vs. 1.40, $Z = -0.504$, $p = .614$ for amplitudes), as well as the APDs and amplitudes of the paralytic TM (9.10 vs. 10.55, $Z = -1.184$, $p = .236$ for APDs, 0.36 ± 0.15 vs. 0.32 ± 0.10, $t = 1.409$, $p = .163$ for amplitudes) and PCM (9.68 ± 2.65 vs. 9.79 ± 3.34, $t = -0.163$, $p = .871$ for APDs, 0.40 vs. 0.40, $Z = -0.154$, $p = .878$ for amplitudes) (Table 2). Additionally, no disparities were observed in APDs and amplitudes between the ipsilateral PCM and TM, either for patients with left vocal fold paralysis or right vocal fold paralysis due to IVCP ($p > .05$) (**Table 2**). Furthermore, the latencies and amplitudes of the paralytic left SLN and right SLN (1.50 vs. 1.70, $Z = -0.866$, $p = .387$ for latencies, 7.40 vs. 6.45, $Z = -0.599$, $p = .549$ for amplitudes), as well as the APDs of paralytic CM (9.90 ± 3.37 vs. 10.51 ± 3.36, $t = -0.811$, $p = .419$), were found to be similar and comparable between the left and right paralytic sides of IVCP patients ($p > .05$) (**Table 2**). Notably, the amplitudes of the left paralytic CM were significantly lower than those of the right paralytic CM (0.45 vs. 0.53, $Z = -2.013$, $p = .044$), suggesting the involvement of the CM to some extent in IVCP patients.

TABLE 2 The LEMG characteristics of IVCP patients with different paralytic sides.

Indices	Paralytic side Left ($n = 52$)	Right ($n = 32$)	t/Z	p
SLN				
Latency (ms)	1.50 (1.20, 2.08)	1.70 (1.40, 2.50)	−0.866	.387
Amplitude (mv)	7.40 (3.05, 11.63)	6.45 (2.73, 11.50)	−0.599	.549
RLN				
Latency (ms)	1.40 (1.20, 1.73)	1.50 (1.20, 1.75)	−0.097	.923
Amplitude (mv)	1.40 (0.73, 3.40)	1.40 (0.90, 1.80)	−0.504	.614
CM				
APD (ms)	9.90 ± 3.37	10.51 ± 3.36	−0.811	.419
Amplitude (mv)	0.45(0.37,0.53)	0.53(0.38,0.68)	−2.013	.044
TM				
APD (ms)	9.10 (6.40, 11.30)	10.55 (7.60, 11.83)	−1.184	.236
Amplitude (mv)	0.36 ± 0.15	0.32 ± 0.10	1.409	.163
PCM				
APD (ms)	9.68 ± 2.65	9.79 ± 3.34	−0.163	.871
Amplitude (mv)	0.40 (0.30, 0.47)	0.40 (0.32, 0.45)	−0.154	.878

Abbreviations: APD, action potential durations; CM, cricothyroid muscle; IVCP, idiopathic vocal cord paralysis; LEMG, laryngeal electromyography; PCM, posterior cricoarytenoid muscle; RLN, recurrent laryngeal nerve; SLN, superior laryngeal nerve; TM, thyroarytenoid muscle.

Furthermore, there were also no statistically significant differences observed in measures such as the latencies and amplitudes of SLN and RLN, the APDs and amplitudes of TM and PCM, the APDs of CM except for the amplitude of CM, no matter the disease course of which was less than 3 months or more than 3 months ($p > .05$). Interestingly, when the disease course was less than 3 months, the amplitude of CM in IVCP patients with left vocal fold paralysis (0.45 ± 0.14) was significantly lower than those with right vocal fold paralysis (0.60 ± 0.24) ($t = -2.692$, $p = .011$), yet which was almost the same with each other between IVCP patients with left vocal fold paralysis and those with right vocal fold paralysis (0.45 ± 0.12 vs. 0.42 ± 0.13, $t = 0.454$, $p = .654$) when the disease course was more than 3 months, suggesting that the involvement of the CM to some extent in IVCP patients concentrated on those with a disease course of less than 3 months.

4 | DISCUSSION

In the context of IVCP, the specific site and severity of RLN injury are unknown, although it is established that the nerve remains intact.[7] However, the severity of RLN injury could be assessed by observing decreased amplitude and prolonged latency through LEMG.[12] This study examined patients with left vocal fold paralysis and found that the amplitudes and latencies of the left RLN, as well as the APDs and amplitudes of the left PCM and TM, were comparable to those of the right RLN, PCM, and TM in patients with right vocal fold paralysis. Notably, a similar trend was also observed when comparing voice parameters such as MPT and VHI in individuals with IVCP. These findings suggest that the damages to the RLN and its innervated laryngeal muscles are comparable in different sides of patients with IVCP.[7]

Despite various hypotheses attempting to elucidate the etiology and pathogenesis of IVCP, the precise cause of RLN dysfunction remains uncertain. The pathology is characterized by distal axonopathy of the RLN, involving demyelination and partial remyelination.[13] Consequently, this axonopathy may result in denervation of the intrinsic laryngeal muscles and subsequent muscle atrophy. Certain scholars have posited that the etiology of IVCP may not be attributed to a focal axonal lesion, but rather to neuritis, particularly in the proximal segment of the laryngeal nerve. This alternative mechanism suggests that IVCP patients exhibit relatively minor denervation alterations in the affected RLN and a higher likelihood of spontaneous recovery compared to those with iatrogenic vocal fold paralysis.[14] It is worth noting that the diminished amplitude of the laryngeal nerve is linked to axonal damage, while prolonged latency is associated with demyelinating nervous changes, and it is hypothesized that there may be similar serous axon damages and demyelinating nervous changes in the left and right RLN fibers in patients with IVCP.[15] This speculation is based on the observation that the latencies and amplitudes of the paralyzed RLN were nearly identical. Kollech et al. discovered a higher presence of epineurium in distal segments (neck region) compared to proximal segments (thorax region) in both the left and right RLN.[16] This finding suggests that the RLN is less susceptible to injury or minor damage in IVCP, likely due to the influence of neuropathy affecting nerves proximal to the RLN and the protective effect of epineurium in distal segments.[3] Furthermore, despite the earlier impact on the abducent PCM compared to the adductive TM in cases of vocal fold paralysis, there is no discernible disparity in APDs and amplitudes between the ipsilateral PCM and TM. This holds true for both left and right vocal fold paralysis in patients with IVCP, suggesting that the subtle denervation changes of the paralyzed RLN are insufficient to elicit significant variations or alterations between the ipsilateral PCM and TM.

A recent review of IVCP highlights that the majority of improvements in vocal fold function and voice quality manifest within the initial year. Husain et al. demonstrated that the temporal progression of vocal recovery in IVCP differs from that of iatrogenic vocal fold paralysis. They observed a higher rate of recovery within the initial 5 months, and patients at the 6-month mark from onset exhibited significantly lower chances of recovery compared to those at 1 month.[5,6] Additionally, as the disease progressed, the proportion of patients with denervated potential decreased, while the proportion of patients with regenerative potential increased.[17] It was found that denervated potential was frequently observed in the PCM and TM of patients with unilateral vocal cord paralysis who had a disease duration of 1–3 months, and our findings indicate that the average disease duration of IVCP patients with paralysis on the left or right side was similar (nearly 45 days), and both of them were less than 3 months. Conversely, regenerative potential was more commonly observed in patients with a disease duration exceeding 3 months.[18] That is also the reason why we chose 3 months as a differentiation point for disease course to analyze the differences of voice indicators and LEMG results in IVCP patients with left or right vocal fold paralysis. Husain et al. found that two-thirds of patients with IVCP recovered vocal function within 6 months of onset, and laterality, age and gender, did not influence recovery rate. Specially, the mean time to recovery for the IVCP patients with left vocal fold paralysis was almost the same as those with right vocal fold paralysis, indirectly indicating that the degree of damage on the left and right sides is similar with each other.[6] However, the predominant factor contributing to vocal cord immobility in IVCP, as determined by LEMG, is denervation potential rather than regenerative potential. This observation provides insight into the underlying mechanism of vocal cord immobility in IVCP.

The involvement of SLN and CM in IVCP is a topic of interest. Mau's research revealed a significantly higher occurrence of simultaneous CM involvement in IVCP cases compared to iatrogenic cases.[8] Additionally, Chang et al.'s quantitative LEMG analysis demonstrated that 53% of IVCP patients exhibited concurrent deficits in the RLN and SLN. In contrast, only 22% of patients with iatrogenic vocal fold paralysis displayed simultaneous RLN/SLN deficits.[3] This discrepancy in proportions of patients with simultaneous RLN/SLN deficits between IVCP and iatrogenic cases necessitates further investigation. Pei et al. postulated that a significant number of instances of IVCP may be attributed to neuritis affecting the segment of vagus nerve situated proximal to the point at which the SLN branches off.[4] However, the absence of disparity between left-sided and right-sided paralysis in IVCP involving SLN aligns with the hypothesis posited by Mau et al.[8] This hypothesis suggests that an equal number of patients with combined RLN and SLN involvement on both sides of IVCP implies a pathophysiological cause that occurs symmetrically and affects a location proximal to the bifurcation of RLN and SLN.[19]

5 | CONCLUSION

Overall, the degree of RLN and SLN damage appeared to be similar in IVCP patients with left and right vocal cord paralysis, provided that the disease course was comparable.

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CONFLICT OF INTEREST STATEMENT

All authors have no conflict of interest.

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