ORIGINAL ARTICLE

Aetiology and Treatment of Vocal Fold Paralysis: Retrospective Study of 108 Patients

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KEYWORDS
Vocal fold paralysis; Thyroplasty; Vocal fold injection; Cordectomy

Abstract

Objectives: To review the aetiology and treatment of laryngeal paralysis diagnosed at our hospital and to describe the available therapeutic options.


Results: Of the 108 cases analysed, 70% had unilateral vocal fold immobility and 30% bilateral immobility. The most frequent aetiology in both cases was trauma (represented mainly by surgical injury), followed by tumours in unilateral paralysis and medical causes in bilateral paralysis. Half of the patients with unilateral paralysis (38) were treated surgically, with medialization thyroplasty. In bilateral vocal fold immobility, the treatment consisted of tracheostomy in patients with threatened airway (40%). We planned to widen the air passage in 9 patients (27%), performing cordectomy in most of them.

Conclusions: The aetiology observed in our patients is similar to that described in the literature. In cases of unilateral vocal fold paralysis, we believe thyroplasty is the procedure of choice. In bilateral paralysis, it is possible to perform cordectomy in selected patients once the airway has been secured.

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PALABRAS CLAVE
Parálisis cuerda vocal; Tirolastia;

Etiología y tratamiento de la parálisis laringea: estudio retrospectivo de 108 pacientes

Resumen

Objetivos: Revisar la etiología y el tratamiento de la parálisis laringea de los pacientes atendidos en nuestro centro y describir las opciones terapéuticas disponibles.

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Métodos: Revisión retrospectiva de las historias clínicas de 108 pacientes diagnosticados de parálisis glótica unilateral y bilateral entre el año 2000 y el 2012, identificando la causa de la parálisis y el tratamiento realizado.

Resultados: De los 108 casos analizados, el 70% presentaron inmovilidad glótica unilateral y el 30% bilateral. La etiología más frecuente en ambos casos fue la traumática representada principalmente por lesión quirúrgica, seguida de la tumoral en parálisis unilaterales y de causas médicas en parálisis bilaterales. La mitad de los pacientes con inmovilidad unilateral (38) fueron tratados con cirugía consistente en una tiroplastia de medialización. El tratamiento de la inmovilidad glótica bilateral consistió en traqueotomía en pacientes con compromiso ventilatorio (40%). Se propuso ampliar el paso aéreo en 9 pacientes (27%), efectuando cordotomía en la mayoría de los casos.

Conclusiones: La etiología de nuestros pacientes es similar a la descrita en la literatura. En las parálisis unilaterales consideramos que la tiroplastia de medialización es el procedimiento de elección. En las bilaterales, una vez que se ha asegurado la permeabilidad de la vía aérea se puede plantear cordotomía en determinados pacientes.

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Introduction
Vocal fold paralysis is defined as the loss of mobility of the real vocal fold secondary to disruption of the motor innervation of the larynx. It should be differentiated from fixation caused by infiltration of musculature or ankylosis of the cricoarytenoid joint.

The larynx is a specialised organ which regulates air flow during respiration, deglutition and phonation. These functions depend on the ability to modify the position of the vocal cords; if there is glottic incompetence, symptoms such as dysphonia, aphony or breathy voice, aspiration, dysphagia and dyspnoea will present. The clinical symptoms will depend on whether the lesion is unilateral or bilateral, on the level of nerve involvement and on the final position adopted by the vocal cords.1-3

The causes of this disorder can be put into four groups: neoplasia (due to compression/infiltration of the vagus or recurrent nerve), trauma (surgical or non surgical), secondary to neurological or systemic disease, and idiopathic.2

Therapeutic approaches range from expectant management (observation), speech therapy, to different surgical techniques. The decision on treatment will depend on the clinical context of each patient.

The objective of this research study is to review the causes and the therapeutic management undertaken on the patients seen in our centre over the past 10 years.

Materials and Methods
We performed a retrospective review of 108 patients diagnosed with glottic paralysis in our department during the period from January 2000 to February 2012. Despite there not being a systematised register of the patients with this disease, we compiled the data on those for whom there was available information from electronic clinical records. We excluded cases of immobility deriving from tumours of the larynx or hypopharynx. We reviewed epidemiological data of unilateral and bilateral paralyses and focussed our analysis on the group of patients who were treated surgically, describing the techniques used and the postoperative results.

The approach adopted for cases of unilateral glottic immobility was observation with or without speech therapy for the first 6–12 months, offering surgery to those without clinical compensation (aspiration and/or poor voice quality). Type I thyroplasty was the most frequent surgery performed and intracordal injection was used far less frequently. Thyroplasty was performed under local anaesthesia with superficial sedation in the majority of cases, except for those patients who had undergone surgery during the same operation which compromised the integrity of the vagus or recurrent nerve (excision of vagal parangangiomas or cervical tumours with infiltration of the recurrent nerve) on whom surgery was performed under general anaesthetic. The technique used in our centre is as described in literature for type I thyroplasty, with the creation of a window in the thyroid cartilage and placement of Montgomery prosthesis according to the manufacturer’s indications. The intracordal injections were given under general anaesthetic.

For the bilateral paralyses the initial treatment objective was to ensure the viability of the airway, performing a tracheotomy on patients with ventilation limitation and periodic controls on patients who were tolerating the bilateral immobility. Cordotomy was offered to widen the airway in some patients. This procedure was performed endoscopically under general anaesthetic.

Results
Aetiology
Of the 108 patients studied, 75 (69.44%) presented unilateral and 33 (30.55%) bilateral glottic paralysis.

Unilateral paralysis was slightly more common in women (54%) and the left vocal cord was the most compromised (50 cases, corresponding to 67%). The main aetiology of unilateral immobility was trauma (45.33%), surgical injury caused by thyroidectomy being the most frequent (10 cases), followed by cardiac/aortic/carotid surgery (7 cases),
pneumectomy and other thoracic surgery (5 cases), and less frequently: oesophagectomy, cervical dissection, excision of meningioma, prolapsed disc and parathyroidectomy. We encountered three cases of unilateral paralysis post orotracheal intubation and one caused by a fire arm (Table 1). The next most common aetiological group comprised tumours (40%), divided into benign tumours: paragangliomas and X pair neurinomas and extralaryngeal malignant tumours: lung neoplasias (6 cases), oesophagus (3 cases), mediastinal (3 cases) and thyroid (one case). Medical causes were the least frequent (8%): 2 cases of sarcoidosis, one case of pulmonary tuberculosis, 2 cases of neurological disease and one aortic aneurysm. Finally, idiopathic aetiology was observed in 5 patients (6.66%).

Of the cases with unilateral glottic paralysis, 53 were caused by an injury to the recurrent nerve (70%) and 22 due to an injury to the vagus nerve (30%). Table 2 shows the causes of injury to the tenth cranial pair.

Bilateral paralyses were slightly more common in males (55%). The main cause of these paralyses was traumatic injury which presented in 48.48% (16 patients), the majority of the cases being post thyroidectomy. The next most common was medical aetiology (27.27%; 9 patients), 4 neurological paralyses and one sarcoidosis being highlighted. And finally, there were 4 cases of malignant extralaryngeal tumours (12.12%) and 4 cases were idiopathic (12.12%).

### Treatment of Unilateral Laryngeal Paralysis

We divided the patients into two groups to review the treatment of unilateral laryngeal paralysis: injury to the recurrent nerve and injury to the vagus nerve.

Of the 53 patients with paralysis due to an injury to the recurrent laryngeal nerve, 24 were treated by medialisation thyroplasty. Intracordal injection with Vox® Implant was associated in one of these patients at a different surgical time. The postoperative results were assessed one month after surgery, subjectively qualifying them as satisfactory or unsatisfactory depending on the presence or otherwise of aspirations and on voice quality. Satisfactory results were obtained in all cases except one patient who continued to have glottis leakage; this defect was corrected by Vox® Implant injection and presented clinical improvement. The 29 patients with laryngeal paralysis due to involvement of the recurrent nerve who were not operated, followed controls and some received speech therapy.

Twenty-two patients presented glottic paralysis due to involvement of the vagus nerve, 14 were treated by type I thyroplasty (11 paragangliomas, 2 neurinomas of the cranial X pair, one post excision of meningioma) and intracordal fat injection was associated in one of these patients at a different surgical time. In two cases complex symptoms resulted in a tracheotomy being performed (one patient with meningioma and another with type 2 neurofibromatosi). The 6 remaining patients were not operated.

Two cases with an unsatisfactory postoperative result were encountered amongst in the patients with vagal paralysis: one due endolaryngeal extrusion of the Montgomery’s prosthesis and the other due to associated pharyngeal paralysis with persistent aspiration. In the first case the prosthesis was removed under local anaesthesia and in the second a partial pharyngectomy was performed for exclusion.

### Table 1 Aetiology of Laryngeal Paralysis Hospital de la Santa Creu i Sant Pau.

<table>
<thead>
<tr>
<th>Aetiology of laryngeal paralysis</th>
<th>Unilateral</th>
<th>Bilateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traumatic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical trauma</td>
<td>34 (45.33%)</td>
<td>16 (48.48%)</td>
</tr>
<tr>
<td>Thyroidectomy</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Cardiac–aortic–carotid surgery</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Thoracic surgery</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>surgery–pneumectomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oesophagectomy</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cervical dissection</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Meningioma excision</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Prolapsed disc</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Parathyroidectomy</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Non-surgical trauma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ootracheal intubation</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Fire arm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Tumoral</td>
<td>30 (40%)</td>
<td>4 (12.12%)</td>
</tr>
<tr>
<td>Benign tumours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vagal paraganglioma</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Jugular paraganglioma</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Carotid paraganglioma</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Neurinoma</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Malignant tumours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung neoplasias</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Oesophageal neoplasias</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Mediastinal neoplasias</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Thyroid neoplasias</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>6 (8%)</td>
<td>9 (27.27%)</td>
</tr>
<tr>
<td>Granulomatos (sarcoidosis, tuberculosis)</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Neurological</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Idiopathic</td>
<td>5 (6.66%)</td>
<td>4 (12.12%)</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>33</td>
</tr>
</tbody>
</table>

### Table 2 Aetiology of Unilateral Laryngeal Paralysis Due to Injury to the Tenth Cranial Pair.

<table>
<thead>
<tr>
<th>Paralysis of the tenth pair</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paragangliomas</td>
<td>13</td>
</tr>
<tr>
<td>Meningioma surgery</td>
<td>2</td>
</tr>
<tr>
<td>Schwannoma surgery on jugular foramen</td>
<td>1</td>
</tr>
<tr>
<td>Cervical Schwannoma surgery</td>
<td>1</td>
</tr>
<tr>
<td>Neurofibromatosis</td>
<td>2</td>
</tr>
<tr>
<td>Wallenberg’s syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Encephalitis</td>
<td>1</td>
</tr>
<tr>
<td>Traumatic (fire arm wound)</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
</tr>
</tbody>
</table>
Treatment of Bilateral Laryngeal Paralysis

The bilateral glottic immobility was treated by performing an emergency tracheotomy in patients with dyspnoea and insufficient glottic passage (13 cases, 39.4%) and observation of those who were tolerating the paralysis without significantly limited breathing (20 cases, 60.6%). Of the 13 tracheotomised patients, 6 were decannulated and 7 kept the tracheotomy.

In subsequent controls it was suggested that 9 patients’ airways should be widened, 8 of them had not required tracheotomy. 10 procedures were performed on the 9 patients: 7 underwent isolated cordotomy (unilateral for 5 patients and bilateral for 1), one patient underwent an arytenoidectomy and another patient underwent two operations: an arytenoidectomy and later cordotomy.

For 6 of the patients who underwent cordotomy, the postoperative result was satisfactory as dyspnoea improved with an acceptable voice quality. In 2 patients the result was not entirely satisfactory because, despite an improvement in their dyspnoea, their voices were not very strong. One case of postoperative complications was observed due to oedema in the area of the cordotomy which necessitated a tracheotomy 48 h after surgery. The result was not satisfactory for the two arytenoidectomy cases as their resulting voice was not strong and one of them presented aspirations.

Discussion

In recent years the aetiology of laryngeal paralysis has remained stable, the most frequent causes of unilateral paralyses have been found to be advanced extralaryngeal neoplasias (lung cancer, mediastinal neoplasias) and surgical injury. This distribution is similar to that observed in our series of patients, where the principal aetiology was surgery, closely followed by extralaryngeal tumours. When these results were compared with those published in our centre in 2001 by León et al., we observed a decreased percentage of idiopathic causes of unilateral paralyses (29% in the 2001 study vs 6% in the present review). It is probable that the reduction of idiopathic paralyses is due to the more exhaustive study which has currently been undertaken using cervical, thoracic and skull base imaging tests.

Unilateral Laryngeal Paralysis

In unilateral paralyses, the left vocal fold is more frequently affected: explained by the fact that the left recurrent nerve is longer and is more prone to injury due to mediastinal and lung disease. In our case studies we observed immobility of the left vocal fold in 67% of patients.

Unilateral laryngeal paralyses can evolve in 3 ways: spontaneous recovery of mobility, no recovery but compensation by the contralateral vocal cord or no recovery or compensation with flaccid paralysis. The probability of recovery depends greatly on the aetiology, there is a good prognosis for recurrent idiopathic paralysis or when the cause is surgical injury; the prognosis with extralaryngeal tumours is less good.

It is possible for spontaneous reinnervation of the vocal cord to occur, however, movement is not usually recovered due to the synkinesis resulting from the non-selective innervation of the abductor muscles and larynx abductors. The innervation obtained is due to the existence of anastomoses between the laryngeal nerves (recurrent, internal and external laryngeal nerves). The variability in nerve anastomoses would explain the different positions adopted by the vocal fold.

Patients who do not recover mobility are frequently observed, but they do gain compensation by abduction of the contralateral vocal fold. For some authors speech therapy is a useful tool for all patients with dysphonia and in some cases avoids the need for surgery. Galcerán et al. found that 75% of patients with unilateral laryngeal paralysis made satisfactory recoveries using speech therapy, in the majority of cases due to adequate glottic compensation rather than recovery of mobility. Rehabilitation exercises are aimed at adequately controlling breathing to prevent hypersonic supraglottic compensation which might compromise the result of medialisation surgery if it were necessary.

Given the possibility of spontaneous recovery or compensation, it is recommended that patients who do not have many symptoms should wait for about a year before undergoing any irreversible surgery. If during this period, the symptoms become moderate to severe reabsorbable substances can be injected to place the cord in a better position.

If surgery is the chosen route, the operations available are medialisation (by injection or thyroplasty), abduction of the arytenoids, arytenopexy and reinnervation.

Laryngoplasty by injection, is a technique which involves injecting a substance into the paraglottic space or into the lateral portion of the thyroarytenoid muscle in order to medialise the vocal fold. Various absorbable and non-absorbable materials have been used over the years.

Absorbable materials include autologous fat, hyaluronic acid, collagen and gel foam. Their absorption time varies; it is usually around 6 months. The temporary effect on the position of the vocal cord which is observed with the use of these materials is a disadvantage in the case of permanent paralysis, because repeated injections or other techniques to correct glottal incompetence are required. However, in patients who recover vocal fold mobility it is as advantage that the material is absorbed.

Yung et al. compared the probability of requiring definitive thyroplasty amongst patients treated with the injection of substances for temporary medialisation and patients managed conservatively; they found that the former group had a significantly lower rate of permanent surgical intervention.

For their part, the study by Laccourreye et al. concludes that although the injection of fat is a safe and useful procedure, the impossibility of predicting the amount of material which is reabsorbed and the duration of results, resulted in their opting in most cases for medialisation thyroplasty. They reserve injection for patients with a high likelihood of recovery.

The other substances available for injection in the vocal fold are non-reabsorbable, such as Teflon, silicone, bioplastics and calcium hydroxapatite. Use of these materials can cause complications in some patients, including the material migrating, reactions to a foreign body, the formation of
granuloma (with Teflon) and hypersensitivity. This has lead to the use of some of these materials being discontinued.\textsuperscript{13,14,16}

In recent years bioplastics have come onto the market such as Vox\textsuperscript{®} Implant or polimethylsiloxane. This is a material with appropriate viscoelastic properties and good biocompatibility.\textsuperscript{16} Turner et al. found that 32 out of 39 patients treated by endoscopic medialisation with Vox\textsuperscript{®} Implant presented satisfactory results with a significant difference on the vocal disability index (VHI-10) pre and post treatment, and normal fluoroscopy was achieved post surgery in those who had impaired swallowing.\textsuperscript{17}

Intracordal injection of absorbable or non-reabsorbable materials can be transoral or percutaneous, the latter route offers the advantage that the patient can be awake and an outpatient.\textsuperscript{14} The injection must be given accurately in order to prevent irregularities on the surface of the vocal cord.

Medialisation thyroplasty is another available technique to achieve glottic closure. It was first described in 1974 by Isshiki et al. and revolutionised the management of laryngeal paralysis; minor variations have been made in the technique since then and nowadays it is considered as the treatment of choice for unilateral paralyses.\textsuperscript{4,13}

In order to improve subsequent glottic leakage it is useful to change the position of the arytenoids, this is achieved by adducting them (anterior and medial rotation), using arytenopexy or thyroplasty with posterior flap.\textsuperscript{4}

The complications associated with thyroplasty include; oedema of the airway, haemorrhage, haematoma, pyriform sinus injury, extrusion of the prosthesis and wound infection. In general they are rare, around 14\%.\textsuperscript{4,17} In our study we only observed one consistent complication which was migration of the prosthesis.

There is controversy as to the most appropriate and safe procedure for patients with unilateral vocal paralysis secondary to advanced extralaryngeal malignant disease. Some authors prefer intracordal injection and do not justify thyroplasty due to the short life expectancy of these patients. Morrissey et al. suggest that thyroplasty is a safe procedure and an excellent palliative measure for these patients.\textsuperscript{4} In their study, mean survival in these patients was 608 days (20 months) from the date of thyroplasty until death or the end of the period of follow-up. They consider that thyroplasty is an effective procedure which is performed in a single operation and achieves better communication and quality of life for oncology patients while at the same time reducing swallowing disorders and aspiration, and reducing morbidity.\textsuperscript{4}

Bilateral Laryngeal Paralysis

In bilateral glottic paralysis, there is good quality of voice whereas the airway is threatened by the paramedian position of both vocal folds (in the case of recurrent paralysis). A high percentage of patients require emergency tracheotomy. It is possible to operate later to improve glottic passage, lateralising one or both vocal cords, which has negative repercussions on voice quality.\textsuperscript{4} This situation obliges the patient to decide between good voice quality, but with a tracheotomy, or airway integrity with a more aphonie voice.

The most frequent procedures for bilateral paralysis in adduction are cordotomy and laser endoscopic arytenoidectomy.\textsuperscript{1} It is also possible to use sutures which ensure lateralisation (cordopexy) and external or mixed approaches (arytenoidectomy or arytenoidopexy).

Cordotomy consists of resecting the pars membranosa of the glottis at the level of the vocal apophysis, enabling glottal permeability to be restored with less alteration of voice quality and a lower risk of aspirations.\textsuperscript{4} Its potential complications include the formation of granuloma, scar or chondritis.\textsuperscript{1,18} Resection of arytenoids, whether or not associated with lateralisation suture, is another solution for a lack of glottal space. Currently the endoscopic route with CO\textsubscript{2} laser is preferred.

Another option described in cases of bilateral immobility is the injection of botulinum toxin in the cricothyroid muscle, which theoretically reduces tension of the vocal fold with subsequent lateralisation and increased glottic permeability.\textsuperscript{4}

Cordotomies have been increasingly performed in our centre in recent years, as the airway is widened and the voice is less affected. This is why arytenoidectomy (both external and endoscopic), which was previously the only operation we performed in our department for bilateral paralysis in adduction,\textsuperscript{4} has now become the second choice of surgery.

Conclusions

Post surgical and neoplastic aetiologies stand out as the causes of laryngeal immobility amongst the group of patients studied. Our proposal is to wait for a year from detecting the unilateral paralysis until surgery, except for those cases where the paralysis is expected to be irreversible, with significant aspirations or vagal nerve paralysis. In these situations, the treatment is performed early and tends to be more aggressive. In fact, when we sacrifice the vagal nerve we perform a thyroplasty during the same operation.

In unilateral glottic paralysis, we consider that medialisation thyroplasty is the procedure of choice, based on the satisfactory results achieved long term, its low complication rate and its potential reversibility. Over the last 10 years we have reduced the number of intracordal injections with fat and reabsorbable materials as they require repeated applications. In terms of non-reabsorbable materials, we have one case of Vox\textsuperscript{®} Implant with a good result at one-year follow-up.

In the case of bilateral paralysis, the primary therapeutic objective is to ensure the viability of the airway, performing tracheotomy if necessary. Cordotomy is the technique most used in our centre to widen the glottal passage, but it needs to be explained to the patient that their voice quality will be reduced when their airway is widened.

Conflict of Interest

The authors have no conflict of interests to declare.

References