Transient recurrent laryngeal nerve palsy after interventional therapy

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Conflict of Interest: The authors declare that they have no conflict of interest.

Abstract:
Background: Hoarseness due to laryngeal nerve injury is a known complication after cardiothoracic surgery involving the aortic arch. However, this complication is only rarely reported after catheter interventions.

Results: In this article we present the unusual case of a left sided vocal cord paralysis in four patients after primary stenting of a recoarctation, redilatation of a stented coarctation, a primary stenting of the left pulmonary artery and prestenting for percutaneous pulmonary valve implantation with dilation of the left pulmonary artery (LPA). After implanting bare metal stents, it is common practice, whilst contemplating the diameters of the adjacent structures, to optimize the stent diameter in a two-step procedure and dilate the stent until a maximum diameter is achieved and there is no residual gradient after applying this technique. Four of our patients experienced hoarseness after the intervention and a vocal cord paralysis was diagnosed. Angiography revealed no signs of extravasation or dissection. Clinical symptoms improved over the course of the following 6 months; patients with interventions at the aortic arch showed a complete remission, patients with procedures involving the LPA showed only mild regression of the symptoms.

Conclusion: To our knowledge, this complication (Ortner-Syndrome, cardiovocal syndrome) after such interventions has rarely been reported before. Although a rare complication, the recognition of these symptoms may support colleagues in managing affected patients. In addition, awareness for hoarseness after interventional therapies and systematic screening for this complication might help to identify patients at risk in the future.

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figure 1

Angiographies of Patient A

a: There is a significant re-coarctation after the second surgery at the age of 17. The minimal diameter is 9 mm, systolic pressure gradient under general anesthesia is 40 mmHg. (Angiography of the aorta, lateral view).

b: Immediately before the re-dilatation of the stent at the age of 26 years there was a significant re-coarctation in the area of the stent. The minimal diameter is 12 mm, systolic pressure gradient in deep sedation is 20 mmHg. (Angiography of the aorta, lateral view).

c: Immediately after the re-dilatation at the age of 26 years with an 18 mm balloon the diameter increased to 17 mm and there was no residual gradient left, no signs of extravasation or dissection visible. (Angiography of the aorta, lateral view).

figure 2

Angiographies of Patient B

a: Re-coarctation after two-time resection and end-to-end anastomosis.

→ PDA-Clip (angiography of the aorta, lateral view)

b: After implantation of a 4,5cm CP Stent, the stent was dilated to a diameter of 17mm, with the diameter of the transverse arch measuring at 17mm and that of the descending aorta at 21mm. (angiography of the aorta, lateral view)
Abstract

**Background:** Hoarseness due to laryngeal nerve injury is a known complication after cardiothoracic surgery involving the aortic arch. However, this complication is only rarely reported after catheter interventions.

**Results:** In this article we present the unusual case of a left sided vocal cord paralysis in four patients after primary stenting of a recoarctation, redilatation of a stented coarctation, a primary stenting of the left pulmonary artery and prestenting for percutaneous pulmonary valve implantation with dilation of the left pulmonary artery (LPA). After implanting bare metal stents, it is common practice, whilst contemplating the diameters of the adjacent structures, to optimize the stent diameter in a two-step procedure and dilate the stent until a maximum diameter is achieved and there is no residual gradient after applying this technique. Four of our patients experienced hoarseness after the intervention and a vocal cord paralysis was diagnosed. Angiography revealed no signs of extravasation or dissection. Clinical symptoms improved over the course of the following 6 months; patients with interventions at the aortic arch showed a complete remission, patients with procedures involving the LPA showed only mild regression of the symptoms.

**Conclusion:** To our knowledge, this complication (Ortner-Syndrome, cardiovocal syndrome) after such interventions has rarely been reported before. Although a rare complication, the recognition of these symptoms may support colleagues in managing affected patients. In addition, awareness for hoarseness after interventional therapies and systematic screening for this complication might help to identify patients at risk in the future.

1. Introduction
The Ortner-Syndrome, also known as cardio-vocal syndrome, is defined as a vocal cord paralysis caused by palsy of the left recurrent nerve due to pressure applied on the nerve by enlarged cardiovascular structures [1]. Vocal cord paralysis is also a well-documented complication in patients undergoing cardiothoracic surgery, especially after median sternotomy or left sided thoracotomy [2]. First described by Norbert Ortner 1897 while treating a patient with stenosis of the mitral valve and dilation of the left atrium [1], there have been many studies and case reports since then, connecting the cardio-vocal syndrome to other cardiovascular pathologies and iatrogenic complications [2-4].

Interventional treatment of the coarctation of the aorta (CoA), the stenosis of pulmonary arteries as well as the right ventricular outflow tract (RVOT) pathologies is established for many years and commonly used for native as well for reoccurring pathologies after surgical or interventional treatment [5-7].

The most common side effects of this treatment’s modality include vascular complications at the side of the catheter entry as well as early and late complications at the site of the pathology.

The anatomic pathway followed by the left recurrent laryngeal nerve – i.e. a sling around the aortic arch behind the ligamentum arteriosum - makes it prone to damage when operated in this area [8, 9].

2. Patients and Methods

Between 1994 and 2020 four patients with a congenital heart disease (CHD) received interventional treatment for re-coarctation of the aorta or stenosis of the left pulmonary artery (LPA) in three German departments for pediatric cardiology [table1]. Post-
interventional clinical signs of a laryngeal nerve palsy led to endoscopic ENT examination validating the diagnosis of left vocal cord paralysis.

We performed a systematic review of the databases of PubMed up to March 29, 2022, for the following medical subject heading terms and free-text terms individually or in combination: “Ortner Syndrome” or “cardiovocal syndrome” or “laryngeal nerve palsy” and “cardiothoracic surgery” or “stent placement” or “balloon angioplasty” or “congenital heart disease” or “aortic arch” or “patent ductus arteriosus” and “Case Reports” or “study” or “trial” or “outcome”. The cases were independently extracted by 2 reviewers without any discrepancies. Articles were excluded if they concerned treatment of the head-neck-vessels or if they did not provide sufficient clinical details.

3. Results
The interventions – stent implantation, stent dilatation, balloon-angioplasty, percutaneous pulmonary valve intervention - were uneventful and technically successful in all four patients. No patient died. Postinterventional angiography showed no extravasation and hemodynamics confirmed no residual gradients or valve regurgitations in all patients. All four patients were discharged from the hospital within one week. The mean follow-up was 18 months. Until now, echocardiography confirms successful interventions. The two patients undergoing procedures involving the LPA still show persistent symptoms of vocal cord dysfunction, the other two with procedures at the aortic arch are in full remission.

Most of the studies and reports documenting the cardio-vocal syndrome focus either on pathologies of the cardiovascular system or post-surgical complications [1-4, 10-25]. Studies connecting the paralysis to interventional procedures concentrate mostly on
interventional closure of the patent arterial duct, but in general, this complication is only rarely reported after interventional therapy. A detailed survey of the published literature on cardio-vocal syndrome after endovascular intervention is documented in table 2.

4. Discussion

Recurrent laryngeal nerve injury is a known complication after cardiothoracic surgery and clinically suspected when postoperative hoarseness develops. A paper from García-Torres et al. documented retrospectively a cardio-vocal syndrome in 25 out of 206 patients (12.1%) after undergoing aortic arch repair, patent ductus arteriosus ligation and left pulmonary artery surgeries [4]. A report from Kaushal et al. reports a temporary recurrent laryngeal nerve paresis in 6 out of 201 patients (3%) after extended end-to-end anastomosis for coarctation repair [11]. The fact, that the paresis is only temporary might indicate, that surgical interruption of the nerve is rare and other reasons like mechanical alteration due to compression, traction, tension, or thermal stress during preparation might induce temporary injuries. A study by Forbes et al. reported 1 out of 72 patients with vocal cord paralysis after surgery for aortic coarctation (approximately 1.4%) [23] and a study by van Son et al. noted 1 out of 52 patients with this complication after a surgical coarctation repair (approximately 1.9%) [24]. The incidence might even be higher in the management of recurrent stenosis, i.e., surgical treatment of recurring coarctation of the aorta through a left thoracotomy: In a review Massey and Shore report of a study in which 6 out of 65 patients developed a laryngeal nerve palsy, 5 in the group undergoing reoperation [25]. Other studies do not mention this complication, either because the incidence is too low or because awareness is missing [39-41].
In an elaborate meta-analysis of the literature concerning the unilateral vocal cord paralysis following cardiothoracic surgery of congenital heart defects, Strychowsky et al. reviewed the results of thirty-two studies (n = 5625 patients). Of all the patients included, 10% underwent a postoperative assessment of their vocal cords’ function. Among all studies, the weighted pooled proportion of unilateral vocal cord palsy was 9.3% [2]. Just in 11 of those studies (n = 584 patients) the vocal cords of all patients were assessed postoperatively, revealing a unilateral paralysis at 29.8%.

In general, mechanical injury of the recurrent laryngeal nerve during interventional treatment of congenital heart defects is only rarely reported. Based on the named anatomy and the surrounding structures, interventions that can possibly affect the recurrent laryngeal nerve include interventions at the aortic arch and isthmus as well as the arterial duct (PDA) and the distal main pulmonary artery or the origin of the left and right pulmonary arteries. It may be postulated that any intervention in this area leading to an alteration of the integrity or structure by the implantation of a device may cause injury of the recurrent nerve by applying mechanical force like pressure or tension to the surrounding tissue or the nerve or by hematoma.

There are some reports supporting this theory: Kobayashi et al. reported one case where left recurrent laryngeal nerve palsy occurs secondary to left pulmonary artery stent in a child [32]. The patient did not recover from vocal cord paralysis demonstrated by direct laryngoscopy 21 months after the procedure. The authors claim that vocal cord paralysis is due to compression of the left recurrent laryngeal nerve between the left pulmonary artery and the aortic arch while being held in place by the ligamentum arteriosum.

A different case report by Assaqqat et al. could correlate stent placement in the left pulmonary artery in conjunction with coil placement in the arterial duct to paralysis of
the left recurrent laryngeal nerve [35]. Hoarseness was detected the second day after intervention and paralysis persisted longer than 6 months, demonstrated by repeated indirect laryngoscopy showing persistent paralysis of the left vocal cord. As coils usually are not very big structures, additional edema caused by an inflammatory process, or a possible hematoma may have influenced this event.

Finally, vocal cord paralysis after Gianturco coil embolization of the patent duct was studied in a paper by Liang et al. who found this complication in 3 out of 75 patients in this retrospective study. [35] All patients with vocal cord paresis were <1 year old. The patients with vocal cord paresis had a longer ductus length and a smaller ductus compared to the patients without vocal cord paresis. The authors speculate, that tense stretching, and angulation of the ductus leads to compression injury of the recurrent laryngeal nerve. Two of the three patients had normal phonation without hoarseness after 1-year of follow-up.

In a multi-center study published 2022, Shahrer et al. report of recurrent laryngeal nerve injury following left pulmonary artery placement (6 out of 1337 patients), PDA device closure (two out of 4001 patients) as well as the two procedures combined (4 out of 26 patients). It is intriguing that also in this study, 92% of the patients showed resolution of symptoms; the only persistent vocal cord paralysis was observed at one patient who underwent LPA stent placement [26].

Dalili et al. reported of interventional PDA closure by using radiofrequency ablation. In 2 out of 6 patients, a transient vocal cord palsy was detected. This high incidence can be interpreted that the electric current leads to a direct thermal injury of the adjunct tissue including the recurrent nerve [27].
To the best of our knowledge, this complication has rarely been reported for the interventional treatment of aortic coarctation. We presume that the incidence of this pathophysiology is low as studies on interventional treatment of this pathology with stent angioplasty do not list this complication; except in one case report by Fürniss et al. [28].

The COAST study included 105 patients in a multicenter study receiving a CP stent for coarctation of the aorta, no vocal cord paresis was reported [8]. Sadiq et al. reports 56 patients who received covered stents for coarctation treatment, no vocal cord paresis was reported [30]. The study of Hamdan et al. included 34 patients, 33 received a stent for coarctation, no vocal cord paresis was reported [36]. Tzifa et al. implanted covered CP stents for coarctation of the aorta in 30 patients, no vocal cord paresis was reported [33].

In our four cases presented above, stent dilatation resulted in an adequate increase of the diameter of the re-coarctation as well as the left pulmonary artery. As three out of four patients had multiple surgeries before, adhesions may have formed in the perivascular tissue. We postulate, that the dilation of the stent has distended the surrounding tissue including the recurrent laryngeal nerve leading to subsequent loss of function. We can however not exclude an additional tissue hematoma even though none of the cases demonstrated any extravasation of contrast following any of the interventions.

3.1. Limitations

There are several limitations to our review. First, we cannot accurately ascertain the prevalence of an post-interventional Ornter-syndrome since most of the cardiological centers do not systematically screen for laryngeal nerve lesions after an intervention or even surgery. Second, in many cases there was no follow-up to assess the grade of the
palsy. Third, the low numbers of cases and potential selection bias (often premature newborns or patients with redo surgery) limits our ability to make definitive claims regarding the risk of a cardiovocal-syndrome. Despite these limitations, our systematic review is, to our knowledge, the first to summarize the relevant clinical data from all cases in the peer-reviewed literature and present cases after several interventional procedures so as to better inform clinicians and increase awareness of this problem.

4. Conclusion
We document three patients with left vocal cord paralysis after stent dilatation for treating a re-coarctation of the aorta or a stenosis of the left pulmonary artery as well as one patient receiving a percutaneous pulmonary valve implantation with LPA-stent dilation, an entity that has previously rarely been reported. This might reflect the low incidence of Ortner’s syndrome as a complication after catheter interventions, but it can also be seen as the result of poor screening to assess mild irritations of the vocal cord function after intervention. However, awareness for signs of vocal cord palsy such as hoarseness after interventional therapies and systematic screening for this complication might help to identify patients at risk. Interestingly, the paralysis following interventions on the LPA seems to show permanent symptoms compared to that cause after interventions concerning the aortic arch. In many cases reported, the clinical signs improve or even resolve over time, and this can be communicated to the patients affected.

5. References


[27] Dalili M., Rao J., Meraji M. Ductal closure with radiofrequency energy; outcomes of the first series. Indian Heart Journal, Volume 72, Issue 6, 2020, Pages 606-609, ISSN 0019-4832


<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Number of patients</th>
<th>Pathology</th>
<th>Intervention</th>
<th>outcome</th>
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<td>Shahrier et al.</td>
<td>2022 [26]</td>
<td>6/1337</td>
<td>PDA</td>
<td>LPA stent placement</td>
<td>11 complete remission</td>
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<td></td>
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<td>2/4001</td>
<td>LPA stenosis</td>
<td>PDA device closure</td>
<td>1 persistent symptoms</td>
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<td></td>
<td></td>
<td>4/26</td>
<td>PDA+LPA stenosis</td>
<td>Both procedures</td>
<td>(LPA stenosis group)</td>
</tr>
<tr>
<td>Dalili et al.</td>
<td>2020 [27]</td>
<td>2</td>
<td>PDA</td>
<td>PDA radiofrequency ablation</td>
<td>Complete remission</td>
</tr>
<tr>
<td>Fürniss et al.</td>
<td>2019 [28]</td>
<td>1</td>
<td>CoA</td>
<td>Stent implantation</td>
<td>Complete remission</td>
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<td>Tanidir et al.</td>
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<td>1</td>
<td>PDA</td>
<td>PDA closure with ADO plug</td>
<td>Persistent symptoms</td>
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<td>Ringel et al.</td>
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<td>Kobayashi et al.</td>
<td>2012 [32]</td>
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<td>LPA stenosis</td>
<td>LPA stenting</td>
<td>Persistent symptoms</td>
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<tr>
<td>Tzifa et al.</td>
<td>2006 [33]</td>
<td>0/30</td>
<td>CoA</td>
<td>Stent placement</td>
<td>-</td>
</tr>
<tr>
<td>Assaqqat et al.</td>
<td>2005 [34]</td>
<td>1</td>
<td>PDA</td>
<td>PDA occlusion with coil</td>
<td>Persistent symptoms</td>
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<tr>
<td>Study</td>
<td>Year [Ref]</td>
<td>PDA Coils</td>
<td>Procedure</td>
<td>Results</td>
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<td>Liang et al.</td>
<td>2003 [35]</td>
<td>3/18</td>
<td>PDA</td>
<td>PDA coil embolization</td>
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<td></td>
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<td>2 complete remission</td>
<td></td>
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<td></td>
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<td>1 persistent symptoms</td>
<td></td>
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<tr>
<td>Hamdan et al.</td>
<td>2001 [36]</td>
<td>0/33</td>
<td>CoA</td>
<td>Stent placement</td>
<td></td>
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<td>LeBlanc et al.</td>
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<td>PDA</td>
<td>transcatheter coil occlusion</td>
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<td>Hawkins et al.</td>
<td>1996 [38]</td>
<td>0/20</td>
<td>PDA</td>
<td>transcatheter coil occlusion</td>
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PDA: patent ductus arteriosus, LPA left pulmonary artery, CoA coarctation of the aorta
<table>
<thead>
<tr>
<th></th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
<th>Case D</th>
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<td><strong>sex</strong></td>
<td>female</td>
<td>male</td>
<td>male</td>
<td>female</td>
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<td>Critical CoA</td>
<td>CoA</td>
<td>Hypoplastic left arterial pulmonary system</td>
<td>LPA-coarctation</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>moderate PV stenosis</td>
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<td></td>
<td></td>
<td></td>
<td>moderate TV regurgitation</td>
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<td></td>
<td></td>
<td></td>
<td>ASD II</td>
<td></td>
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<td><strong>Primary treatment</strong></td>
<td>End-to-end anastomosis</td>
<td>End-to-end anastomosis</td>
<td>Balloon-valvuloplasty of PV</td>
<td>Balloon-angioplasty</td>
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<tr>
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<td>(14mm Tyshak II Balloon)</td>
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<td></td>
<td></td>
<td>and stent-angioplasty of the LPA (26mm EV3 IntraStent LD Max, final minimal diameter 14mm)</td>
</tr>
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<td><strong>Secondary diagnosis</strong></td>
<td>-</td>
<td>α1-antitrypsin deficit</td>
<td>Mosaic monosomy 18</td>
<td>CCM1 gene mutation</td>
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<td>(homozygote, PiZZ-mutation)</td>
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<td></td>
<td>COPD (GOLD IV)</td>
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<td><strong>Further operations / interventions</strong></td>
<td>Extended end-to-end anastomosis with left subclavian artery flap due to re-CoA</td>
<td>Extended end-to-end anastomosis due to re-CoA with left heart failure</td>
<td>Balloon-valvuloplasty of PV due to reoccurring stenosis</td>
<td>-</td>
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<td>Reconstruction of TV, patch-closure of the ASD, commissurotomy of PV, patch-plastic of the LPA due to combined pulmonary stenosis and regurgitation</td>
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<td>Stent angioplasty of the LPA due to severe stenosis with progressive PV regurgitation</td>
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<td><strong>Intervention</strong></td>
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<td>4,5cm CP stent</td>
<td>Pre-stenting of the</td>
<td>Primary treatment</td>
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</table>
leading to VCP from 12 to 17mm due to hemodynamically significant restenosis [figure 1a-c]

implantation due to re-re-CoA (final diameter 17mm) [figure2a,b]

RVOT, transcatheter pulmonary valve implantation (26mm Edwards Sapien) and re-dilation of the LPA due to progressive pulmonary regurgitation with right heart failure

<table>
<thead>
<tr>
<th>Course of VCP</th>
<th>Complete remission after 6 months</th>
<th>Complete remission after 10 months</th>
<th>Persistent after three years</th>
<th>Regressive but persistent after four months</th>
</tr>
</thead>
</table>

CoA coarctation of the aorta, LPA left pulmonary artery, ASD II ostium secundum atrial septal defect, PV pulmonary valve, TV tricuspid valve, COPD chronic obstructive pulmonary disease