



Transient Recurrent Laryngeal Nerve Palsy after Interventional Therapy

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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 re-coarctation, re-dilatation of a stented coarctation, a primary stenting of the left pulmonary artery (LPA), and pre-stenting for percutaneous pulmonary valve implantation with dilation of the 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's 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.

Keywords

- cardiovocal syndrome
- stent placement
- laryngeal nerve palsy
- pediatric

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Introduction

The Ortner's syndrome, also known as cardiovocal 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 in 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 cardiovocal 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 pathologies is established for many years and commonly used for native as well as 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}

Patients and Methods

Between 1994 and 2020, four patients with a congenital heart disease received interventional treatment for re-CoA or stenosis of the left pulmonary artery (LPA) in three German departments for pediatric cardiology (►Table 1). Postinterventional clinical signs of a laryngeal nerve palsy led to endoscopic ENT (ear, nose, and throat) 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 two 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.

Results

The interventions—stent implantation, stent dilatation, balloon angioplasty, and 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 1 week. The mean follow-up was 18 months. Until now, echocardiography has confirmed 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 cardiovocal syndrome focus either on pathologies of the cardiovascular system or postsurgical 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 cardiovocal syndrome after endovascular intervention is documented in ►Table 2.

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 cardiovocal syndrome in 25 out of 206 patients (12.1%) after undergoing aortic arch repair, patent ductus arteriosus (PDA) ligation, and LPA surgeries.⁴ A report from Kaushal et al documented 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 CoA through a left thoracotomy: in a review, Massey and Shore report on 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 32 studies ($n=5,625$ 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

Table 1 Patients' history and interventional treatment data

	Case A	Case B	Case C	Case D
Sex	Female	Male	Male	Female
Primary diagnosis	Critical CoA	CoA	Hypoplastic left arterial pulmonary system Moderate PV stenosis Moderate TV regurgitation ASD II	LPA-coarctation
Primary treatment	End-to-end anastomosis	End-to-end anastomosis	Balloon-valvuloplasty of PV	Balloon-angioplasty (14 mm Tyshak II Balloon) and stent-angioplasty of the LPA (26 mm EV3 IntraStent LD Max, final minimal diameter 14 mm)
Secondary diagnosis	–	α1-antitrypsin deficit (homozygote, PIZZ-mutation) COPD (GOLD IV)	Mosaic monosomy ¹⁸	CCM1 gene mutation
Further operations/ interventions	Extended end-to-end anastomosis with left subclavian artery flap due to re-CoA Palmaz Genesis stent (PG1910P) implantation due to re-re-CoA stent re-dilation 6 months later due to pressure difference >20 mmHg between the upper and lower extremity	Extended end-to-end anastomosis due to re-CoA with left heart failure	Balloon-valvuloplasty of PV due to reoccurring stenosis Reconstruction of TV, patch-closure of the ASD, commissurotomy of PV, patch-plastic of the LPA due to combined pulmonary stenosis and regurgitation Stent angioplasty of the LPA due to severe stenosis with progressive PV regurgitation	–
Intervention leading to vocal cord paralysis (VCP)	Stent re-dilation from 12 to 17 mm due to hemodynamically significant re-stenosis (► Fig. 1a–c)	4.5 cm CP stent implantation due to re-re-CoA (final diameter 17 mm) (► Fig. 2a, b)	Prestenting of the RVOT, transcatheter pulmonary valve implantation (26 mm Edwards Sapien) and re-dilation of the LPA due to progressive pulmonary regurgitation with right heart failure	Primary treatment
Course of VCP	Complete remission after 6 months	Complete remission after 10 months	Persistent after 3 years	Regressive but persistent after 4 months

Abbreviations: ASD II, ostium secundum atrial septal defect; CoA, coarctation of the aorta; COPD, chronic obstructive pulmonary disease; LPA, left pulmonary artery; PV, pulmonary valve; RVOT, right ventricular outflow tract; TV, tricuspid valve.

Table 2 Published literature of laryngeal nerve palsy following catheter interventions

Author	Year	Number of patients	Pathology	Intervention	Outcome
Shahrier et al	2022 ²⁶	6/1,337 2/4,001 4/26	PDA LPA stenosis PDA + LPA stenosis	LPA stent placement PDA device closure Both procedures	11 complete remissions 1 persistent symptom (LPA stenosis group)
Dalili et al	2020 ²⁷	2	PDA	PDA radiofrequency ablation	Complete remission
Fürniss et al	2019 ²⁸	1	CoA	Stent implantation	Complete remission
Tanidir et al	2019 ²⁹	1	PDA	PDA closure with ADO plug	Persistent symptoms
Sadiq et al	2013 ³⁰	0/56	CoA	Stent placement	–
Ringel et al	2013 ³¹	0/105	CoA	Stent placement	–
Kobayashi et al	2012 ³²	1	LPA stenosis	LPA stenting	Persistent symptoms
Tzifa et al	2006 ³³	0/30	CoA	Stent placement	–
Assaqqat et al	2003 ³⁴	1	PDA LPA stenosis ASD II mild Ebstein's	PDA occlusion with coil LPA stenting ASD device occlusion	Persistent symptoms
Liang et al	2003 ³⁵	3/18	PDA	PDA coil embolization	2 complete remissions 1 persistent symptom
Hamdan et al	2001 ³⁶	0/33	CoA	Stent placement	–
LeBlanc et al	2000 ³⁷	0/30	PDA	Transcatheter coil occlusion	–
Hawkins et al	1996 ³⁸	0/20	PDA	Transcatheter coil occlusion	–

Abbreviations: ASD, atrial septal defect; CoA, coarctation of the aorta; LPA, left pulmonary artery; PDA, patent ductus arteriosus.

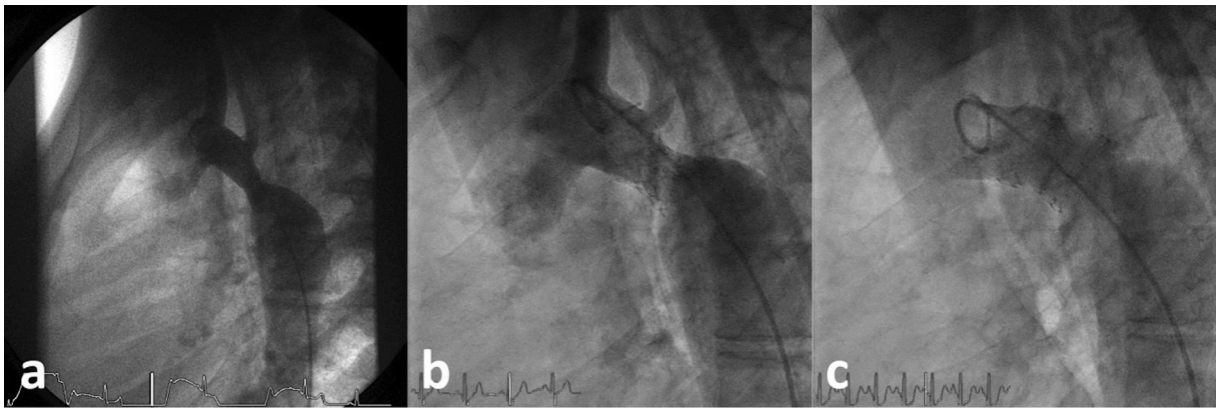


Fig. 1 Angiographies of Patient A. (a) There is a significant re-coarctation after the second surgery at the age of 17. The minimal diameter is 9 mm; systolic pressure gradient under general anesthesia is 40 mmHg (angiography of the aorta, lateral view). (b) Immediately before the re-dilatation of the 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).

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 LPA 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 LPA 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 LPA in conjunction with coil

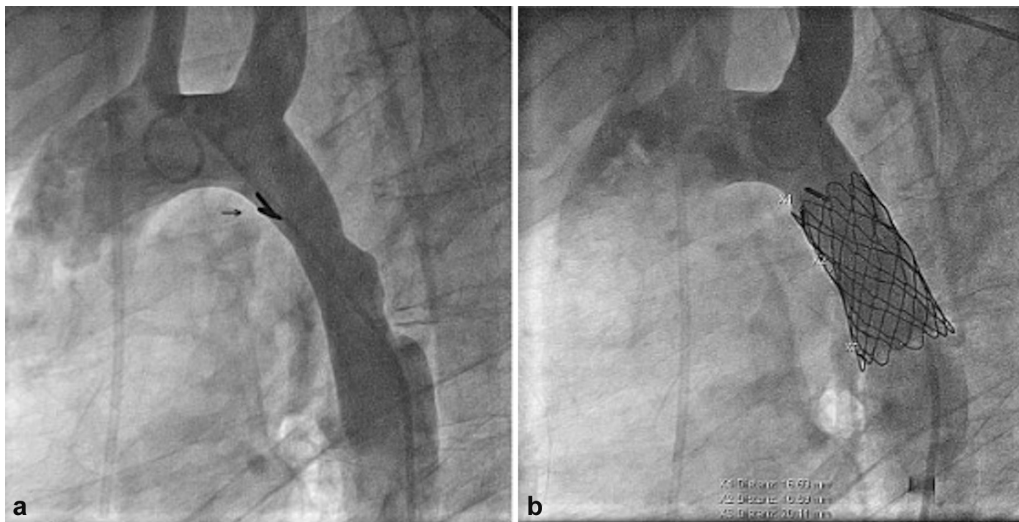


Fig. 2 Angiographies of Patient B. (a) Re-coarctation after two-time resection and end-to-end anastomosis. → PDA-Clip (angiography of the aorta, lateral view). (b) After implantation of a 4.5 cm CP Stent, the stent was dilated to a diameter of 17 mm, with the diameter of the transverse arch measuring at 17 mm and that of the descending aorta at 21 mm (angiography of the aorta, lateral view).

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 lead 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 multicenter study published in 2022, Shahrier et al report on recurrent laryngeal nerve injury following LPA placement (6 out of 1,337 patients), PDA device closure (2 out of 4,001 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 in one patient who underwent LPA stent placement.²⁶

Dalili et al reported on interventional PDA closure by using radiofrequency ablation. In two out of six patients, a transient vocal cord palsy was detected. This high incidence can be interpreted that the eclectic 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 CoA, and no vocal cord paresis was reported.⁸ Sadiq et al report 56 patients who received covered stents for coarctation treatment, and no vocal cord paresis was reported.³⁰ The study of Hamdan et al included 34 patients, 33 received a stent for coarctation, and no vocal cord paresis was reported.³⁶ Tzifa et al implanted covered CP stents for CoA in 30 patients, and 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 LPA. 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.

Limitations

There are several limitations to our review. First, we cannot accurately ascertain the prevalence of a postinterventional Ortner's 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) limit 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.

Conclusion

We document three patients with left vocal cord paralysis after stent dilatation for treating a re-CoA or a stenosis of the LPA 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.

Conflict of Interest

None declared.

References

- Ortner N. Recurrent laryngeal nerve paralysis due to mitral valve stenosis. *Wien Klin Wochenschr* 1897;10:753–755
- Strychowsky JE, Rukholm G, Gupta MK, Reid D. Unilateral vocal fold paralysis after congenital cardiothoracic surgery: a meta-analysis. *Pediatrics* 2014;133(06):e1708–e1723
- Stocker HH, Enterline HT. Cardio-vocal syndrome: laryngeal paralysis in intrinsic heart disease. *Am Heart J* 1958;56(01):51–59
- García-Torres E, Antón-Pacheco JL, Luna-Paredes MC, et al. Vocal cord paralysis after cardiovascular surgery in children: incidence, risk factors and diagnostic options. *Eur J Cardiothorac Surg* 2020;57(02):359–365
- Haas NA, Rickers C, Kozlik-Feldmann R, Cesnjevar R. Leitlinie Pädiatrische Kardiologie: Aortenisthmusstenose. DGPK; 2018. Accessed January 10, 2023 at: https://www.dgpk.org/fileadmin/user_upload/Leitlinien/2018_06_20_LL_Aortenisthmusstenose.doc.pdf
- Bertram H, Schneider M, Horke A. Krankheitsbezeichnung: Periphere Pulmonalarterienstenosen. DGPK; 2018. Accessed January 10, 2023 at: https://www.dgpk.org/fileadmin/user_upload/Leitlinien/peripherePst17_02_18.pdf
- Jux C, Weil J, Oberhoffer R, Bennink G. Leitlinie Pädiatrische Kardiologie: Valvuläre Pulmonalstenose. DGPK; 2017. Accessed January 10, 2023 at: https://www.dgpk.org/fileadmin/user_upload/Leitlinien/LL_valvPstnachVSS.pdf
- Pesti V. 2019. Nervus laryngeus recurrens anatomy and pathology [WWW Document]. ECR 2019 EPOS Accessed on January 16, 2023 at <https://epos.mysr.org/poster/esr/ecr2019/C-2121>
- Condon LM, Katkov H, Singh A, Helseth HK. Cardiovascular syndrome in infancy. *Pediatrics* 1985;76(01):22–25
- Fan LL, Campbell DN, Clarke DR, Washington RL, Fix EJ, White CW. Paralyzed left vocal cord associated with ligation of patent ductus arteriosus. *J Thorac Cardiovasc Surg* 1989;98(04):611–613
- Tammiraju I, Radha Krishna T, Vittal Prasad P, Jagadish Babu K. Ortner's syndrome (cardio vocal hoarseness) – a rare entity in modern era. A case report. *IJH Cardiovas Case Rep (CVCR)* 2018;2(02):82–84
- Subramaniam V, Herle A, Mohammed N, Thahir M. Ortner's syndrome: case series and literature review. *Rev Bras Otorrinolaringol (Engl Ed)* 2011;77(05):559–562
- Henry BM, Hsieh WC, Sanna B, Vikse J, Tattera D, Tomaszewski KA. Incidence, risk factors, and comorbidities of vocal cord paralysis after surgical closure of a patent ductus arteriosus: a meta-analysis. *Pediatr Cardiol* 2019;40(01):116–125
- Al Kindi AH, Al Kindi FA, Al Abri QS, Al Kemyani NA. Ortner's syndrome: cardiovascular syndrome caused by aortic arch pseudoaneurysm. *J Saudi Heart Assoc* 2016;28(04):266–269
- Kaushal S, Backer CL, Patel JN, et al. Coarctation of the aorta: midterm outcomes of resection with extended end-to-end anastomosis. *Ann Thorac Surg* 2009;88(06):1932–1938
- Hörmann M, Pavlidis D, Brunkwall J, Gawenda M. Long-term results of endovascular aortic repair for thoracic pseudoaneurysms after previous surgical coarctation repair. *Interact Cardiovasc Thorac Surg* 2011;13(04):401–404
- Lew WK, Patel K, Haqqani OP, Weaver FA. Endovascular management of hoarseness due to a thoracic aneurysm: case report and review of the literature. *Vasc Endovascular Surg* 2009;43(02):195–198
- Morales JP, Chan YC, Bell RE, Reidy JF, Taylor PR. Endoluminal repair of distal aortic arch aneurysms causing aorto-vocal syndrome. *Int J Clin Pract* 2008;62(10):1511–1514
- Wang JY, Chen H, Su X, Zhang ZP. Aortic dissection manifesting as dysphagia and hoarseness: Ortner's syndrome. *Am J Emerg Med* 2016;34(06):1185.e1–1185.e3
- Azuma S, Shimada R, Motohashi Y, Yoshii Y. 2022. Postoperative results of the in situ fenestrated open stent technique for acute aortic dissection type A. *Gen Thorac Cardiovasc Surg* Accessed on January 18, 2023 at <https://doi.org/10.1007/s11748-022-01878-4>
- Matteucci MLS, Rescigno G, Capestro F, Torracca L. Aortic arch patch aortoplasty for Ortner's syndrome in the age of endovascular stented grafts. *Tex Heart Inst J* 2012;39(03):401–404
- Stoob K, Alkadhi H, Wildermuth S, Lachat M, Pfammatter T. 2004. Resolution of Hoarseness after Endovascular Repair of Thoracic Aortic Aneurysm: A Case of Ortner's Syndrome. *Ann Otol Rhinol Laryngol* 113:43–45. Available at: <https://doi.org/10.1177/000348940411300109>
- Forbes TJ, Kim DW, Du W, et al; CCISC Investigators. Comparison of surgical, stent, and balloon angioplasty treatment of native coarctation of the aorta: an observational study by the CCISC (Congenital Cardiovascular Interventional Study Consortium). *J Am Coll Cardiol* 2011;58(25):2664–2674
- Van Son JA, Mohr FW, Hess H, Hamsch J, Haas GS. Early repair of coarctation of the aorta. *Ann Thorac Cardiovasc Surg* 1999;5(04):237–244
- Massey R, Shore DF. Surgery for complex coarctation of the aorta. *Int J Cardiol* 2004;97(Suppl 1):67–73
- Shahrier AZ, Chinchilli VM, Qureshi AM, et al. The incidence of recurrent laryngeal nerve injury resulting in vocal cord paralysis following interventional congenital catheterisation procedures. *Cardiol Young* 2022;32(12):1952–1956
- Dalili M, Rao JY, Meraji M. Ductal closure with radiofrequency energy; outcomes of the first series. *Indian Heart J* 2020;72(06):606–609
- Fürniss HE, Hummel J, Stiller B, Grohmann J. Left recurrent laryngeal nerve palsy following aortic arch stenting: a case report. *World J Cardiol* 2019;11(12):316–321
- Tanidir IC, Yükcü B, Öztürk E, Güzeltaş A. Vocal cord paralysis after transcatheter patent ductus arteriosus closure with AMPLAT-ZERTM Vascular Plug II. *Anatol J Cardiol* 2019;21(06):345–346
- Sadiq M, Ur Rehman A, Qureshi AU, Qureshi SA. Covered stents in the management of native coarctation of the aorta—intermediate and long-term follow-up. *Catheter Cardiovasc Interv* 2013;82(04):511–518
- Ringel RE, Vincent J, Jenkins KJ, et al. Acute outcome of stent therapy for coarctation of the aorta: results of the coarctation of the aorta stent trial. *Catheter Cardiovasc Interv* 2013;82(04):503–510

- 32 Kobayashi D, Turner DR, Humes RA. Left recurrent laryngeal nerve palsy secondary to left pulmonary artery stent in a child. *Catheter Cardiovasc Interv* 2012;80(03):482–484
- 33 Tzifa A, Ewert P, Brzezinska-Rajszyz G, et al. Covered Cheatham-platinum stents for aortic coarctation: early and intermediate-term results. *J Am Coll Cardiol* 2006;47(07):1457–1463
- 34 Assaqqat M, Siblini G, Fadley FA. Hoarseness after pulmonary arterial stenting and occlusion of the arterial duct. *Cardiol Young* 2003;13(03):302–304
- 35 Liang CD, Ko SF, Huang SC, Huang CF, Niu CK. Vocal cord paralysis after transcatheter coil embolization of patent ductus arteriosus. *Am Heart J* 2003;146(02):367–371
- 36 Hamdan MA, Maheshwari S, Fahey JT, Hellenbrand WE. Endovascular stents for coarctation of the aorta: initial results and intermediate-term follow-up. *J Am Coll Cardiol* 2001;38(05):1518–1523
- 37 LeBlanc JG, Russell JL, Sett SS, Potts JE, Human DG, Culham JA. The evolution of ductus arteriosus treatment. *Int Surg* 2000;85(01):1–5
- 38 Hawkins JA, Minich LL, Tani LY, Sturtevant JE, Orsmond GS, McGough EC. Cost and efficacy of surgical ligation versus transcatheter coil occlusion of patent ductus arteriosus. *J Thorac Cardiovasc Surg* 1996;112(06):1634–1638, discussion 1638–1639
- 39 Cowley CG, Orsmond GS, Feola P, McQuillan L, Shaddy RE. Long-term, randomized comparison of balloon angioplasty and surgery for native coarctation of the aorta in childhood. *Circulation* 2005;111(25):3453–3456
- 40 Chiu HH, Chiu SN, Hu FC, et al. Late cardiovascular complications after surgical or balloon angioplasty of coarctation of aorta in an Asian cohort. *Am J Cardiol* 2009;104(08):1139–1144
- 41 Früh S, Knirsch W, Dodge-Khatami A, Dave H, Prêtre R, Kretschmar O. Comparison of surgical and interventional therapy of native and recurrent aortic coarctation regarding different age groups during childhood. *Eur J Cardiothorac Surg* 2011;39(06):898–904