We detected no interference with the atrioventricular valves, and the patient maintained sinus rhythm. The device eliminated the left-to-right transatrial shunt, and the coronary veins continued to drain into the left atrium (the coronary sinus remained unroofed). The right ventricular enlargement gradually regressed during follow-up, and the device remained in the correct position after 6 months.

Unroofed coronary sinus accounts for less than 1% of ASDs.[1] The condition can occur alone or together with other cardiac defects such as persistent left superior vena cava (LSVC), tricuspid atresia, and some forms of heterotaxy.[1–5]

Kirklin and Barratt-Boyes proposed an anatomical classification of unroofed coronary sinus, which is still in use. Types I and II denote complete unroofed coronary sinus, either with (type I) or without (type II) persistent LSVC; types III and IV are partial forms in which the coronary sinus is unroofed in the midportion or terminal portion, respectively.[2] The case described here is an example of type II unroofed coronary sinus, occurring with dilatation of the coronary sinus ostium.

Although most children with unroofed coronary sinus are asymptomatic, it is important to diagnose this ASD because of its possible long-term complications. These complications include cyanosis due to right-to-left shunting, pulmonary hypertension, brain abscess, and paradoxical embolism.[1–5]

Percutaneous closure of unroofed coronary sinus is a valid alternative to surgery, first described in 2003.[4,6] Since then, a handful of articles have reported percutaneous closure of unroofed coronary sinus with a covered stent or the Amplatzer septal occluder.[5,6] Closure with a stent carries a risk of obstructing coronary venous drainage.[6] Moreover, since the patient described here had a completely unroofed coronary sinus without LSVC, stent closure was not an option due to the lack of anchorage sites. We therefore opted for closure of the coronary sinus ostium with a percutaneously placed device, despite the small left-to-right short circuit inherent to this procedure due to the direct drainage of the coronary veins into the left atrium, which causes a slight desaturation.

Although surgery continues to be the treatment of choice for the closure of coronary sinus ASDs, the percutaneous approach is developing rapidly. In specific cases, this approach provides a valid, safe, and less invasive alternative.

APPENDIX. SUPPLEMENTARY DATA

Supplementary data associated with this article can be found in the online version, at https://doi.org/10.1016/j.rec.2019.03.014.

Marc Figueras-Coll,[a,*] Anna Sabaté-Rotés,[b] Gemma Giralt-Garcia,[b] Gerard Martí-Aguasca,[a,c] and Pedro Betrián-Blasco[a]

[a]*Unidad de Hemodinámica Pediátrica, Servicio de Cardiología Pediátrica, Hospital Universitario Vall d'Hebron, Barcelona, Spain*
[b]*Servicio de Cardiología Pediátrica, Hospital Universitario Vall d'Hebron, Barcelona, Spain*
[c]*Unidad de Hemodinámica, Servicio de Cardiología, Hospital Universitario Vall d'Hebron, Barcelona, Spain*

* Corresponding author:
E-mail address: mfiguerascoll@gmail.com (M. Figueras-Coll).

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Transcatheter Mitral Valve Repair: Single Stage Combo Approach

Reparación mitral percutánea: abordaje combinado en procedimiento único

To the Editor,

Mitral regurgitation (MR) is one of the major valvular diseases. Surgical mitral valve (MV) repair is the standard of care for patients with severe degenerative MR due to prolapse or flail of a valve leaflet. Surgical MV repair is performed combining ring annuloplasty with leaflet and chordal repair as necessary.

Within the growing era of percutaneous treatments for valvular heart disease, the echo-guided NeoChord MV repair procedure (NeoChord, Inc, St Louis Park, MN, USA) has demonstrated early safety and efficacy outcomes in a selected group of patients with posterior MV prolapse/flail not requiring an adjunctive annuloplasty.[1]

Recent analyses have provided more insights into patient selection for the NeoChord procedure, finding precise morphological and echocardiographic criteria.[1,2] In particular, the leaflet-to-annulus index (LAI), which precisely defines those patients who do not have a leaflet-to-annulus mismatch and who for this reason could benefit of an isolated leaflet therapy without concomitant annuloplasty.

The LAI is defined as the ratio between the sum of anterior mitral leaflet length (AML) and posterior mitral leaflet length (PML) over the anteroposterior diameter (AP) of the MV annulus (AP; AML + PML/AP). The LAI was a positive postoperative predictor of MR $\leq$ mild at 1-year of follow-up once it was superior to 1.2.[2]

Moreover, the estimated coaptation length (CL) index has been recently introduced as an additional tool to estimate the potential postoperative leaflet CL.[3] The CL index is defined according to the following formula: [(AML + PML)-AP]/2]. Postoperative CL is a predictive factor for durable MV repair when it is longer than 6 mm.[4]

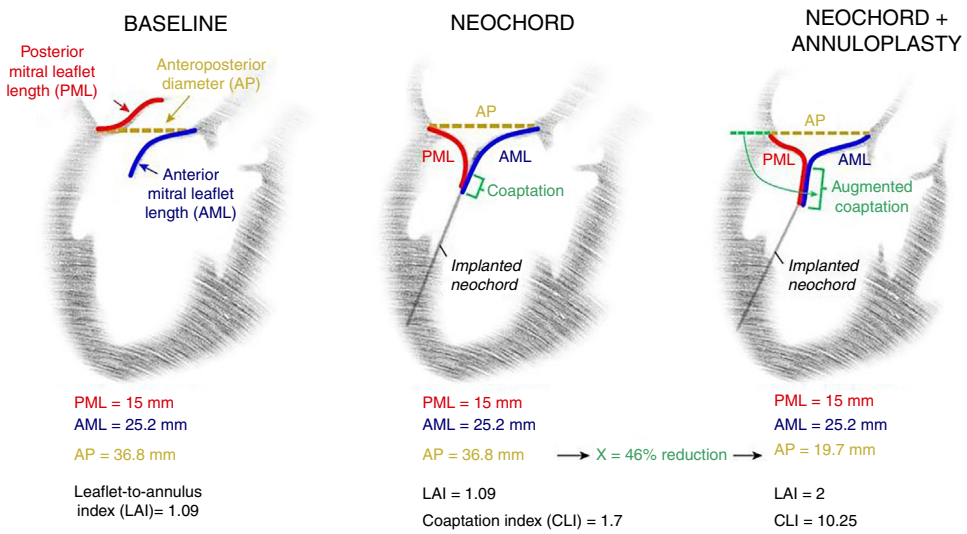

Figure 1. Schematic representation of a treated patient showing the heart in an echocardiographic long-axis view, after only leaflet treatment with NeoChord implantation and after combination of NeoChord and direct annuloplasty procedures. AML, anterior mitral leaflet length; AP, anteroposterior diameter; CLI, coaptation index; LAI, leaflet-to-annulus index; PML, posterior mitral leaflet.

On the basis of these assumptions, we proposed to use the combination of the validated LAI and CL index formulas to discriminate between patients who benefit from a ringless NeoChord procedure alone because the predicted final CL will be adequate to gain an effective and durable result and those who require an adjunctive annular therapy to reduce the AP diameter, resulting in an improvement of the CL (figure 1).

Transcatheter annuloplasty procedures have also been demonstrated to be safe and effective in reducing AP annulus diameter. Transcatheter annuloplasty can be performed with devices acting directly or indirectly on the MV annulus.

Indirect annuloplasty through the coronary sinus (Carillon Mitral contour system, Cardiac Dimensions, Kirkland, USA) is recommended when the preoperative computed tomography scan shows a correct alignment and closed continuity between the coronary sinus and the MV annulus.

Direct annuloplasty can be performed using the Cardioband system (Edwards Lifesciences, Irvine, CA, USA). It is advisable not to have annular calcifications and proximity of the circumflex artery. Both devices can achieve an AP diameter reduction of 20% to 45%.[5]

Six patients considered not suitable for conventional MV repair based on their specific characteristics by the local Heart Team (table 1) were treated with single-stage transcatheter annular and leaflet therapies. All patients had an advanced-stage degenerative MV pathology with the presence of leaflet flail and concomitant annular dilatation. All patients underwent leaflet treatment with NeoChord implantation with a mean number of 3 chordae and concomitant annuloplasty procedure implanting the Cardioband device in 2 patients (video 1 of the supplementary data, transesophageal echocardiogram showing baseline condition, implantation of the Cardioband followed by implantation of the NeoChord with maximum cinching of the annuloplasty device), and the Carillon in 4 patients (video 2 of the supplementary data, transesophageal echocardiogram showing baseline condition, implantation of the Carillon followed by implantation of NeoChord). In a single NeoChord plus Cardioband case, a commissural MitraClip (Abbott, Menlo Park, CL, USA) was also implanted at the end of the procedure to treat a residual mild MR due to a commissural prolapse. This resulted in trace MR as the final outcome. The decision process for selecting the annuloplasty device was tailored based on the integration of the patient's anatomical and echocardiographic data (MV annulus and leaflet measurements, presence/absence of annular calcifications, location of the coronary sinus, and circumflex artery).

In all patients, we implanted the annuloplasty device first, observing an immediate reduction in the MR but with persistent leaflet flail requiring additional leaflet therapy to reduce its height and generating stable coaptation. All procedures were successful with minimal residual MR (table 1). All patients showed an echocardiographically effective AP reduction with consequent postoperative increase in the LAI and CL index. All patients achieved the 30-day follow-up with residual MR $<$ mild and New York Heart Association class I.

This article describes the initial clinical experience of the application of a new single-stage combined transcatheter approach to treat patients presenting advanced-stage degenerative MV disease with the concomitant combination of transcatheter annular and leaflet therapies. This surgical-like transcatheter MV repair was safe, feasible, and effective in treating a specific subset of highly selected patients. It is important to highlight that the decision-making algorithm derives from the knowledge acquired in the field of surgical MV repair over the last 50 years of practice after demonstration that those concepts provided excellent results. The present toolbox concept of transcatheter MV devices to treat MV leaflet and annulus represents the contemporary evolution of the wide variety of surgical techniques described and used by surgeons to perform MV repair. Future clinical studies will be required to further validate this surgical-like single stage transcatheter MV repair COMBO approach.

Table 1
Preoperative and postoperative characteristics of the patients treated with COMBO mitral valve repair procedures

Patient number	1	2	3	4	5	6
PROCEDURES	Carillon + NeoChord	Carillon + NeoChord	Carillon + NeoChord	Carillon + NeoChord	Cardioband + Neochord + Mitraclip	Cardioband + NeoChord
Baseline Characteristics						
Sex, male	1	1	1	1	1	1
Age	75	82	78	73	70	60
STS score valve repair						
Mortality, %	1.27	2.65	1.86	6.10	0.80	1.59
Morbidity, %	13.81	20.68	18.28	38.19	9.99	14.83
Comorbidities						
CAD	2 VD	0	3 VD	1 VD	0	3 VD
Previous MI	0	0	0	1	0	1
Previous PCI	1	0	0	1	0	1
Previous heart surgery	0	0	CABG + AVR	0	0	CABG
Previous TAVI	0	0	0	0	0	0
Systolic pulmonary artery pressure, mmHg	45	50	40	30	30	50
COPD	0	0	0	0	0	0
AF	1	0	1	1	0	0
Past CVA	0	0	1	0	0	0
Chronic renal failure (GFR < 60mL/min)	52	50	66	28	61	95
NYHA						
II	0	0	0	0	0	0
III	1	1	1	1	1	1
IV	0	0	0	0	0	0
Hospital admission for HF (number of times before admission for treatment)	0	1	1	1	0	2
LVEF	50	50	60	20	65	30
Preoperative Echocardiography						
IC, mm	48.3	41.7	45.4	44.0	48.0	45.7
AP, mm	38.8	38.4	35.1	35.3	38.6	36.8
AML, mm	23.0	24.0	22.9	18.0	19.0	25.2
PML, mm	16.3	20.3	9.3	10.0	21.0	15.0
EROA, cm^2	0.6	0.5	0.6	0.7	0.7	0.7
R Vol, mL	85.4	69.4	88.5	125.0	88.2	58.0
LAI	1.0	1.15	0.91	0.8	1.03	1.09
CI, mm	0.25	2.95	−1.45	−7	0.7	1.7
Postoperative Echocardiography						
IC, mm	30.9	31.3	33.2	25.7	34.3	19.3
AP, mm	28.1	23.9	25.7	25.3	27.1	19.7
EROA, cm^2	0.04	0.08	0.01	0.04	0.01	0.02
R Vol, mL	6.3	10.3	1.6	8.3	1.6	2.1
LAI	1.4	1.8	1.25	1.1	1.5	2.0
CI, mm	5.65	10.1	3.25	2.7	6.5	10.25
IC postoperative reduction, %	36	25	27	42	28	58
AP postoperative reduction, %	28	38	28	31	30	46

AF, atrial fibrillation; AML, anterior mitral leaflet length; AP, anteroposterior mitral annulus diameter; AVR, aortic valve replacement; CABG, coronary artery bypass graft; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; CI, coaptation length Index; EROA, effective regurgitant orifice area; GFR, glomerular filtration rate; HF, Heart Failure; IC, intercommissural diameter; LVEF, left ventricle ejection fraction; LAI, leaflet-to-annulus index; MI, myocardial infarction; NYHA, New York heart Association; PCI, percutaneous coronary intervention; PML, posterior mitral leaflet length; R vol, regurgitant volume; TAVI, transcatheter aortic valve implantation; VD, vessel disease.

DISCLOSURES

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CONFLICTS OF INTEREST

A. Colli received travel grants from NeoChord, Inc. A. Beiras-Fernández was a proctor for NeoChord, Inc. S. von Bardeleben received travel grants from NeoChord, Inc, Edwards Lifesciences and Cardiac Dimensions.

The other authors have nothing to disclose.

APPENDIX. SUPPLEMENTARY DATA

Supplementary data associated with this article can be found in the online version, at https://doi.org/10.1016/j.rec.2019.04.003.

Andrea Colli,[a,◇,*] Andres Beiras-Fernández,[b] Tobias Ruf,[c] Christian-Friedrich Vahl,[b] Thomas Munzel,[c] and Ralph Stephan Von Bardeleben[b,◇]

[a]*Cardiac Surgery Unit, Department of Cardiac, Thoracic, and Vascular Sciences, University of Padua, Padua, Italy*
[b]*Department of Heart Surgery, Heart Center Mainz, University Medicine Mainz, Germany*
[c]*Department of Cardiology I, Heart Center Mainz, University Medicine Mainz, Germany*

[*] Corresponding author:
E-mail address: colli.andrea.bcn@gmail.com (A. Colli).
[◇]These authors equally contributed to the manuscript.

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Use of MitraClip in the Percutaneous Treatment of Severe Mitral Regurgitation in Heart Transplant Recipients

Implante de MitraClip en el tratamiento percutáneo de la insuficiencia mitral grave en pacientes con trasplante cardiaco

To the Editor,

The onset of mitral regurgitation (MR) after heart transplant (HT) is uncommon, but not rare, and appears in around 6% of cases. The condition has been associated with graft vascular disease and heart failure, and it has also been linked to increased mortality[1] in these patients. Traditional therapeutic options have been medical treatment and surgery, with the latter often posing a very high risk due to comorbidities, functional status, and the need for a new sternotomy. The MitraClip implant (Abbott Vascular, Menlo Park, California, United States) is a percutaneous alternative for which some scientific evidence is available.[2,3] This technique may be useful in transplant recipients in whom further surgery would represent a high risk, although there is a paucity of published reports.[4–6]

We describe 2 patients with severe MR following HT who underwent MitraClip implantation. Surgery for MR had been ruled out in these patients, and both had clear worsening of their functional class related to MR.

The first patient was a 64-year-old man with a Killip IV acute myocardial infarction in 1993 who required emergency HT using the Lower and Shumway biatrial suture technique, with very good clinical progress. In 2012 (19 years post-HT), echocardiography revealed severe MR, which subsequently remained stable with medical therapy until 2018 (25 years post-HT), when he required multiple hospitalizations due to decompensated heart failure and pleural effusion. Echocardiography showed severe (grade III-IV) MR in relation to mitral valve prolapse, predominantly of leaflets A2 and A3, with normal coaptation and cusp mobility, a regurgitant orifice of 0.89 cm^2, ejection fraction of 64%, and a nondilated left ventricle.

The second patient was a 57-year-old man who underwent HT in 2003 with the bicaval atrial suture technique due to dilated cardiomyopathy of ischemic etiology. The patient had several episodes of acute cell rejection in 2006, 2007, and 2008 that were resolved with corticosteroid treatment. He experienced progressive development of graft vascular disease, leading to a loss of ventricular function and requiring the implantation of multiple drug-eluting stents in the anterior descending, obtuse marginal, and right coronary arteries. He also had complete atrioventricular