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Surgery in patients with stents. New challenges in congenital heart disease

Cirugía sobre stents. *Nuevos retos en cardiopatías congénitas*

To the Editor,

Percutaneous interventions for the treatment of congenital heart disease are constantly improving.[1] As surgeons we must be familiar with the advances in this technology for 2 reasons:

- The approach to certain heart diseases has changed, particularly complex defects, which require staged percutaneous intervention and surgery.
- We will come across stents in the operating room; we must therefore learn how to deal with them and establish patterns or protocols to follow.

We present a series of 105 patients enrolled over 7 consecutive years (2013-2019) in whom previously implanted stents were manipulated during surgery. A previous study[2] reviewed the few publications on stents in tetralogy of Fallot,[3] patent ductus arteriosis,[4] and pulmonary arteries.[5]

In total, 131 stents were manipulated (table 1) in the following positions: 18 in ductus arteriosus, 34 in the right ventricular outflow tract, 11 in atrial septal defect, 14 in the right pulmonary artery (RPA), 36 in the left pulmonary artery, 7 in the superior vena cava, 7 in the inferior vena cava, 2 in the ascending aorta, and 2 in the left atrium (figure 1). The surgical procedures performed in the 105 patients (table 1) were as follows: 25 transplants, 13 Fontan procedures, 7 Glenn procedures, 2 comprehensive repairs (Norwood + Glenn), 2 Glenn take-downs, 23 conduit replacements (between the right ventricle and the pulmonary arteries), 11 Fallot repairs, 6 Rastelli procedures, 1 Ross-Konno procedure, 1 Yasui procedure (Norwood + Rastelli) and 14 others. Forty-seven of the patients had univentricular physiology.

Depending on the anatomical location, the stents were ligated externally (ductal clip) and partially removed (longitudinal opening and/or trimming the edge) or completely removed (after blunt dissection of the underlying structures). The criteria for partial or complete removal was based on the fragility/consistency of the stented vessel (pulmonary branches, right ventricle) and the surgeon's judgement (according to their experience). In addition, any additional unplanned procedures were also recorded, such as the use of deep hypothermic circulatory arrest (which increases surgical time and morbidity).

The most common anatomical locations stented were the left pulmonary artery and the right ventricular outflow tract. Together these represented two thirds (66%) of all stents. Transplants, conduit replacements and univentricular surgery together made up 80% of the main diagnoses. Unsurprisingly, these were all reinterventions (in some cases, multiple interventions were performed) and in children undergoing staged surgery and percutaneous procedures. Transplant surgery was where most double (or triple) stents were encountered (usually in the left pulmonary artery and superior or inferior vena cava).

The position of the device was not necessarily related to whether it was completely or partially removed. Paradoxically, a left pulmonary artery stent from a Glenn procedure can be cut to accommodate the suture in an extracardiac Fontan procedure (partial removal, easy), while the same patient would require complete removal of a stent in an identical position (plus pericardial patch enlargement of the pulmonary arteries) to allow a transplant to be performed (complete removal, difficult).

In the case of ductal stents, we should differentiate 2 groups: the 10 patients who ultimately would undergo Fallot or Rastelli procedure (external clip, simple procedure) and the other 8 with a hybrid procedure[6] and subsequent complex surgery (Norwood-Glenn, Ross-Konno, Yasui, transplant).

Table 1
Stent locations and surgical procedures

Stent locations	n = 131
Left pulmonary artery	36
Right ventricular outflow tract	34
Ductus	18
Right pulmonary artery	14
Atrial septum	11
Superior vena cava	7
Inferior vena cava	7
Ascending aorta	2
Left atrium	2
Interventions performed	n = 105
Transplant	25
Conduit replacement	23
Fontan	13
Fallot	11
Bidirectional Glenn	7
Rastelli	6
Glenn take-down	2
Norwood-Glenn (comprehensive)	2
Ross-Konno	1
Norwood-Rastelli (Yasui)	1
Other	14

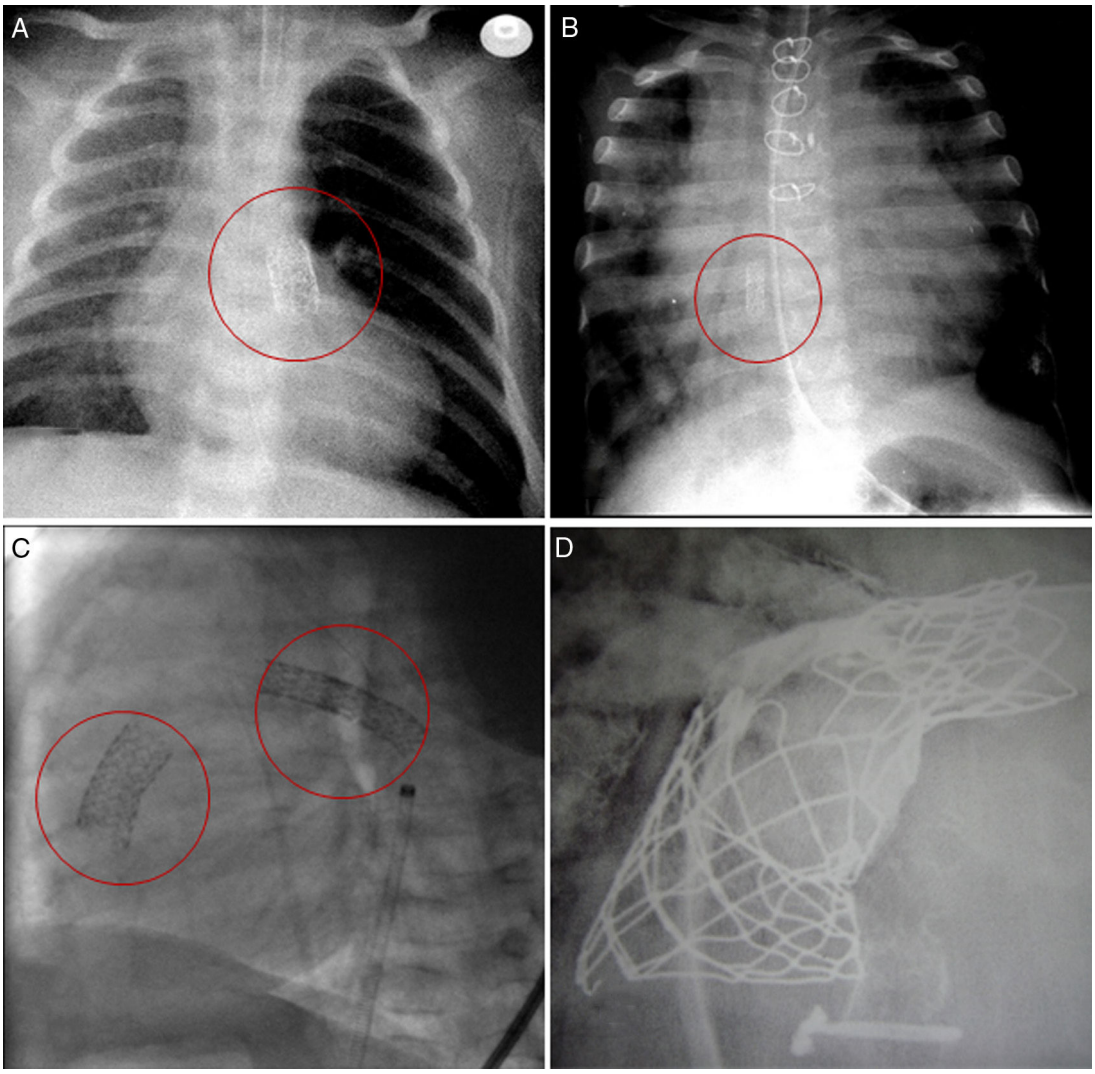

Figure 1. Postoperative X-rays showing the stents (circles). A: right ventricular outflow tract. B: atrial septum. C: right ventricular outflow tract and ductus. D: valved conduit in the pulmonary trunk and left pulmonary artery (2 overlapping stents).

Almost half of the patients who underwent surgery in our series had univentricular surgery, in various stages, transplant surgery being the archetypal procedure, involving reinterventions, previous catheterization, univentricular physiology, etc. Surgical planning allows surgeons to anticipate periods of deep hypothermic circulatory arrest if there are 1 or more stents in various positions.

As interventional cardiologists and cardiac surgeons, we must expand our horizons. The challenges we face with more complex patients (multiple surgeries and interventions) provides an opportunity to modify surgical times, offering surgery or catheterization as an alternative or simultaneously (hybrid procedures). One point we can reflect on is that as surgeons we should learn to deal with previously implanted stents, and we can plan the surgical strategy according to the stent location and underlying diagnosis. A stent in a ductus is easy to retrieve in tetralogy of Fallot surgery but difficult to retrieve in a hybrid procedure; a device in the left pulmonary artery is easy to deal with in a conduit replacement but complex if performing a Fontan for subsequent transplant. The data analyzed in this study show us that complex heart defects (eg, reinterventions, univentricular heart, transplant) often involve intracardiac stents. As surgeons acquire experience in their management during subsequent surgery, interventionalists may be encouraged to offer stenting in future patients, either alone or combined with surgery (hybrid procedures). As both specialties evolve (interventional cardiology and cardiac surgery) we must constantly review our processes.

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Ductal stenting in congenital heart disease with duct dependent pulmonary blood flow

Stent ductal en cardiopatía congénita con flujo pulmonar dependiente del ductus

To the Editor,

Stenting of ductus arteriosus in patients with congenital heart disease and duct-dependent pulmonary flow has a long history and validated outcomes.[1,2]

Our objective was to retrospectively review our experience of this technique. We collected cases of patients born between January 2008 and July 2019, who had been discussed at medical-surgical meetings and referred for ductal stenting based on their underlying heart defect, comorbidities, and ductal anatomy. A total of 32 neonates were included.

Table 1 shows the patients' characteristics; the most common defect was pulmonary atresia with intact ventricular septum (PAIVS), with 7 cases.

We provided prostaglandin E_1 at the dose required to achieve preprocedure saturations of 70% to 75%. For patients with possibly transient (days to at least a week) duct dependence (such as PAIVS, pulmonary stenosis following valvuloplasty, or Ebstein anomaly), we waited 2 to 3 weeks before performing the procedure; in all other cases, it was performed within the first 7 to 10 days.

The location and characteristics of the ductus (eg, tortuosity or peripheral pulmonary stenosis) are prognostic factors for procedural success and duration,[3] allowing a distinction to be made between complex and relatively noncomplex (normally-positioned and straight) cases.

It is not uncommon to find peripheral pulmonary stenosis (25%) due to the presence of ductal tissue in the branches, which in severe cases requires the placement of longer stents to fully cover the ductus and also treat the peripheral stenosis.[4]

Table 2 provides information on the procedure and follow-up. The procedure was always carried out under general anesthetic. In normally-positioned ductus, access was usually via the femoral artery using a 4-Fr long sheath for implantation. In other locations, access was via the femoral vein with transcardiac passage of a 5–6-Fr guide catheter or a 4-Fr long sheath, plus access via the carotid artery with a 4-Fr short sheath. Fluoroscopy and procedure times decreased with experience, and are currently very short, especially in noncomplex ductus cases; the difference in times between complex and noncomplex cases was not statistically significant, due to the sample size.

Our patients required a median 13 hours' intubation and 3 days' stay in the ICU after the procedure.

The overall success rate was 94% but rose to 100% for cases after 2014. The unsuccessful cases (2/32) corresponded to the initial phase of the series and were due to lack of guidewire stability in complex cases.

The stents used were coronary stents, with a median 1 stent per patient; the last 8 stents implanted were drug-eluting stents to reduce neointimal growth.

Table 1
Patient characteristics

Sex	
Female	14
Male	18
Birth weight, g	3090 (1375-3870)
Gestational age, wk	38 (30-40)
Age at catheterization, d	15 (4-165)
Heart disease	
PAIVS	7
DORV+PS	6
TA	6
PA+IVC	6
PS	3
TA+PS	3
Ebstein anomaly	1
Previous procedures	
Rashkind	2
PVP	8
Shunt	1
Scheduling	
Elective	26
Urgent	6
Initial Nakata index	129 (82-168)
Ductus	
Position	
Transverse	15
Isthmus	13
Brachiocephalic trunk	3
Left subclavian	1
Morphology	
Tortuous	18
Straight	14
Length	15 mm (9-26)
Diameter, mm	
Maximum	3,50 (1–5.5)
Minimum	1 (0.2-3)
Peripheral pulmonary stenosis	8

DORV, double outlet right ventricle; IVC, interventricular communication; PA, pulmonary atresia; PAIVS, pulmonary atresia with intact ventricular septum; PS, pulmonary stenosis; PVP, pulmonary valvuloplasty/valvulotomy; TA, tricuspid atresia; TF, tetralogy of Fallot.
Values are expressed as absolute number of cases or median (range).