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# Contributions of Children's Hospital Ricardo Gutiérrez to Pediatric Cardiac Surgery

## *Aportes del Hospital de Niños Ricardo Gutiérrez a la cirugía cardíaca pediátrica*

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The Department of Cardiovascular Surgery was created by Dr. Eduardo Galíndez more than 50 years ago in the former children's hospital garden. It was the starting point for the opening of the Argentine Pediatric Cardiovascular School, which strengthened after the beginning of the residency program, in 1972. The first resident was Dr. Andrés Schlichter, who became part of a solid team of professionals for more than 42 years. Since then, internationally recognized contributions have been made at the Children's Hospital and Clínica Bazterrica. Those contributions will be presented here in chronological order, so as to appreciate how ideas were developed.

1. August, 1971. *An operation for the hemodynamic correction of tricuspid atresia: Presentation of the first successful case.* Fifth scientific meeting of the Argentine Society of Cardiology (August, 1971), (1) published later in the Journal of Thoracic and Cardiovascular Surgery (JTCVS): "An operation for the correction of tricuspid atresia". (2) This surgical procedure was carried out in July 1971, ignoring that Fontan had already published it (January, 1971). It was performed following a different hemodynamic principle than that of Fontan, who tried to "ventricularize" the right atrium performing a Glenn shunt (anastomosis of the superior vena cava [SVC] - pulmonary right branch), and using valve homografts at the right atrial inflow and outflow. Faced with a dying patient with type 1B tricuspid atresia and occluded Waterston anastomosis without apparent perfusion of the right lung, we were obliged, given the urgency, to operate with no time for prior experimental surgery. We had three options: a) to perform an atriopulmonary anastomosis (a surgical innovation), b) to enlarge the ventricular septal defect (VSD) to increase pulmonary flow, or c) to perform left subclavian-pulmonary artery anastomosis with extracorporeal circulation given the right bundle branch

block (a rarely used technique at that time). We chose the first option (Figure 1). Our concept, promoted by Dr. Alberto Rodríguez Coronel\*, was that end-diastole of the main ventricular chamber is the suction pump of the venous flow that allows the functioning of that univentricular heart. Furthermore, we presented the first patient with atrial fenestration worldwide. That year, in the same publication, (2) another original surgical variant was presented on the basis of previous studies by Dr. Luis Becú\*\*, who claimed that pulmonary valve is commonly normal in type 1B tricuspid atresia. Hence, following the suggestions of Donald Ross for pulmonary valve implantation in aortic position, the pulmonary annulus with its valve was removed from the right ventricle, and was anastomosed to the right appendage. This technique was praised by Sir Brian Barrat Boyes in "Hemodynamics following the Kreutzer procedure for tricuspid atresia in patients under two years of age". (3) In 1975, we operated a female patient following the first technique. Today, after the conversion to noncardiac conduit in 2006, the patient -currently 58 years of age- is the oldest survivor in the world leading a normal life with a total pulmonary ventricular bypass and 7 METs during

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\*Alberto Rodríguez Coronel, former SAC president, brilliant pediatric interventional cardiologist, upon his return after more than 5 years of living in the United States, introduced systematized scientific catheterization in Argentina. His clear concepts on catheterization have been of fundamental help in the development of Pediatric Cardiology and Cardiovascular Surgery.

\*\*Luis M. Becú (Argentine pathologist, who died in 1997). He made important contributions on congenital cardiac malformations, with ample worldwide impact. These contributions include the anatomical classification of ventricular septal defects based on the relationship with the crista supraventricularis (ventricular, supracristal or infracristal septal defects). This study was the result of his work at the Mayo Clinic, and was published in *Circulation* in 1956 (*Editor's Note*).

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<sup>3</sup> Senior member of The American Association for Thoracic Surgery

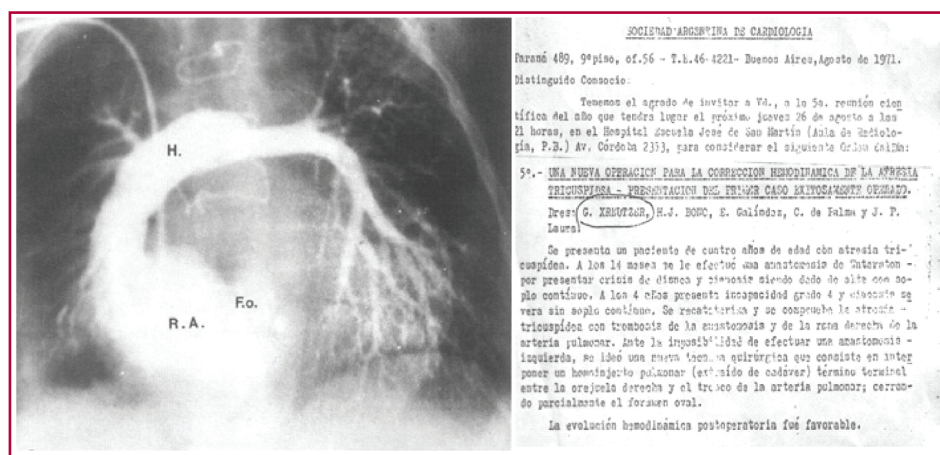
stress testing. (4)

In 1978, we innovated the technique by developing direct, posterior atriopulmonary anastomosis. In this technique, with single ventricles and normal position of the great arteries, the pulmonary trunk was sectioned (without the valve) and passed behind the aorta. Thus, the opening to the right pulmonary artery was enlarged and a wide anastomosis to the "roof" of the right atrium was performed, prior to the repair of intracardiac defects –if any– and partial closure of atrial septal defects (ASD) (fenestration). This technique was first introduced in 1980 in London during

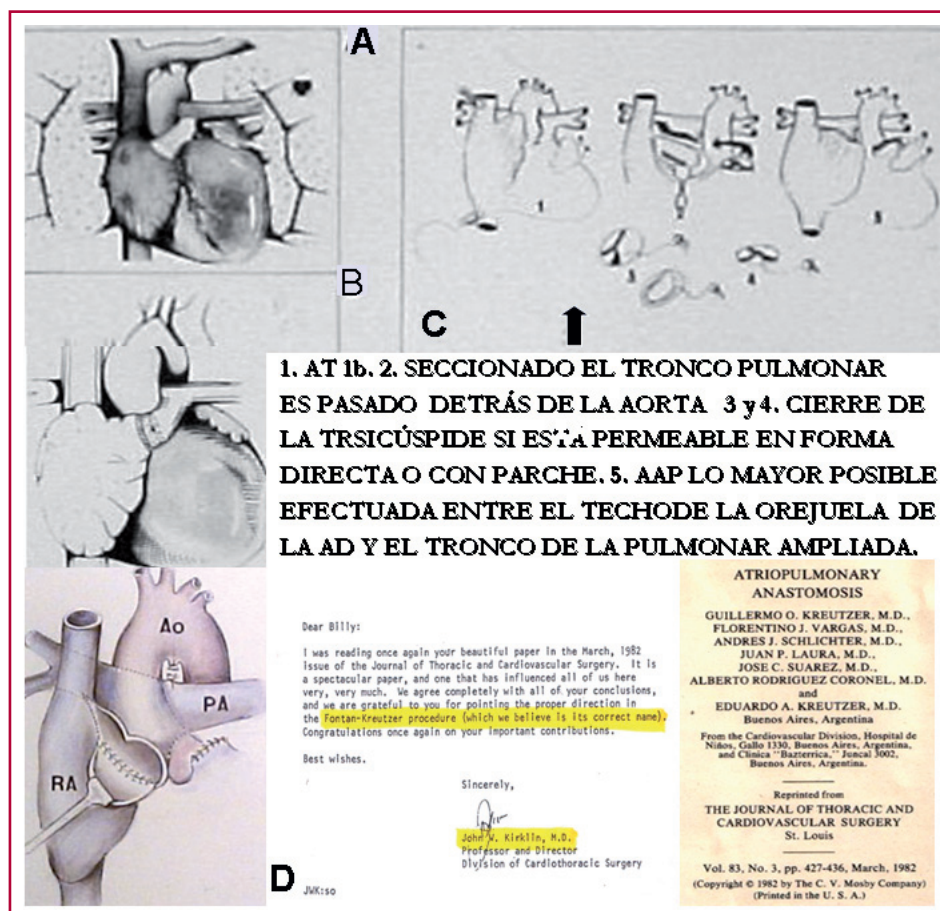
the 1st World Congress of Pediatric Cardiology (5) and later published in *Arquivos Brasileiros de Cardiologia* in 1981 (6) and in *JTCVS* in 1982 (7) (Figure 2). This work was praised by one of the fathers of cardiac surgery, Dr. J. W. Kirklin.

Since 1987, the atriopulmonary anastomosis procedure was surpassed by the lateral tunnel procedure (8) and by the extracardiac conduit, (9) as acknowledged in our work presented at the AATS meeting in Boston. (10)

2. In 1977, we performed the third worldwide anatomical correction with Jatene's technique for repair



**Fig. 1.** Right: Scientific proceedings of SAC meeting (1), August, 1971 Left: Angiocardiography [2] opacifying the right atrium (RA), pulmonary homograft (H) and fenestration (Fo).



**Fig. 2.** Development of atrio-pulmonary anastomosis (APA). **A.** Autograft between the right appendage and pulmonary trunk. [2] **B.** After removal of the valved pulmonary annulus, it is anastomosed to the right appendage. **C.** Posterior APA [7]: once the pulmonary trunk is transected, it is passed behind the aorta, and anastomosed to the roof of the RA. **D.** Dr. J. W. Kirklin's letter, praising this technique.



of transposition of the great vessels. The innovation in the work published by JTCVS (11) was the suggestion of using this procedure in transposed newborns without VSD, since ventricular hypertrophy is maintained by neonatal pulmonary hypertension. Nowadays, this is the technique of choice for the newborn with transposition of the great vessels (Figure 3).

3. In 1978, the *Annals for Thoracic Surgery* published the first international experience in tetralogy of Fallot with subpulmonary VSD. (12)

4. In 1978, the *Annals for Thoracic Surgery* published and labeled as “original technique” our proposal to repair the transposition of the great arteries with VSD and PS. (13) In this article, we proposed to avoid the AV block by placing a cross intracardiac patch from the inferior edge of the VSD, which –sutured to the superior edge of the ventriculotomy– occluded the pulmonary outflow tract. Then, a pericardial valved conduit was placed (14) between the outflow tract of the venous ventricle (anatomically on the left) and the pulmonary artery (PA). Thus, a diverticulum is closed within the systemic ventricle containing the conduction system, thus avoiding the AV block –common in the correction of this condition.

5. In 1985, the *Revista Latina de Cardiología y Cirugía Cardiovascular Infantil* [Latin American Journal of Pediatric Cardiology and Cardiovascular Surgery] published the original surgical technique of

the autologous pericardial valved conduit. (14) The long-term outcomes were published in the *Annals of Thoracic Surgery* (15) in 1996 and later the outcomes at 15 years in the *Pediatric Cardiac Surgery Annual of the Seminars in Thoracic and Cardiovascular Surgery* (16); and in 2000, in JTCVS (17) (Figure 4). This technique uses a conduit from the patient’s own tissue, with growth potential, which replaces the homograft implantation.

6. In 1985, JTCVS (18) published the original technique for the correction of the total anomalous pulmonary venous return in superior vena cava, performing a rerouting to the ASD, implanting the superior vena cava in the right appendage.

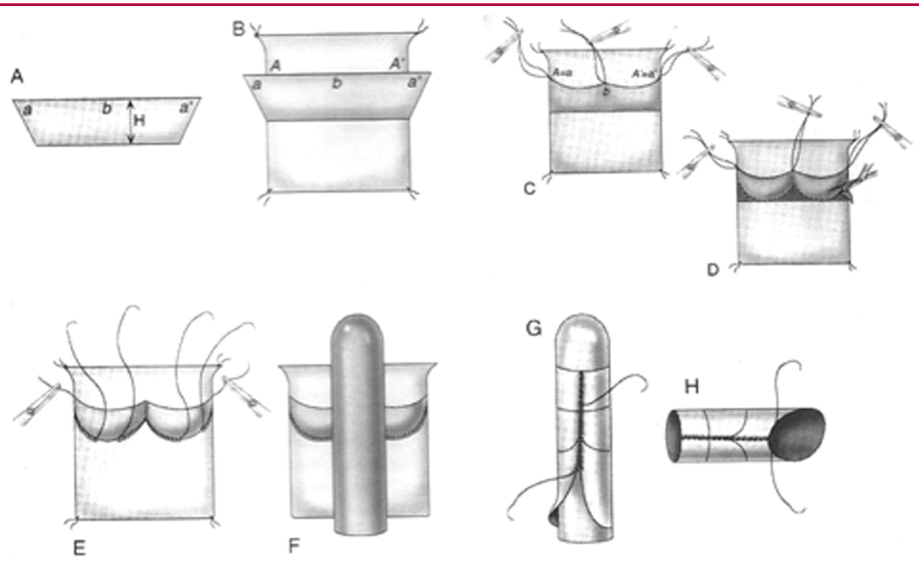
7. In 1997, the *Journal of Cardiac Surgery* (19) published the original technique for cavo atriopulmonary anastomosis via a nonprosthetic medial tunnel. The advantage consists in using autologous tissue, with interatrial intubation of the IVC to the old atrio-pulmonary anastomosis, performing a Glenn procedure –if it was not performed before.

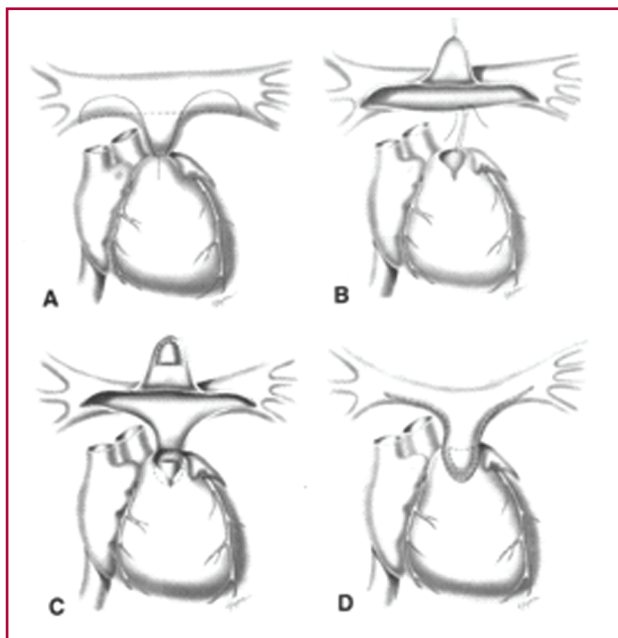
8. In 1996, JTCVS (20) published an original technique for the tetralogy of Fallot repair with agenesis of the pulmonary valve, modifying the relationship between the aneurysmally dilated pulmonary arteries and the bronchi, resecting the posterior wall of the pulmonary trunk, and anastomosing the anterior and posterior edges of the pulmonary branches to the up-

**Fig. 3.** First international suggestion [11] on the possibility of using the Jatene technique in newborns with transposition, taking advantage of the transient left ventricular hypertrophy due to neonatal pulmonary hypertension.

bly prove to be valid and long lasting. However, it is not clear whether or not those patients with an intact ventricular septum might be suitable candidates for the anatomic repair early in life, before the onset of significant atrophy of the left ventricle.

**Fig. 4.** Preparation of the autologous pericardial valved conduit. [14-16] On a large pericardial plaque, a pericardial trapezium is overlapped to become the future bicuspid valve. The conduit is then closed on a Hegar bougie according to the patient’s body surface area.





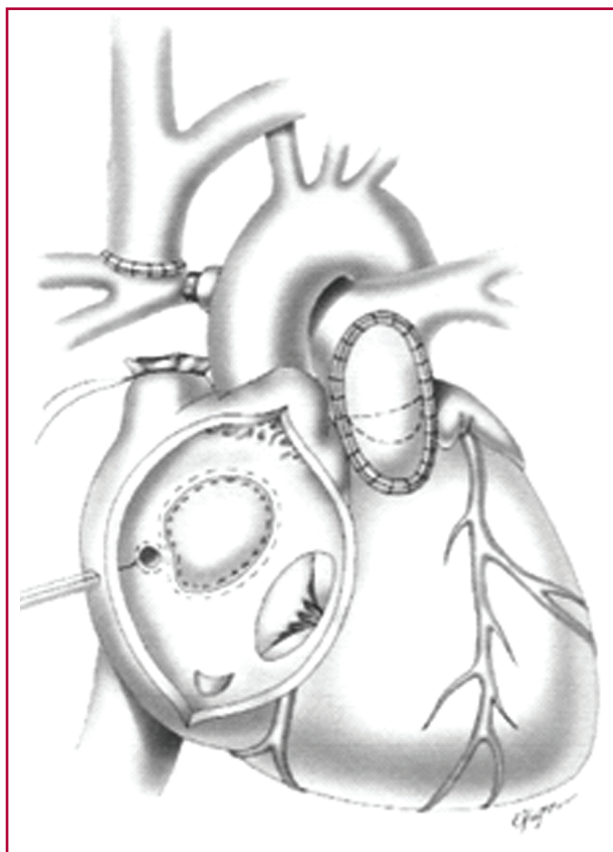
**Fig. 5.** Original technique for the tetralogy of Fallot repair with agenesis of the pulmonary valve. [20] The purpose of this technique is to modify the relation between the aneurismal pulmonary branches and the bronchi, turning the configuration of the pulmonary T into V.

per edge of the ventriculotomy. Thus, the pulmonary T becomes a V and modifies the relationship between the pulmonary branches and the bronchi in these patients, who often have severe bronchial disorders due to pulmonary branch aneurysms (Figure 5).

**9.** In 1999, JTCVS (21) published our experience in the one and a half ventricle correction in patients with right ventricular hypoplasia. When performing Glenn's surgery, we suggested doing a discrete cerclage in the origin of the right pulmonary branch to avoid Glenn reflux to the RV when placing a transannular patch that causes pulmonary failure (Figure 6).

**10.** In 2003, the *Annals of Thoracic Surgery* published "A new method for reliable fenestration in extracardiac conduit". (22) This simple fenestration technique (Figure 7) consists in suturing a pericardial "skirt" to the extracardiac conduit surrounding the fenestration. The "skirt" is then sutured to the atrial opening resulting from IVC removal. During the closure of the chest, the "skirt" is outlined with a prolene 0 suture that is left in the subcutaneous tissue for possible fenestration "garroting" and closure before patient discharge, if venous pressure is <14 mm Hg. A future occlusive device by catheterization can thus be avoided. It presents economic advantages, in addition to not placing a foreign body in a venous territory of slow, continuous flow.

**11.** In 2014, WJPCHS (23) published an original suggestion in which a 24 mm cerclage of the PA is performed in patients with tetralogy of Fallot, after transannular patch repair or autologous pericardial

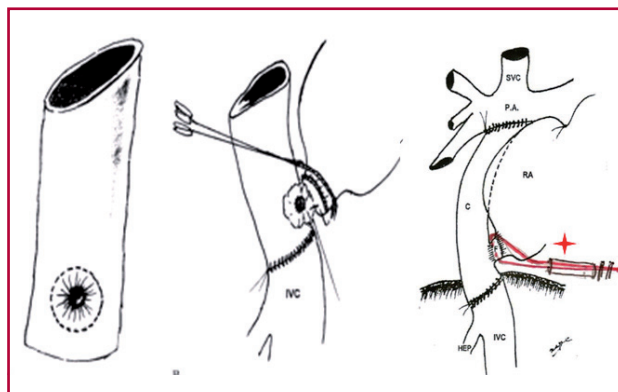


**Fig. 6.** A The Glenn procedure for one and half ventricle correction is recommended in cases of right ventricular hypoplasia. They usually require transannular patch due to small annulus. As innovation, a discrete cerclage [21] of the right pulmonary branch was suggested to avoid Glenn reflux to the right ventricle.

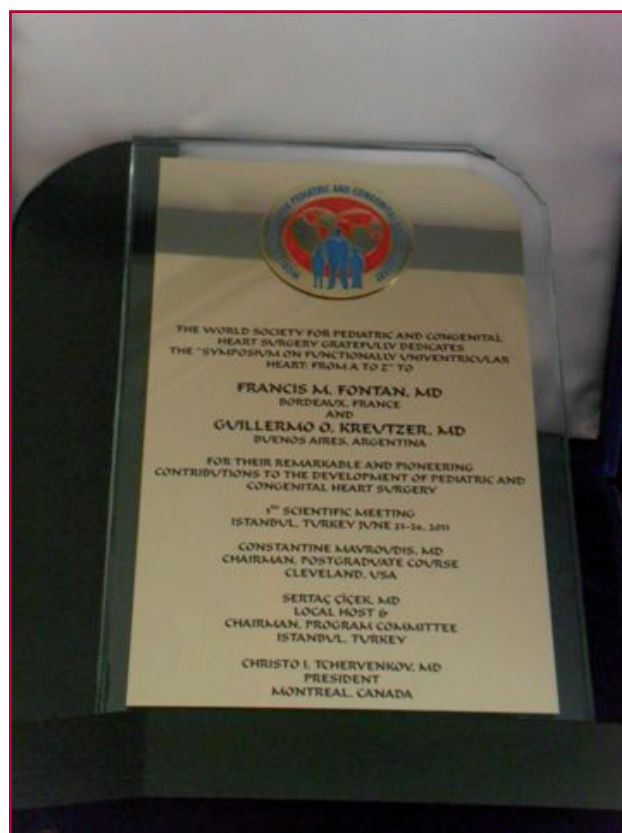
valved conduit. Cerclage is placed before closing the chest, fixed loosely with 4 stitches to the pulmonary annulus. The idea is that in the future, when patients develop pulmonary failure with impaired ventricular function (>160 cm<sup>3</sup> in the RV), it will permit the percutaneous insertion of a pulmonary valve anchored to the previous cerclage, thus avoiding reoperation.

**12.** The Department of Cardiovascular Surgery of the *Hospital de Niños* was honored by the *American Association for Thoracic Surgery* for granting the Graham Fellowship award to two of its former residents, Dr. José F. Vargas in 1984/5 and Dr. Christian Kreutzer in 1988/9. This award is granted annually to a single former resident of cardiovascular surgery worldwide, excluding the United States and Canada. They have been the only Argentine cardiovascular surgeons achieving such award.

**13.** In June 2011, during the World Congress of the World Society for Pediatric and Congenital Heart Surgery in Istanbul, prior to the Symposium of Functionally Univentricular Heart, Dr. Francis M. Fontan and Dr. Guillermo O. Kreutzer were honored for their remarkable contributions to the development of pediatric cardiac surgery (Figure 8).



**Fig. 7.** Patients with noncardiac conduit during a pulmonary ventricle bypass usually require fenestration to reduce venous pressure. This fenestration is then closed with a device, if hemodynamic conditions allow it. To avoid this foreign body, the fenestration is outlined with a suture [22] that is left in the subcutaneous tissue, and then is "garroted" with local anesthesia, if the venous pressure permits it.



**Fig. 8.** Award from the World Society for Pediatric and Congenital Heart Surgery on the occasion of the Third Scientific Meeting in June, 2011, in Istanbul to Dr. Francis M. Fontan and Guillermo Kreutzer for their remarkable contributions to pediatric cardiac surgery.

#### Conflicts of interest

None declared

(See author's conflicts of interest forms in the web / Supplementary Material)

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