Technique of interdigitating flaps for repair of abnormal origin of right pulmonary artery from ascending aorta

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Title: Technique of interdigitating flaps for repair of abnormal origin of right pulmonary artery from ascending aorta

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Keywords: Interdigitating flaps; right pulmonary artery; ascending aorta; LeCompte position; Hemitruncus

Word Count: 738
### Glossary of Abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AORPA</td>
<td>Abnormal origin of right pulmonary artery</td>
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<tr>
<td>RPA</td>
<td>Right pulmonary artery</td>
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</table>
Central Picture Legend:

Diagram of interdigitating pulmonary artery flap and aortic flaps in LeCompte position
Central Message:

The novel technique of interdigitating autologous great arterial flaps is an effective option in the surgical armamentarium for repair of abnormal origin of right pulmonary artery from ascending aorta.
Abstract:

Abnormal origin of right pulmonary artery from ascending aorta (Hemitruncus) is a very rare entity. Management includes surgical correction involving detachment of the right pulmonary artery from the ascending aorta and its implantation onto the main pulmonary artery.

We successfully employed a novel technique of implantation of the right pulmonary artery onto the main pulmonary artery, passing anterior to the ascending aorta. This includes interdigitating two aortic wall flaps on either side, with a pulmonary artery flap in the centre, forming the posterior 2/3rd of the anastomosis. The remainder of the reconstruction was completed by treated autologous pericardium.
Introduction:

Abnormal origin of right pulmonary artery (AORPA) from ascending aorta (right hemitruncus) is a rare congenital cardiovascular anomaly presenting in infancy with 70% first-year mortality if not operated. Early primary surgical repair is the treatment of choice with good outcomes. We describe a novel technique of interdigitating flaps of autologous great arterial walls to implant AORPA onto the main pulmonary artery.

Case Report:

The Institutional Ethics Committee of KLE Academy of Higher Education and Research approved this case report and waiver of patient consent was obtained (KAHER/EC/2023-24/D-12012401; Dated 12.01.2024).

A 27-day old male child, weighing 2.6 kg, with severe respiratory distress, was diagnosed with AORPA from ascending aorta, confirmed on contrast enhanced computerized tomography scan (Figure 1).

Surgical repair was performed through median sternotomy. The right pulmonary artery (RPA) (Figure 2A) and aorto-pulmonary groove were dissected, and both branch pulmonary arteries were looped. Cardiopulmonary bypass was established with aorto-bicaval cannulation. Cardioplegic cardiac arrest was achieved and transverse aortotomy was done just above the origin of RPA (Figure 2B). A transverse ring of ascending aortic wall was harvested adjoining the origin of RPA and the ring was divided exactly opposite to the origin to create two equal flaps of aortic wall. The aorta was reconstructed by direct anastomosis (Figure 2C, 2D).

Aortic flaps attached to the RPA origin were now slightly tilted to form an antero-superior (anterior) flap and a postero-inferior (posterior) flap. A transverse flap was incised on the anterior wall of main pulmonary artery like a trapdoor opening medially towards the RPA origin.
This pulmonary artery flap was sutured in-between the two aortic flaps, using 6-0 polypropylene continuous sutures, so that the great arterial wall flaps interdigitate amongst each other (Figure 2F). This formed the posterior 2/3rd of the RPA wall, anterior to the reconstructed ascending aorta. The anterior wall of RPA was reconstructed with treated autologous pericardium (Figure 2G, 2H).

The cardiopulmonary bypass was weaned off uneventfully and the patient was shifted out with closed chest. Heparin infusion was started 8 hours after surgery and antiplatelet therapy the next day. He was discharged on low-dose antiplatelet therapy. Postoperative and follow-up echocardiography showed good flow in RPA (Supplementary Figures 1 & 2).

Discussion:

Several surgical techniques have been described for repair of AORPA from ascending aorta\textsuperscript{2}. Posterior direct anastomosis and pericardial patch anteriorly (Technique III)\textsuperscript{2} always has a possibility of compression by ascending aorta from front. Technique IVA and IVB\textsuperscript{2} create aortic flaps and directly anastomose it to pulmonary artery with/without using pulmonary artery flap. These techniques are well described but it is not always possible to get a direct anastomosis without stretch or luminal compromise.

In our technique, the posterior 2/3rd or more of RPA anastomotic lumen is native tissue. This preserves its growth potential. As the flaps move towards each other, there is no stretch on the reconstructed anastomosis. Also, direct anastomosis of aorta behind the reconstructed RPA ensures that the ascending aorta is pushed posteriorly, avoiding compression on RPA.

There is always an option of using a prosthetic interposition graft\textsuperscript{4}, but at the cost of a definitive redo-surgery. Early direct anastomosis without use of any graft material has been recently reported with good outcomes\textsuperscript{5}. 
We manipulate the anterior flap to anterosuperior position, and the posterior flap to posteroinferior position, possibly causing a clockwise rotation of the RPA lumen to around 45 degrees. But we believe that as the rotation is distributed all along the length of RPA, it does not introduce significant obstruction. This is evident by laminar blood flow in RPA noted in immediate postoperative and follow-up echocardiography studies (Supplementary Figures 1 & 2). We recommend regular long-term follow-up imaging to ensure unobstructed flow in RPA.

We conclude that our novel technique of repairing AORPA from ascending aorta is simple, reproducible, and tension-free, preserving the future growth potential of the vessel.
References:


Figure Legends:

Figure 1-
A. Contrast enhanced computerized tomography image in coronal section showing abnormal origin of right pulmonary artery from the ascending aorta (★).
B. Another contrast enhanced computerized tomography image in coronal section showing main pulmonary artery continuing as left pulmonary artery (●).

Figure 2-
A. Intraoperative photo following pericardiotomy showing right pulmonary artery (RPA) arising from ascending aorta (arrow).
B. Transverse aortotomy has been done showing the origin of RPA (arrow).
C. Right pulmonary artery has been harvested along with the flaps of native aortic wall (left arrow). Direct anastomosis of ascending aorta has been commenced (right arrow).
D. Origin of RPA with its antero-superior flap (AS) and postero-inferior flap (PI). Arrow is pointing towards the completed aortic reconstruction.
E. Transverse main pulmonary artery flap has been created (held in the forceps) which opens like a trapdoor towards the RPA origin, to interdigitate between the two aortic wall flaps (AS, PI).
F. Completed anastomosis of the interdigitating flaps using 6-0 polypropylene continuous sutures. The arrow is pointing towards the origin of left pulmonary artery.
G. Autologous, treated pericardial patch being used to reconstruct the anterior wall of the RPA (arrow).
H. Completed reconstruction of the RPA showing anterosuperior flap (vertical arrow) and posteroinferior flap (oblique arrow).

**Supplementary Figure 1**

A. 2-D echocardiography image in short axis view showing the pulmonary confluence (PC) along with the origin of right pulmonary artery (RPA), anterior to the ascending aorta (AA).

Superior vena cava (SVC) seen anterior to distal RPA.

B. Colour Doppler image of the same view showing laminar flow in the RPA.

**Supplementary Figure 2**

A. 2-D echocardiography image at 4-month follow-up in short axis view showing the main pulmonary artery (MPA) and the right pulmonary artery (RPA).

B. Colour Doppler image of the same view showing laminar flow in the RPA.
Abnormal origin of RPA from ascending aorta

Interdigitating flaps in LeCompte position