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CASE REPORT

The trans-caval approach for surgical correction of sinus venosus atrial septal defect with partial anomalous pulmonary venous drainage into the superior vena cava: Early experience

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Abstract *Background:* Many techniques have been developed to address the partial anomalous pulmonary venous drainage into the superior vena cava. The morphology of this anomaly is responsible for the possible surgical complications including sinus node dysfunction, systemic and/or pulmonary venous channels obstruction.

Objectives: Since 2010, we started to adopt the vertical trans-caval incision for the correction of this anomaly. Here, we present our early experience.

Methods: Between April 2010 and 2011, six patients, were addressed using one patch of gluteraldehyde prepared autologous pericardium, after vertical superior vena caval incision at the mouth of the anomalous pulmonary veins. Follow up ranged from 2 to 12 months.

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Results: There was no mortality. Post-operative echocardiographic examination of all patients showed unobstructed caval and pulmonary venous flow. Follow up ECG confirmed the absence of arrhythmia.

Conclusion: Vertical trans-caval approach is a reproducible technique for correction of partial anomalous pulmonary venous drainage into the superior vena cava.

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1. Introduction

The incidence of anomalous pulmonary venous drainage has been reported to be around 0.7% in some autopsy series.¹ The anomalous drainage into the right side of the heart is usually associated with sinus venosus inter-atrial communication, which is present in 87–97% of reported cases.^{1,2}

Anomalous pulmonary venous connection to the superior vena cava has always been an attraction to embryologist, anatomist, cardiologists and certainly surgeons.

When it comes to the embryological events that stand behind such anomaly, many investigators tried to postulate theories to explain what exactly happens. The concept of pulmonary venous drainage being originally a part of the sinus venosus portion of the primitive atrium^{3–5} has been strongly opposed by some authors who believe that the topogenesis of the primary pulmonary venous pit is far to the left side of the primitive atrium away from the sinus venosus portion.^{6–8}

Contributions to define the sinus venosus defect have added more and more to the conflict. While Van Praagh et al.⁹ relayed such an anomaly to the absence of a common wall between the pulmonary veins and the cava, Al Zaghafal et al.¹⁰; proposed that overriding of either the superior or inferior caval vein is the key criterion for diagnosis.

Diagnosis of anomalous pulmonary venous drainage to the superior vena cava is somewhat difficult and requires a high index of suspicion and an experienced echo-cardiographer. In many cases, trans-thoracic echocardiography is unable to reveal the defect and the use of trans-esophageal echo is frequently needed.

When it comes to the surgical correction of the anomalous pulmonary venous connection to the superior vena cava and the inter-atrial communication, many techniques are found for what may be considered at the end a simple form of atrial septal defect. This anomaly has been addressed from the early days of cardiac surgery by Kirklin in 1956.¹¹ Since then, several modifications and different techniques have been invented. The fear of complications including arrhythmia, caval or pulmonary venous obstruction has been the reason for that large technical varieties.

The principle techniques, commonly in use nowadays, can be classified according to the site of incision, whether or not the cavo-atrial junction is crossed and finally according to the need for augmentation of the cavo-atrial junction.

A commonly used technique is the standard right atriotomy crossing the cavo-atrial junction with a single or double patch closure.^{12–15} Some surgeons have adopted the technique proposed by Warden et al. detaching the superior vena cava, closing the inter-atrial communication with reinsertion of the superior vena cava into the right auricle.^{16–18}

In the last decade, interest in a caval incision, avoiding the cavo-atrial junction, has been evident in a number of articles

that describe a longitudinal or a transverse caval incision.^{19–21} One of these techniques was proposed by Nicholson et al.²⁰ who reported their experience with a single patch lateral caval incision that avoided most of the complications reported with other techniques.

2. Methods

Since 2010, patients referred to our center for surgical correction of partial anomalous pulmonary venous drainage into the superior vena cava, with sinus venosus ASD, were addressed using the trans-caval approach.

All patients were diagnosed using trans-thoracic echocardiography. In case of uncertainty, trans-esophageal echocardiography was carried out.

Surgery was carried through a median sternotomy. All were done under moderate hypothermic cardio-pulmonary bypass with direct cannulation of the superior vena cava above the insertion of the highest anomalous pulmonary vein with the Azygos vein well controlled.

After verification of the anatomy and the start of cardio-pulmonary bypass, application of aortic cross clamp and introduction of cold ante-grade crystalloid cardioplegia, the superior vena cava is vertically incised in front of the mouth of the anomalous pulmonary veins. The cavo-atrial junction was always respected, never crossed.

A patch of glutaraldehyde treated autologous pericardium was used to divide the cavo-pulmonary channel in the manner that the superior vena cava is directed to the right atrium (anterior to the patch) and the anomalous veins are directed towards the left atrium (posterior to the patch). Appropriate sizing of the patch is of crucial importance to avoid obstruction of either channel. The patch is sewn using a running Prolene 5/0 suture fixing the patch to the inferior, medial and superior edges of the defect, while the lateral edge (the incision site) is closed in sandwich.

De-airing and aortic de-clamping is done in the usual manner, followed by weaning of the CPB.

Intra-operative trans-esophageal echo-cardiographic examination, with stress on the presence of any turbulence at the cavo-atrial junction or the mouth of the anomalous pulmonary veins, was done. Post-operative trans-thoracic echo-cardiograph and ECG were recorded. Daily post-operative and pre-discharge ECG were recorded to confirm the absence of any arrhythmia. Patients were followed up regularly with trans-thoracic echocardiography and 12 leads ECG.

3. Results

Between April 2010 and 2011, six patients diagnosed with sinus venosus inter-atrial communication (two males and four females), aged between 7 and 35 years, all in sinus rhythm,

were operated upon using the trans-caval approach. All patients were addressed through a median sternotomy. The number of anomalous veins was two in five patients and three veins in one patient. Persistent left SVC was found in two patients.

Only one patient required augmentation of the site of incision of the superior vena cava to avoid obstruction.

The mean aortic cross clamp time was 44 min with a mean CPB time of 76 min.

Mean ICU stay was two days. There was no mortality. One patient had mild insignificant pericardial effusion detect on echo-cardiography.

The follow up period ranged from 2 to 12 months. Echocardiography confirmed the absence of any residual atrial communication. And there was no obstruction of the pulmonary venous drainage or the caval flow. All patients were in sinus rhythm with no incidence of arrhythmia on follow up ECG.

4. Discussion

Addressing the anomalous pulmonary venous drainage to the superior vena cava carries the risk of injury to the cavo-atrial junction with resultant damage to the sino-atrial node or its arterial blood supply. The consequence of this injury is the development of atrial arrhythmia or sinus block that may require permanent pacing. As a result, any incision trying to avoid the cavo-atrial junction has the potential to decrease the risk of arrhythmia. That is true for the trans-caval incisions with all reviewed data showing a 0% incidence of new arrhythmia.^{19–21} Although the same is expected for the Warden procedure, reports have shown a variable incidence of new onset arrhythmia from 0% to 23%.^{16–18,22} The incidence of new arrhythmia after classical atriotomy has been highly variable. While the Toronto group¹ reported 0% incidence of arrhythmia, despite crossing the cavo-atrial junction with their incision, Takahashi et al.²³; reported a 93% incidence of new arrhythmia, despite respecting the cavo-atrial junction.

Apart from arrhythmia, the other possible complications include the possibility of either systemic or venous drainage obstruction. As Nicholson et al.²⁰; stressed in their technique description, the size of the patch is crucial as under or over sizing of the patch can lead to obstruction of either channel. We have experienced this in one patient, where a large patch had resulted in systemic venous channel obstruction and that was the reason for augmentation of the cavo-atrial junction with another patch. So, proper patch sizing is crucial for sound repair. The trans-caval incisions, whether a single or a double patch was used, has shown 0% incidence of either channel obstruction.^{19–21} Reports of the Warden procedure have shown very low incidence of channel obstruction, especially for the superior vena cava, as they stressed on the importance of a large neo-cavoatrial anastomosis with resection of any atrial trabeculation that may impede the flow.^{16–18} Considering the standard atriotomy, the incidence of channel obstruction is highly variable with results in favor of the double patch technique to avoid channel obstruction.²⁴

5. Conclusion

The simplicity and high reproducibility of the single patch longitudinal trans-caval approach make it an attractive technique

that show a lower incidence of complications when compared to others.

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