

ROLE OF MULTI SLICE COMPUTED TOMOGRAPHIC ANGIOGRAPHY AS AN ADDITIONAL TOOL TO TRANSTHORACIC ECHOCARDIOGRAPHY FOR DIAGNOSIS OF PULMONARY VEIN ANOMALIES

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Contribution

All the authors contributed significantly to the research that resulted in the submitted manuscript.

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ABSTRACT

Objective: To determine the role and safety of CT angiography as an additional tool to transthoracic echocardiography in the diagnosis of pulmonary vein anomalies.

Methodology: All patients with suspected anomalous pulmonary venous connections from first October 2011 to 30 May 2013 were included in the study.

Results: A total number of 99 patients with suspected pulmonary anomalous venous connections or pulmonary vein stenosis were included in the study. Among them 54(54.5%) were male, while 45(45.4%) were females. Mean age was 28.19 ± 34.1 months (2 days to 33 years). The mean weight was 9.1 ± 6.37 kg (2.5kg to 62kg). Sedation with oral chloral hydrate was used in majority of patients i.e 72 (72.7 %), 13(13.1%) required no sedation, 9(9.1%) required midazolam, 4(4%) required morphine while only one patient required ketamine. The sensitivity of transthoracic echocardiography for partial anomalous pulmonary venous connection (PAPVC) was 91.6% and specificity was 96%. The sensitivity of transthoracic echocardiography for total anomalous pulmonary venous connection (TAPVC) was 86.5% and specificity was 100%. The sensitivity of transthoracic echocardiography for isolated pulmonary vein stenosis was 66.6% and specificity was 100%. We were unable to assess pulmonary venous drainage on transthoracic echocardiography in 38(38.4%) patients.

Conclusion: CT angiography is a useful additional tool to transthoracic echo in assessment of pulmonary venous drainage in patients with limited echo windows and other technically difficult echocardiograms.

Key Words: CT angiography, Partial anomalous pulmonary venous connections, Total anomalous pulmonary venous connections.

INTRODUCTION

The standard first-line modality for noninvasive diagnosis of almost all congenital heart lesions, including pulmonary venous anomalies is echocardiography. Echocardiography provides excellent anatomic definition of the pulmonary venous return and is alone usually sufficient in preoperative and postoperative evaluation of TAPVC. Computed tomography is considered to be an alternative to invasive catheterization in the evaluation of pulmonary veins in children. These scanners allow for rapid volume acquisition, with the resolution of the acquired images amenable to 3-dimensional (3D) reformatting. We reviewed our transthoracic echocardiography experience in small infants with congenital heart disease to determine whether this technique could be used as an accurate alternative to CT angiography in defining pulmonary venous anatomy, when other noninvasive methods proved inconclusive. Anomalous pulmonary venous connection is a developmental disorder in which pulmonary veins fail to connect with left atrium. The condition is termed total anomalous pulmonary venous connection (TAPVC) if all the veins connect anomalously, and partial anomalous pulmonary venous connection (PAPVC) if one or more, but not all, of the veins connect anomalously.¹TAPVC is a rare cardiac anomaly that comprises 1.5-2.6% of congenital heart diseases.^{1,2} The signs and symptoms in TAPVC are variable.³⁻⁵ Early detection and surgical correction is essential for survival. PAPVC is an uncommon disorder, which is often associated with other congenital heart defects.^{6,7} Symptoms are uncommon in infancy and childhood but these cardiac anomalies are generally diagnosed by echocardiography.⁸⁻¹⁰ Although echocardiography alone is usually sufficient to provide the necessary preoperative data it has a small field of view and sometimes each pulmonary vein cannot be identified and followed to its entry into the systemic venous system.¹¹⁻¹³ Although angiography has been the gold standard for evaluation it carries certain inherent risks, especially in small and sick infants. Recently, less invasive procedures, such as helical computed tomography, and magnetic resonance angiography (MRA) have been shown to complement or replace the angiography.^{11,12,14-18} In this study, we retrospectively evaluated the diagnostic value of computed tomography angiography comparing the results to echocardiographic findings.

METHODOLOGY

This observational study was carried out in cardiology unit from 1st October 2011 to 30th May 2013. All patients who had suspected anomalous pulmonary venous connection on transthoracic echocardiography or the pulmonary veins could not be assessed by echocardiography were subjected to CT angiography for confirmation. The CT angiography

was considered as gold standard for diagnosis of anomalous pulmonary vein connection. The sampling technique was non probability consecutive sampling. As most of the patients were less than five years of age so light sedation in form of oral chloral hydrate or intravenous midazolam were given. All patients were observed in recovery room for about 2 hours till full recovery.

All the Trans thoracic echocardiography were performed on Xario Toshiba diagnostic ultrasound system model SSA-660A machine. All the CT angiogram was taken with help of Toshiba 64 aquilion CT Angiography Machine. All the CT angiograms were reviewed by a pediatric cardiologist and radiologist. All the data were entered to an already prepared proforma. The data were analyzed by SPSS (statistical package for social sciences) version 19. Categorical variables were expressed as numbers and percentages while continuous variables were expressed as mean \pm SD. The radiation dose was calculated.

RESULTS

A total number of 99 patients with suspected pulmonary anomalous venous drainage or pulmonary vein stenosis were included in the study. 54(54.5%) were male, while 45(45.4%) were females. Mean age was 28.19 ± 34.1 months (2 days to 33 years). The mean weight was 9.1 ± 6.37 kg (2.5kg to 62kg). 13(13.1%) required no sedation, 72(72.7%) required oral chloraldehyde, 9(9.1%) required medazolam, 4(4%) required morphine while only one patient required ketamine. Transthoracic echocardiography (TTE) showing 25(25.3%) have partial anomalous pulmonary venous connection (PAPVC), while CT angiography showing 24(24.2%) PAPVC. TTE shows 32(32.3) have total anomalous pulmonary venous connection (TAPVC) while CT angiography shows 37(37.3%). TTE shows 4 patients have normal pulmonary veins but have stenosis while CT angiography shows 6 patients with normal pulmonary veins but stenosed. The sensitivity of transthoracic echocardiography for PAPVC was 91.6% and specificity was 96%. The sensitivity of transthoracic echocardiography for TAPVC was 86.5% and specificity was 100%. The sensitivity of transthoracic echocardiography for isolated pulmonary vein stenosis was 66.6% and specificity was 100%. we were unable to delineate pulmonary veins on transthoracic echocardiography in 38(38.34%) patients which on Evaluation on CT angiography shows that 30/38 patients have normal pulmonary veins, 4 have TAPVC and 2 have PAPVC and 2 patients have normal pulmonary vein with stenosis. Mean total radiation dose was 2.5 msv (range 0.83–5.5msv). Results are shown in table 1&2.

DISCUSSION

Echocardiography has evolved to become the primary

diagnostic imaging modality in the diagnosis of structural congenital heart disease (CHD) and is now used extensively as the sole pre- and postoperative diagnostic test for many patients.¹⁹ Our study shows that echocardiography has 100% specificity for TAPVC and 96% specificity for PAPVC. Also it has 86.5% and 91.6% sensitivity for TAPVC and PAPVC respectively. Several studies have demonstrated the accuracy of echocardiography in the assessment of CHD in infants and children.²⁰ Tworetzky et al.²¹ found a 2% rate of major errors in a study of 412 patients who underwent cardiovascular surgery based on echocardiography alone. Gutgesell et al.²² showed a sensitivity of 87% for echocardiography in prospectively identifying 259 abnormalities that were diagnosed by catheterization. Real-time two-dimensional echocardiography with color Doppler is usually a reliable tool for detecting APVC. However, echocardiographic diagnosis is occasionally difficult because of the poor far-field resolution and small field of

view.¹¹⁻¹³ This statement support our study in which we were unable to delineate accurately pulmonary veins in 34.3% cases. Although conventional angiography has been the gold standard for evaluation, it carries certain inherent risks, especially in small and sick infants.¹¹ Conventional cardiac catheterization is invasive, and is used nowadays for therapeutic intervention rather than for diagnosis, especially with the advent of other noninvasive modalities such as computed tomography angiography or magnetic resonance imaging and angiography.^{11,12,14-18} Recent trends have favored the use of CTA as the preferred noninvasive supplement to echocardiography. Although there are several case reports on the use of CTA in complex congenital heart disease,^{16,18,23-26} specific studies for evaluating pulmonary venous drainage in case series, especially pediatric patients, are limited.^{15,17} Kim et al,¹⁵ study of 14 patients with total anomalous pulmonary venous connection has been demonstrated that helical computed tomography

Table 1: Showing Baseline Characteristics

Variables	No(%)
Male	54(54.5%)
Female	45(45.4%)
Age(Months)	28.19± 34.1
Weight(kg)	9.1±6.37kg
Oral chloral hydrate	72 (72.7 %)
No sedation	13(13.1%)
Midazolam	9(9.1%)
Morphine	4(4%)
Mean total radiation dose(msev) for CT	2.5(0.83 – 5.5)

Table 2: Sensitivity and Specificity of TTE *

Variables	Sensitivity	Specificity
Total anomalous pulmonary venous connection (TAPVC)	91.6%	96%
partial anomalous pulmonary venous connection PAPVC	86.5%	100%
isolated pulmonary vein stenosis	66.6%	100%

• TTE: Transthoracic echocardiography

angiography and three dimensional reconstruction can be a good diagnostic tool in preoperative evaluation of neonates and infants. Sridhar et al.¹⁷ suggested that helical computed tomography angiography and three dimensional reconstructions can be considered a safe and noninvasive alternative to cardiac catheterization in the evaluation of TAPVC, so we used CT angiography as a gold standard for comparison with transthoracic echocardiography. We detected APVCs using two-dimensional echocardiography with color Doppler. Although, pulmonary venous obstruction, intracardiac defects, and functional variables were assessed by echocardiography, each pulmonary vein could not be identified and followed to its entry into the systemic venous system in some patients. A study published in European heart journal support our study which stated that transthoracic echocardiography can visualize clearly and identify accurately the exact site of each pulmonary vein.²⁷

In a study by Osama A,²⁸ shows that MDCT correctly depicted the TAPVR (Total anomalous pulmonary venous return) and PAPVR (Partial anomalous pulmonary venous return) types of pulmonary venous anomalies with sensitivity 100%, and specificity 100%. The specificity and sensitivity of echocardiography was 50%. This might be because of the fact that echocardiography is more operator dependant as compared to MSCT. MSCT with three dimensional reconstructions shows the courses and draining sites of the anomalously connected pulmonary veins in relation to other extra cardiac structures that were very important from the perspective of a cardiac surgeon. Contrast enhanced angiographic techniques, however, have some limitations. They cannot visualize intracardiac structures well and cannot assess pressure gradients, where echocardiography is superior to CT angiography. Similarly, anatomical and functional data can also be obtained by ECG triggered multi-detector CT examinations. However, these techniques may prolong the examination and sedation time with increased radiation dose. Another shortcoming of contrast enhanced techniques in children is blurred edges of vessels. It can be due to inadequate sedation and respiratory movements and can be overcome by using faster data acquisition and artificial ventilation.

CONCLUSION

CTA is fast and noninvasive technique that allows detailed and comprehensive visualization of the pathology in pediatric patients, especially in small and sick infants, with the anomalous connection of pulmonary veins. We concluded from our study that CTA is a good diagnostic modalities for use in the preoperative evaluation of anomalous pulmonary venous connection as a supplement to echocardiography.

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