FULL LENGTH ARTICLE

Comparative study between real time three dimensional echocardiogram and angiography in evaluation of patent ductus arteriosus, single center experience

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In this study we compared the real time three dimensional echocardiogram data in evaluation of patent ductus arteriosus with the gold standard angiography.

Methods: **This study included 25 patients with PDA referred to Tanta University Hospital for elective cardiac catheterization. The patients comprised seven males and 18 females, with a mean age of 3.7 ± 0.36 years. The study duration was six months. All patients underwent full 2D echocardiogram as well as real time three-dimensional echocardiogram (RT3DE).**

Essential measurements included the pulmonary end of the duct, duct length, aortic end and aortic ampulla as well as the anatomical type of the PDA. Data obtained by RT3DE were compared against 2D echocardiogram and angiography.

Results: **There was no significant difference between 3D echocardiogram and angiography ($P = 0.001$) in the pulmonary end of the duct measurement. Neither were there any significant differences between the length of the duct or the aortic end measured by 3D echocardiogram and by angiography ($P = 0.001$ in both). While there was adequate agreement between both 2D and 3D echocardiogram and angiography in determining the anatomical type of the PDA, 3D echocardiogram determined type A and type E ductus more accurately than 2D echocardiogram. The feasibility of Q lab analysis of PDA was 96%, while the feasibility of gated color flow 3D acquisitions in determining anatomical types was 64%.**

Conclusion: **There was complete agreement on location, size, morphology and surrounding structure of PDA between 2D and 3D echocardiogram, and angiography. This result illustrates the need for the proper placement of the device in catheterization laboratories.**

Keywords: Patent ductous arteriosus, 3D echocardiography, Amplatzer duct occluder

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Introduction

The reported incidence of patent ductus arteriosus (PDA) varies due to methodological differences related to the population group studied, age of consideration, and method of detection [1]. Although the ductus arteriosus is most often functionally closed within 48 h of birth, some authorities consider the patent ductus to be abnormal only after three months of age. In children who were born at term, the incidence of PDA is reportedly ≈1 in 2000 births [1]. This accounts for ≈5% to 10% of all congenital heart diseases. However, if we include children with ''silent'' patent ductus (those discovered incidentally by echocardiography performed for another purpose), the PDA incidence is estimated to be as high as 1 in 500 [2]. The female-to-male ratio is ≈2:1 in most reports [2].

PDA occurs with increased frequency in several genetic syndromes, including those with defined chromosomal aberrations (such as trisomy 21 and 4p-syndrome), single-gene mutations (such as Carpenter's syndrome and Holt-Oram syndrome), and X-linked mutations (such as incontinentia pigmenti) [3]. The genetic mechanism of patent ductus in some patients may be autosomal recessive inheritance with incomplete penetrance [3].

Available treatment modalities include surgical ligation in large ducts not suitable for interventional treatment and transcatheter closure for small to moderate sized ducts whether by coil embolization or occluder devices. The accurate assessment of the size, shape and anatomical type of the PDA represents a crucial step to choosing the most suitable technique to guarantee complete closure of the PDA without complications [4,5].

Two-dimensional (2D) echocardiography is an important diagnostic tool and a mainstay for diagnosis and evaluation prior to management. Cardiac catheterization is also used to re-evaluate the PDA prior to its percutaneous closure [6]. With the recent introduction of 3D echocardiography and its unique ability to allow real-time volumetric imaging and thus improve the accuracy of evaluating cardiac chambers, the idea of using this unique capability in interrogating extra cardiac vascular structures like the PDA to optimize the management seems appealing. In this study, we compared real-time 3D echocardiogram data with angiography (as the gold standard) in the evaluation of patent ductus arteriosus.

Abbreviations

PDA	patent ductus arteriosus
CHD	congenital heart disease
2D	two dimensional
RT3DE	real time 3 dimensions echocardiography
MHz	mega hertz
MPR	multi plane reformatted
RAO	right anterior oblique
ADO	Amplatzer duct occluder

Methods

This study was conducted over a period of six months from January to June 2012, and included 25 patients with PDA who were referred to Tanta University Hospital for percutaneous PDA closure. Full history-taking from our patients, as well as clinical examination, 12-lead surface electrocardiogram (ECG), plain chest X-ray in posteroanterior view, and routine laboratory investigations were made. Full echocardiographic study was carried out using Philips FD 10/10 corporation cath machine, Vingmed, Horten Norway, M4S probe (with selection of pediatric or adult icon according to patient's age) for 2D and V3 matrix array transducer for 3D. This was followed by cardiac catheterization (using Philips FD 10/10 cath machine) for the evaluation of PDA type and PDA closure. The parents of all the children were given informed consent and acceptance to be enrolled in the study.

Echocardiography

Standard 2D echocardiogram was performed on all patients enrolled in the study. Segmental analysis data was obtained for each patient [7]. Three views were used in the 2D echocardiogram to visualize the duct and its course; the high left parasternal or infra-clavicular view, the suprasternal view, and the parasternal short-axis views (at the level of great vessels). The anatomical type of PDA was determined; the aortic end, pulmonary end, and the length of the duct were measured. After deployment of Amplatzer duct occluder, echocardiography was used to assess the results and to determine if there was any residual gradient or shunt flow through the PDA, or any newly developed gradient across descending aorta, main or left pulmonary artery. Echocardiography was also used to assess accurate device position regarding surrounding cardiac structure, or any other complication.