Abstract
Aortic coarctation accounts for 5%–10% of all congenital heart diseases and represents 7% of critically ill infants with heart disease. Magnetic resonance (MR) imaging allows the study of this disease with several advantages in comparison with conventional angiography, transesophageal echocardiography, and computed tomography. The MR protocol applied at our institution for both diagnosis and follow-up after surgical or endovascular treatment consists of four steps: morphologic study, cine MR study, flow analysis, and MR angiography (MRA). The first three sequences are acquired during breath-hold and with electrocardiographic gating. Anatomy is well depicted with dark-blood half-Fourier acquisition single-shot turbo spin-echo (HASTE) sequences. Cine true-fast imaging with steady-state precession (true-FISP) sequences show not only morphologic features but also blood-flow changes inside the aorta. Gradient-echo sequences for phase-velocity mapping allow flow analysis. Application of Bernoulli’s equation – here briefly presented and discussed – allows for calculation of the pressure gradient caused by the coarctation. MRA, acquired with a breath-hold three-dimensional T1-weighted gradient-echo sequence and intravenous administration of paramagnetic contrast material, allows for optimal depiction of the aortic lumen, with a panoramic view of the whole aorta, its main branches and possible collateral circulation.

Keywords
Aorta · Aortic coarctation · Bernoulli’s equation · Magnetic resonance (MR) imaging · MR flow analysis (phase-velocity mapping)

Riassunto
La coartazione aortica rappresenta il 5%–10% di tutte le patologie congenite del cuore e dei grandi vasi e il 7% dei casi di piccoli cardiopatici in condizioni critiche. La risonanza magnetica (RM) permette lo studio di questa patologia con una serie di vantaggi rispetto a tecniche alternative quali l’angiografia convenzionale, l’ecografia transesofagea e la tomografia computerizzata. Il nostro protocollo RM, utilizzato sia per la diagnosi, sia per il follow-up dopo trattamento chirurgico o endovascolare, consiste di quattro fasi: studio morfologico, cinetico, flussimetria e angio-RM. Le prime tre sequenze sono acquisite in apnea e con sincronizzazione elettrocardiografica. L’anatomia è studiata con sequenze a sangue scuro half-Fourier acquisition single shot turbo spin-echo (HASTE). Le sequenze a sangue chiaro true-fast imaging con steady-state precession (true-FISP), oltre a dare informazioni di tipo morfologico, mostrano le alterazioni del flusso ematico all’interno del vaso. Le sequenze gradient-echo con mappaggio fase-velocità consentono la quantificazione del flusso; l’applicazione dell’equazione di Bernoulli (qui brevemente presentata e discussa), consente infatti il calcolo del gradiente pressorio determinato dalla coartazione. Lo studio angio-RM, ottenuto in apnea mediante sequenze gradient-echo tridimensionali T1-pesate con somministrazione endovenosa di mezzo di contrasto paramagnetico, mostra una visione volumetrica panoramica del lume dell’aorta, delle sue principali ramificazioni e, quando presenti, dei circoli collaterali.

Parole chiave
Aorta · Coartazione aortica · Equazione di Bernoulli · Flussimetria RM · Risonanza magnetica (RM)
Introduction

Over recent years, several magnetic resonance (MR) techniques have been successfully applied for evaluating congenital heart diseases. Coarctation of aorta (CoA) is a clinical entity to be considered in clinical practice, representing 5%–10% of all congenital heart diseases [1]. We summarize here the currently available knowledge about CoA, including epidemiology, aetiopathogenesis, topographic classification, and the different MR imaging techniques.

Definition

Coarctation is a term derived from the Latin coarctatio, meaning narrowing or stricture. More precisely, coarctation refers to a narrowing of the lumen of a vessel, producing a flow obstruction. A focal aortic narrowing is termed coarctation, whereas a more diffuse narrowed segment is known as tubular hypoplasia. Similar congenital malformations are aortic atresia and the true aortic interruption, mostly located at the arch (interrupted aortic arch).

CoA, also known as congenital aortic stenosis, was originally noted during autopsy by J.F. Meckel in 1750 [2] and by G.B. Morgagni in 1761 [3]. M. Paris [4] provided the first accurate description in 1791. The first postmortem series was published by J. Abbot in 1928 [5]. He collected 200 previously documented cases, but CoA was not regularly diagnosed until after 1933 [6].

Epidemiology and aetiology

CoA accounts for 5%–10% of all congenital heart diseases and represents 7% of critically ill infants with heart disease. It is seven times more common in Caucasian than in Asian population. Male-to-female predominance is 1.3–2.1 in most series [1]. In Atlanta (USA) from 1970 to 1983, the prevalence per 1,000 live births was as follows: interruption of the aortic arch, 0.05; coarctation, 0.36; hypoplasia of the aorta, 0.06 [7], giving a total prevalence of 0.47 per 1,000 live births. A CoA prevalence of 0.32 per 1,000 live births has been reported for Island from 1980 to 1994 [8]. In Bohemia in 1980, a prevalence of 6.67 congenital heart malformations per 1,000 live births was reported, and 5.77% of these malformations consisted of CoA cases [9], giving a CoA prevalence of 3.84 per 1,000 live births.

The aetiology of CoA is still unclear. Up to 60% [10] or 85% [1] of CoA cases are associated with bicuspid aortic valve, supporting the hypothesis of a common cause for the two congenital malformations [11] or an influence of the bicuspid aortic valve on the development of CoA [1]. Pathologic examination of the ascending aorta of patients with