Abstract

**Purpose.** The study aimed to investigate the correlation between apparent diffusion coefficient (ADC) and gestational age by applying diffusion-weighted imaging (DWI) in the study of normal fetal kidneys.

**Materials and methods.** We performed magnetic resonance (MR) imaging on 88 fetuses (gestational age range 17–40 weeks) after ultrasound had ruled out urinary system malformations. A multiplanar study of the urinary system was obtained by using conventional T2-weighted sequences and echoplanar imaging (EPI). DW sequences with ADC maps were subsequently acquired, and kidney ADC values were correlated with gestational age, dividing the fetuses into six groups according to age.

**Results.** We found a correlation between ADC values and gestational age. The ADC values, ranging from 0.99 to 1.62 × 10^{-3} mm²/s (mean 1.22; 95% confidence interval (CI) 1.19–1.25, standard deviation (SD) 0.147), showed a tendency to decrease with increasing gestational age. The relationship between ADC values and gestational age was expressed by a linear regression equation: ADC (mm²/s)=1.69–0.0169 (GA) (R²=37.7%, R² ADJ=37.0%, p<0.005, Pearson correlation=–0.614).

**Conclusions.** DWI with ADC mapping provides functional information on fetal renal parenchyma development and may thus become a useful tool in the management of pregnancy and treatment of the newborn child.

Riassunto

**Obiettivo.** Applicare le sequenze pesate in diffusione (DWI) nello studio dei reni fetali, per valutare l’esistenza di una correlazione fra coefficiente di diffusione apparente (ADC) ed età gestazionale nei feti sani.

**Materiali e metodi.** Abbiamo studiato con esame RM 88 feto (età gestazionale 17–40 settimane), già valutati con esame ecografico che escludeva malformazioni del tratto urinario. L’apparato urinario fetale è stato studiato con sequenze T2 pesate ultraveloci; successivamente sono state acquisite sui reni fetali sequenze DWI (con calcolo automatico delle mappe di ADC) ed i valori di ADC messi in relazione con l’età gestazionale, suddividendo i feto in sei gruppi in base all’età gestazionale. La normale funzionalità renale è stata confermata dopo la nascita attraverso dati clinico-laboratoristici ed ecografia renale.

**Risultati.** Abbiamo riscontrato che i valori di ADC, compresi fra 0,99 e 1,62×10^{-3} mm²/s (media 1,22; 95% CI 1,19–1,25; deviazione standard 0,147) tendono a decrescere con l’aumentare delle settimane di gestazione. La migliore correlazione è stata espressa dall’equazione di regressione lineare: ADC (mm²/s)=1,69–0,0169 (GA) (R²=37,7%, R² ADJ=37,0%, p<0,005, correlazione di Pearson=–0,614).

**Conclusioni.** Le sequenze DWI ed le mappe di ADC, fornendo informazioni funzionali sullo sviluppo del parenchima renale fetale, risultano di grande utilità soprattutto nella gestione della gravidanza e nel management post-natale.
Introduction

Prenatal ultrasound is the imaging modality of choice in the study of fetal anatomy, although its accuracy may be limited by pathological fetal conditions such as anhydramnios, oligohydramnios and complex malformations as well as maternal conditions such as obesity [1–7]. Magnetic resonance (MR) imaging provides a detailed morphological study of the fetal renal system anatomy as well as allowing assessment of possible urinary tract disorders, which may be isolated or associated with abnormalities of other organs or systems, especially of the gastrointestinal tract or lungs [8–10].

Prior to the introduction of ultrafast sequences [11, 12], the use of diffusion-weighted imaging (DWI), which is extremely sensitive to motion, was confined to neuroradiology [13]. With the advent of ultrafast imaging, however, the applications for DWI have been greatly expanded [14, 15]. In recent years, researchers have suggested the possibility of using DWI sequences with calculation of the apparent diffusion coefficient (ADC) of water in the human kidney for the study of renal function in adults [16, 17].

The aim of our study was to apply DWI sequences to the study of the fetal kidney in order to verify the existence of a correlation between ADC maps and gestational age in normal fetuses, as such additional functional information would be useful in the event of suspected urinary system abnormalities.

Materials and methods

Patients

Between June 2005 and April 2008, 85 pregnant women with 88 fetuses (gestational age 17–40 weeks, mean 28 weeks; maternal age 18–44 years, mean 29 years) were consecutively evaluated with MR imaging. Patients had previously undergone obstetric ultrasound examination performed with Aloka Prosound SSD-5500 equipment by one of three gynaecologists with >10 years’ experience at the Department of Gynaecology and Obstetrics of our teaching hospital.

The clinical indications for the MR study were diverse, but in no case was there a suspicion of urinary tract malformations. In particular, the fetal organs with suspected malformations to be confirmed by MR imaging were the