CASE REPORT

Virtual Three-Dimensional Magnetic Resonance Fetal Cystoscopy: A Novel Modality for Precise in Utero Evaluation of Urinary Tract

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Urogenital anomalies are the most prevalent anomalies detected in the fetus during pregnancy. Timely detection of these conditions could facilitate proper post-natal management and improve outcomes. In some cases, precise delineation of fetal urinary tract utilizing ultrasonography is not feasible. Moreover, sometimes the ultrasound study is technically limited. Magnetic resonance imaging could clarify the diagnosis in these situations. Prenatal ultrasonography indicated hydronephrosis and a 14 mm cystic lesion at the right ureterovesical junction in a -25 week fetus. However, fetal magnetic resonance urography was not able to precisely clarify the condition and extension of ureterocele into the urethra. Fetal magnetic resonance virtual cystoscopy clearly demonstrated anatomy and extension of ureterocele. This modality provides three-dimensional cystoscopic-like view of the urinary bladder and facilitates postnatal management.

Keywords: fetal MRI ; ureterocele; three-dimensional; virtual cystoscopy

INTRODUCTION

Urogenital anomalies are considered as the most common abnormalities detected during prenatal period[(1)]. Most of these anomalies may result in the development of unilateral or bilateral antenatal hydronephrosis (ANH). As the underlying causes of ANH are highly diverse, the accurate diagnosis, management, and prognosis of this condition are still a matter of debate. Initially, the presence of urogenital anomaly and ANH is suggested during prenatal ultrasonography (US) as the first line imaging modality. This technique can facilitate determination of ANH severity, diagnosis and postnatal outcome[(1)]. Additionally, detecting presence of other organ abnormalities and evaluation of adjacent structures are feasible with this technique.

Despite the fact that US is considered as the modality of choice for fetal screening, it is limited in several conditions such as oligohydramnios, maternal obesity, and undesirable fetal position[(2)]. In such circumstances with inconclusive US findings, magnetic resonance imaging (MRI) will play a major role for further evaluation of fetal

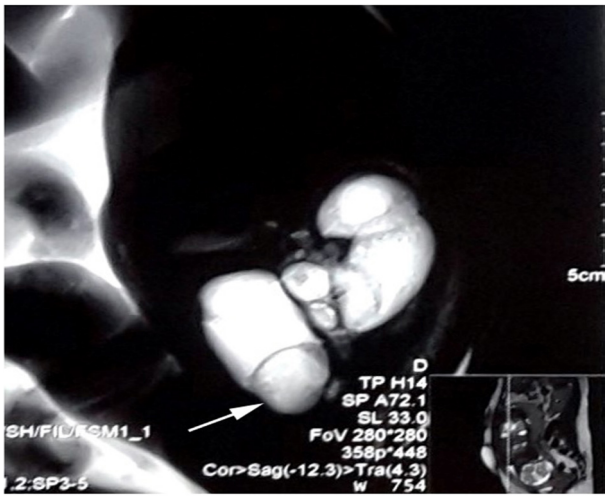

Figure 1. Fetal MRU obtained at 27 weeks of gestation which reveals a ureterocele at right ureterovesical junction (arrow).

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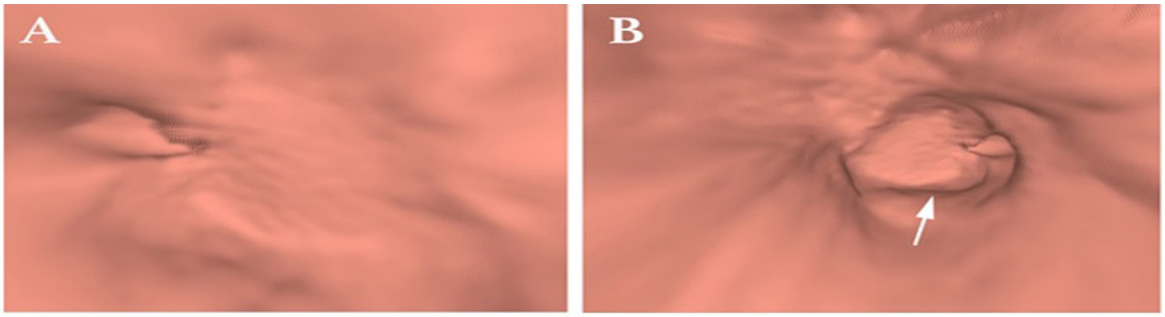

Figure 2. Virtual fetal cystoscopy visualization acquired with magnetic resonance. **(A)**: three-dimensional view of bladder surface and left ureteral orifice. **(B)**: ureterocele with distal extension to the bladder neck (arrow).

urogenital abnormalities[3] facilitating postnatal counseling and early treatment. Fetal magnetic resonance urography (MRU) as a non-ionizing complementary to sonographic imaging, helps to clarify uncertain diagnoses and precisely detect vast majority of urogenital malformations[4]. However, visualization of the lower urinary tract surface and sometimes exact anatomy of malformations is not attainable with this modality.

Three-dimensional (3D) virtual navigation is a cutting-edge technology created from overlapping image layers obtained from US or MRI scan data[5]. This technology is capable of providing information for the evaluation of different hollow fetal structures which is comparable to performing conventional invasive diagnostic procedures such as bronchoscopy[6]. In the present case, we processed MRI data to produce 3D views of the urinary tract in a case of ANH with fetal ureterocele.

CASE REPORT

A 31-year-old pregnant woman (P1 ; first parity) at 25 weeks of gestation was referred to our pediatric urology clinic for further evaluation following detection of severe right fetal hydronephrosis and a 14 mm cystic lesion at the right ureterovesical junction in prenatal US. Anteroposterior diameter of right renal pelvis was equal to 15.3 mm. Other sonographic findings were unremarkable. Amniotic fluid and biophysical profile were reported normal during pregnancy. For further assessment, a fetal MRU was obtained at 27 weeks of gestational age with different sequences and cuts using 1.5 Tesla Magnetom Avanto Siemens machine with advanced shimming gradient (**Figure 1**). No contrast media was used in this regard. Heavily T2-weighted pulse sequence was applied to acquire urine signal in fetal bladder. In order to render 3D images with viewpoint inside the fetal urinary bladder, we used Advantage Workstation for Diagnostic Imaging 4.2.2, General Electric Healthcare. 3D virtual cystoscopy provides detailed multislice images of inner surface of fetal bladder (**Figure 2.A**). Intravesical ureterocele was precisely depicted at right ureterovesical junction which was not obstructing without extension to the urethra (**Figure 2.B**).

The pregnancy was uneventful and labor was induced at 38 weeks with vaginal delivery of a female newborn. The APGAR score was calculated 8 at 1 minute and 10 at 5 minutes. The baby weighed 2.850 kg (15th-25th centile) and measured 47 cm (5th-15th centile) in length. The initial physical examination was completely normal. The newborn was immediately admitted in order to monitor renal function. Laboratory data for renal function were within normal ranges. Neonatal renal US at 3rd day revealed right duplicated collecting system with severe hydronephrosis (Grade 3) in right upper moiety and a dilated tortuous ureter. Right lower renal pelvis was relatively dilated with a diameter of 3.5 mm. Left renal unit appeared normal in US. Moreover, a non-obstructing ureterocele was detected at right ureterovesical junction. Intravenous antibiotic was administered during hospitalization. She was discharged after one week under antibiotic prophylaxis and referred to the pediatric urology clinic. She underwent ureterocele endoscopic double puncture surgery at 3 months of age. She remains symptom-free after 10 months of follow up without any episodes of urinary tract infection (UTI).

DISCUSSION

Ureteroceles account for up to 3% cases of ANH. Historically, ureteroceles were mostly diagnosed in early life, when the symptoms (such as frequent UTIs, urinary retention, failure to thrive and etc.) became unmasked. Currently, with the advent of routine prenatal US, most cases are detected in utero which allows early management of the condition before devastating complications occur. It is highly important to detect ureteroceles during prenatal period to improve postnatal outcomes. In essence, determining distal extension of ureterocele and possibility of bladder outlet obstruction is crucial for optimal postnatal management. In a study by Upadhyay et al., patients with prenatally diagnosed ureteroceles encountered less UTI and decreased risk of reoperation comparing to those with postnatally diagnosed ureteroceles[7]. Fetal ureterocele is visualized as a cyst inside the bladder on US and may be associated with duplicated collecting system. Ectopic subtypes of ureterocele may develop lower urinary tract obstruction and generally require immediate intervention in order to prevent catastrophic complications. In fetal cases of ureterocele, this condition is more prominent. Despite providing additional information comparing to prenatal US, MRU is unable to show true extension of ureterocele into the urethra which is of utmost importance to define the timing of delivery and plan postnatal management and counseling. Also visualization of bladder surface is not feasible by MRU. If distal extension of ureterocele to the urethra and urinary obstruction is evident in a fetus, free urinary drainage should be maintained immediately after the delivery to preserve the newborn's renal function.

In our present case, virtual fetal cystoscopy using MRI,

provides a novel perspective and it was capable of showing 3D cystoscopic-like view of urethra and bladder, clear distal extension of ureterocele, and possibility of bladder outlet obstruction (**Figure 2**). In fact, these findings are crucial for assessing the need for prenatal intervention and planning endoscopic treatment of ureterocele using double puncture technique[8]. Moreover, detection of other etiologies of lower urinary tract obstruction (such as posterior urethral valves [5]) and evaluation of lower urinary tract surface are attainable in this technique. On the other hand, manipulation during conventional cystoscopy and ureteral peristalsis may preclude the diagnosis. Virtual cystoscopy can overcome this issue and present untouched images of ureterocele.

In a recent study, 3D virtual navigation using MRI scan data showed clear visualization of urethral lumen, distended bladder, and hydroureter in a fetus with posterior urethral valve. The rendered images were very close to reality in their case[5].

In conclusion, virtual fetal cystoscopy presents a novel intraluminal view of the fetal lower urinary tract, which could help to elucidate the etiology of ANH. Consequently, proper immediate postnatal counseling and interventions would be facilitated. However, further prospective investigations with larger study population are mandatory to standardize this non-invasive technology as an alternative for precise fetal urinary tract assessment and evaluate its additive value.

CONFLICTS OF INTERESTS

None

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