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Radiological Imaging for Urological Disease in Children

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Published Date: July 22, 2015

INTRODUCTION

Diagnostic imaging is an important component for evaluation of urological disorders in children; Pediatrics with both congenital and acquired conditions commonly requires imaging studies. Widerange of functional and anatomic tests undergoes continuous progress as technology becomes more advanced. Although ultrasound (US), voiding cystourethrography (VCUG) and radionuclide scintigraphy form the basis of urological imaging in children, newer modalities such as CT Urography and MR Urography become of great interest for pediatric Urologist as their availability and ability to provide images with high resolution power [1].

For physician, requesting a diagnostic test should be based on how the information gained from this test will help in directing the subsequent intervention and how benefits from this information aremore significant than any possible adverse effect [2]; in this regard, CT has undergone some of the most advanced growth. However, we have to consider the potential radiation hazards as malignancy which has been explained in previous studies [3,4], particularly as children are more sensitive to radiation;this consideration bring urologistattention to imaging modalities characterize byfree-radiation exposure as MR Urography and Ultrasonography. We aim from this review to address progress in radiological Imaging techniques for pediatrics Urological diseases together with their benefits and limitations.

PEDIATRIC CT UROGRAPHY

With the development and availability of advanced imaging techniques, CT has become the mainstay of urography in adults, CTU is used for evaluation of kidneys, ureters and the urinary bladder, involving excretion phase as a compulsory element [5]. For children CTU applications include the evaluation of congenital anomalies, severe urinary tract trauma, complicated or equivocal urolithiasis, infection, tumors and vascular pathologies [5,6].

CT Urography Versus IV Urography

According to previous studies [6,7], CTU provides more diagnostic information than IV urography. According to Worster et al. meta-analysis [8] CT has more accuracy in diagnosis of urinary stone than IV Urography as the sensitivity is significantly lower than that of CT.

Limitations of Pediatric CT Urography

Despite the advantages of CT scan over IV Urography, their availability in medical centers and the ability to provide rapid, high-quality image [1], high radiation used in paediatric CTU bring a particular consideration as children are more sensitive to radiation, previous study [3] show that malignancy risk is significantly higher for children than adults for the same radiation dose. In this regard, the European Society of Pediatric Radiology recommends that basic diagnostic methods should not include those exposing children to X-ray radiation [1].

To overcome this issue, multiple approaches have been employed for dose modulation, CT scanners employing iterative image reconstruction techniques lead to reduction in radiation doses comparable to those of conventional urographic examinations [9]. However, most of these studies provide imaging findings rather than specific techniques which remain insufficient [1].

MR UROGRAPHY

In order to avoid radiation hazards in children, free-radiation tests as magnetic resonance urography (MRU) has undergone important advanced over the years, MRU - besides being noninvasive- is a powerful examination that has a wide variety of application including: providing anatomical and functional information in one examination, assessing for the possibility of vesicoureteral reflux (VUR), congenital anatomic abnormalities and obstructive uropathy [6]. In addition MRU can be performed in patient with renal failure [10] even as excretory MRU cannot be performed in patients with oliguria and anuria, static fluid MRU may be obtained if the urinary tract is dilated, it has almost no biological adverse effects and can be used in iodine-based contrast allergy [11,12].

MRU Versus Renal Scintigraphy

Previous study [6,13] show that MRU has more powerful contrast and temporal and spatial resolution than Renal Scintigraphy, more effective to recognize pyelonephritis and provides more comprehensive functional information.

Limitations

Despite noninvasive characteristic of MRU and their ability to provide high-quality resolution without radiation exposure, few limitations do exist, for pediatrics, the main limitation is sedation and anesthesia, MRU have relatively long imaging times and is sensitive to motion artifact [12], this sedation requirement limits MRU imaging for assessing vesicoureteral reflux (VUR) as sedated patients unable to completely empty their bladder.

Another limitation of MRU is adverse gadolinium reactions, previous study reveal that allergies to gadolinium-based contrast agents are occurring at a rate of 0.03-0.1% [14], although adverse reaction is very rare, it is linked to nephrogenic systemic fibrosis in patient with moderate to end-stage renal disease [15].

ADVANCED ULTRASONOGRAPHY

Over last years, US are markedly skipped in the imaging algorithm where CT and MRU are performed as the first choice. However, US is a non-ionizing imaging tool that has to be taken in consideration especially in pediatrics field, a variety of new techniques have been introduced into US over the past two decade. Advanced US techniques can replace CT in examination of neonatal brain and infant abdominal structure where there is less tissue differentiation and less body fat [16].

Voiding Urosonography

Vesicoureteral reflux (VUR) is a common pediatric disease, diagnosis is commonly depend on voiding cystourethrography (VCUG) and radionuclide cystography (RNC). However, recent developments of echo-enhancing agents have emerged the use of voiding urosonography (VUS) as an advanced diagnostic tool [16]. Papadopoulou and colleagues in their study conclude that VUS with harmonic imaging and a second-generation contrast agent improved the identification and follow-up of VUR in children in compared with VCUG which prompt the usage of VUS as an alternative radiation-free imaging method.

A minor limitation for VUS is the long time; examination may take up to 30 minutes to perform which may be unsuitable for children. However, the examination time may be decreased with the use of harmonic imaging or newer contrast-specific modalities.

Harmonic Imaging

Harmonic imaging (HI) aims to improve image quality by increasing the contrast-to-noise ratio, it is available optimized either for scanning tissues ('tissue' harmonic imaging = THI) or for depicting microbubbles ('contrast' harmonic imaging = CHI). HI provides clearer and sharper US images than fundamental US, improves border recognition and tissue differentiation and reduces artifacts [16]. Its applications include: detection of renal stones, renal parenchymal lesions and the overall US scan of the urinary tract in children.

On the other hand, improving border recognition and tissue differentiation by HI may result in additional artifact; HI exaggerates the normal cortico-medullary differentiation and may falsely be diagnosed as nephrocalcinosis [17].

Three-Dimensional US

Three- dimensional US improve standardization of renal measurements,it can create multiplane views which provide greater anatomic information, this property can be used to describe dilated, hydronephrotic kidney and distinguish a renal cyst from pyelocalyceal diverticulum [16].

INTRAVENOUS PYELOGRAPHY

IVP is used to estimate the physiologic function of urinary system, detection of anatomical abnormalities of the urinary tract and evaluation the degree of obstruction. IVP involves the injection of contrastto capture the travel of contrast through the urinary tract and has served as the diagnostic test of choice for the investigation of patients with suspected acute urolithiasis [18]. Uses of IVP has been decreased in recent year, Non-contrast helical computed tomography(NHCT) replace IVP in the investigation of patients with suspectedacute urolithiasis, in contrast to IVP, NHCT eliminate patient exposure tointravenous contrast material and visualize the pathology outside of the urinarytract [19]. Worster et al. meta-analysis [8] indicates that CT than IVP.

CONVENTIONAL ULTRA-SOUND

Renal US is one of several imaging modalities available in the evaluation of patients with acute urologic disorders. US is based on the interpretation of sound waves that have been reflected by the interface of different tissues in the body, it is rapid, safe, and noninvasive imaging system for the evaluation of urinary obstruction with the ability not only to detect urinary obstructions but also to exclude other abdominal pathologies such as abdominal aneurysms, free fluid, and gallstones [20]. US provides a safe and reliable working diagnosis for immediate management in renal colic and avoid the necessity for out-of-hours emergency intravenous studies with their inherent problems [21]. The benefits of ultrasound pediatric populations include diagnostic accuracy, ease of use, absence of radiation exposure, and no risk of adverse reactions to contrast agents [22].

CONCLUSION

CT has become the mainstay of urography in adults however children are not” little adults”, radiation hazards remain the main limitation; CT dose-modulating methods like iterative image reconstruction techniques are promising techniques that need more investigation.MRU can replace CT withproviding high-quality resolution without radiation exposure, but the necessity for children sedation may consider as obstacle. US are skipped in imaging algorithm but newer modalities as *Voiding urosonography*, *Harmonic imaging*, *3D-US* can provide clearer and sharper US images than fundamental US and can be used as alternatives for MRU and CT.

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