Imaging strategy for South African children with their first proven UTI in a tertiary hospital setting

S Andronikou
MBBCh (Wits), FCRadDiag (SA), FRCR (London)

C Welman
MBChB

E Kader
MBChB

M McCulloch
*MRCP (UK), MRCPCH (UK), FCP (SA)**

Department of Paediatric Radiology and Paediatrics and Child Health (Nephrology), University of Cape Town and Institute of Child Health, Red Cross War Memorial Children's Hospital, Rondebosch, Cape Town*

Corresponding author
S Andronikou
Department of Paediatric Radiology, Red Cross War Memorial Children's Hospital, Cape Town, 7700
Tel: (021) 658-5422. Fax: (021) 658-5101.
E-mail: docsav@mweb.co.za

Presented as a poster at the 37th Conference of the European Society of Paediatric Radiology, Lisbon, Portugal (22-26 May 2000)

Abstract

Urinary tract infection (UTI) is the most common invasive childhood bacterial infection. While it has a benign course in most children, there is a risk that some will develop renal scarring, hypertension and chronic renal failure. There are no simple clinical means to identify those at risk and who would benefit from treatment and so all children with first proven UTI are subjected to imaging. Imaging is directed at detecting vesico-ureteric reflux (VUR), obstruction from pelviureteric junction (PUJ) obstruction or posterior urethral valves (PUV) and kidneys that are scarred or at a risk for scarring. Unfortunately, no single imaging method is able to detect all of the above. Also, the advantages and limitations of many of the imaging methods are not clearly appreciated. This article presents the uses, advantages and disadvantages of current imaging methods and outlines a strategy that attempts to limit the radiation dose and invasiveness of the procedure.

Key words
Vesico-ureteric reflux, ultrasound, MCUG, DMSA, MAG3

Introduction

Many children develop a urinary tract infection (UTI), but only a few of them develop permanent renal damage. Currently all children with a proven UTI are imaged to detect treatable predisposing conditions. Unfortunately, no single imaging method is able to detect all of these conditions. Also, the advantages and limitations of many of the imaging methods are not clearly appreciated. This article presents the uses, advantages and disadvantages of current imaging methods and outlines a strategy that attempts to limit the radiation dose and invasiveness of the procedure.

Ultrasonography is a basic screening test to demonstrate the presence and size (with reference to standard size for age) of two kidneys, exclude obstruction and demonstrate the post-micturition voiding residue.[11]

to page 5

Imaging strategy for South African children with their first proven UTI in a tertiary hospital setting

from page 4

Discussion

Urinary tract infection (UTI) is the most common invasive childhood bacterial infection. While it has a benign course in most children, there is a risk that some will develop renal scarring, hypertension and chronic renal failure.[1,2] Controversy exists as to the role of the predisposing factors, imaging and management in determining the final outcome in these children.[1,3-7] The commonly accepted treatable causes are vesico-ureteric reflux (VUR) and obstruction from pelviureteric junction (PUJ) obstruction or posterior urethral valves (PUV).

A DMSA scan is useful to assess for renal scarring. Reversible defects in isotope uptake may be seen following a UTI. Scarring should be diagnosed only if it persists for more than three months on follow-up DMSA scans. A DMSA scan provides no information about the lower urinary tracts.[4,9,11]

VUR is associated with UTI and renal scarring and this combination results in a poor prognosis.[2,8,9] There are no simple clinical means to identify those at risk and those who would benefit from treatment and so all boys and girls with a first proven UTI are subjected to imaging on this first episode.[8]

Comparison of the uses, advantages and disadvantages of the major imaging methods used in the investigation of proven UTIs in children

Modality	Major uses	Advantages	Disadvantages
Ultrasound	Identify obstructive nephropathy Identify renal anomalies Identify calculi	No radiation No catheterisation	Poor anatomical detail of lower urinary tracts Operator-dependent No information on renal function or detection of VUR
DMSA	Identify focal renal infection or scarring (look identical) and differential renal function Identify renal ectopia or anomalies	Low radiation dose No catheterisation	No assessment of lower tract function (i.e. obstruction or VUR) Needs intravenous access
Direct isotope cystogram (MAG3 via catheter)	Demonstrate VUR	Low radiation dose	Does not show renal scarring/infection Does not identify posterior urethral valves Requires catheterisation with risk of introducing infection
Indirect isotope cystogram (MAG3 via intravenous route) in co-operative continent older children	Demonstrate renal function Demonstrate VUR Demonstrate obstruction Demonstrate renal ectopia and anomalies	Low radiation dose No catheterisation	Does not show renal scarring Does not show posterior urethral valves Needs intravenous access Requires voiding on demand
MCUG	Demonstrate posterior urethral valves and VUR	Good anatomical detail of urethral valves and bladder Good demonstration of VUR	Does not show renal scarring High radiation dose Requires catheterisation, with risk of introducing infection

No single imaging method is able to detect all of these conditions and children therefore undergo a series of imaging procedures.[10,11] Imaging with a ^{99m}Tc dimercaptosuccinic acid (DMSA) isotope study is directed at identifying renal involvement and those kidneys that are at a risk of damage. Studies to demonstrate renal obstruction and VUR are also performed.[4] The uses, advantages and disadvantages of the various imaging methods are compared in the accompanying table.[1,4] Examples of normal and abnormal findings identified at these investigations are shown in Figures 1 to 10.

While the highest rates of renal scarring occur before one year of age,[9] the risk does not decrease significantly until after the age of five.[8] Scarring occurs in a growing kidney susceptible to delays in treatment of UTI, recurrent UTI and severe VUR.[2,8] Numerous studies on

to page 6

Imaging strategy for South African children with their first proven UTI in a tertiary hospital setting

from page 5

Figure 1: Normal right kidney on ultrasound

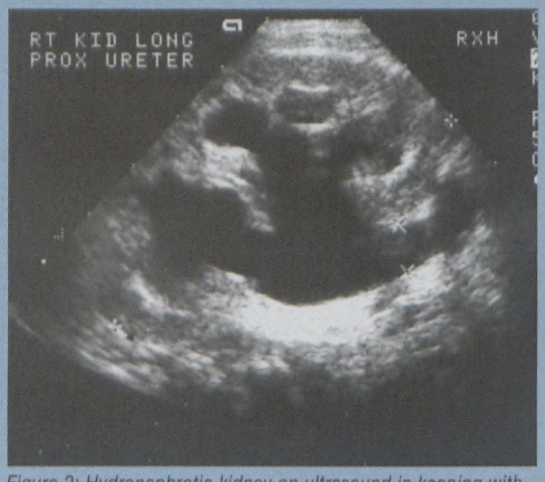

Figure 2: Hydronephrotic kidney on ultrasound in keeping with obstruction

Figure 3: Normal DMSA study showing normal position, configuration and isotope uptake in both kidneys

Figure 4: Abnormal DMSA showing multiple defects representing either scarring or focal infection

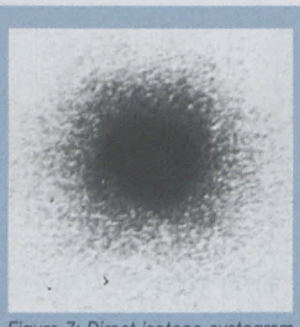

Figure 7: Direct isotope cystogram using MAG3 introduced via a catheter showing a normal bladder with no VUR

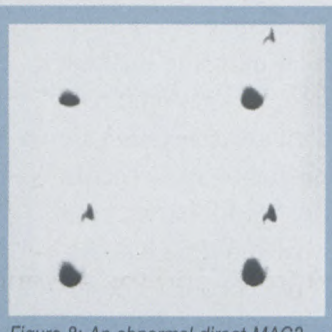

Figure 8: An abnormal direct MAG3 isotope cystogram demonstrating VUR

Figure 5: This MCUG demonstrates a normal bladder and urethra

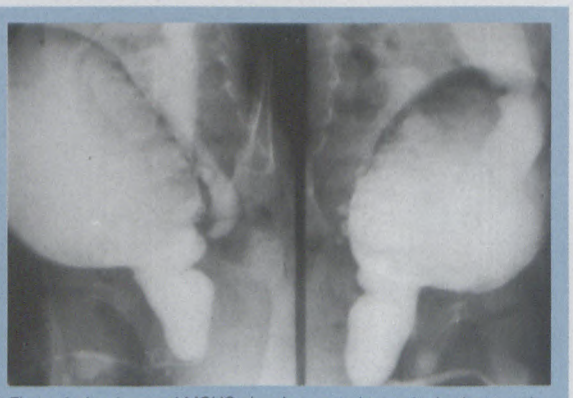

Figure 6: An abnormal MCUG showing posterior urethral valves – note the dilated posterior urethra, a narrow anterior urethra and the VUR

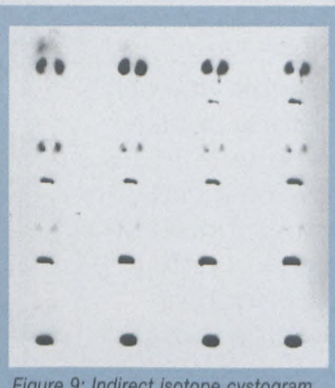

Figure 9: Indirect isotope cystogram using intravenous MAG3 showing normal uptake in both kidneys

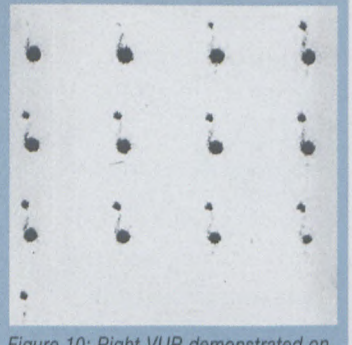

Figure 10: Right VUR demonstrated on this indirect MAG3 cystogram when the child voided on command

first proven UTIs have shown varying results, but overall have demonstrated obstruction in 0-4%,[8] VUR in 8-40%,[2] acute kidney damage in 40%, persistent scarring in 15%, hypertension in 1% and CRF possibly at an incidence of 1 in 20 000.[1] Local experience has found a very low incidence of VUR in the black population.[12]

Realistically, in South Africa, it is

to page 7

Imaging strategy for South African children with their first proven UTI in a tertiary hospital setting

from page 6

not practically manageable to fully investigate every child under five years of age. Figure 11 outlines an imaging strategy that attempts to limit the radiation dose and invasiveness of the procedures while providing information about both the upper and lower urinary tracts. Unfortunately, a DMSA scan is not available in many regions of this country and, where it is offered, may be prohibitively expensive as a screening tool. Figure 12 outlines an alternative approach that takes into account these problems.

An MCUG provides good detail of the bladder and urethra. It does not provide information about the upper renal tracts and the absence of VUR does not exclude the possibility of significant renal scarring.[11]

Are we missing pathology? Most children with a surgically treatable condition will present before two years of age or have an abnormal ultrasound and hence will be further investigated with an MCUG and will be detected. Are we missing renal scarring? Remember that the development of hypertension and chronic renal failure is rare.[1] This concern is addressed by investigating those children with severe (systemic symptoms and signs) or recurrent infections. Also, milder grades of VUR may resolve spontaneously.[4]

Conclusion

The highest risk for scarring is in children less than two years of age and they therefore need appropriate investigation and aggressive therapy. The objective of imaging is to show

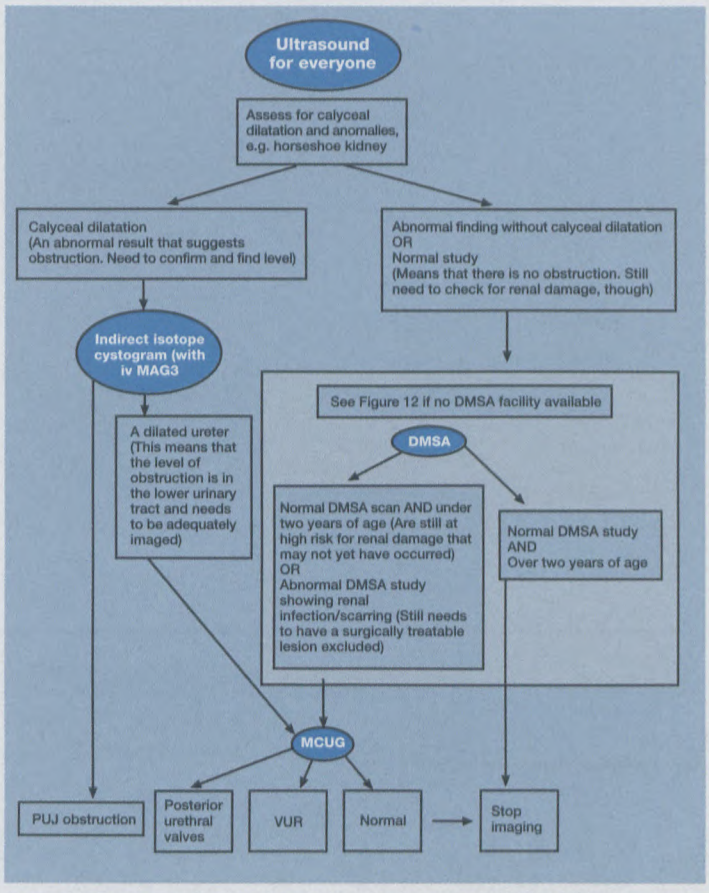

Figure 11: Recommended imaging strategy for first proven UTI in children

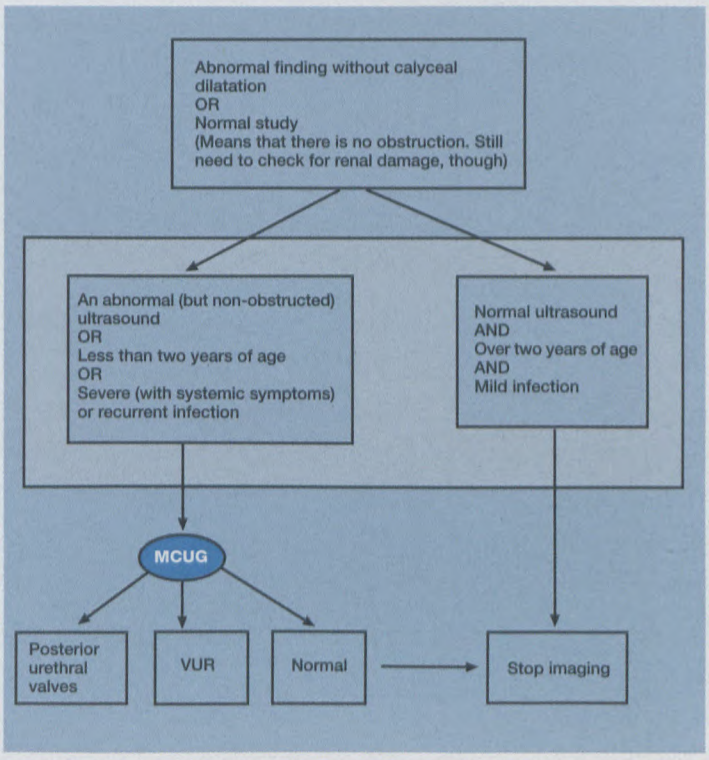

Figure 12: Alternative imaging strategy for first proven UTIs in children where obstruction has been excluded by ultrasound (see Figure 11) and further imaging with a DMSA scan is not available

renal scarring, obstruction and VUR. While catheterisation is traumatic and should be avoided where possible in children, all boys must have a micturating cystourethrography (MCUG) to exclude posterior urethral valves.[9] Isotope studies have a far lower radiation dose than fluoroscopic studies.[1] In an older child that can void on demand (something many adults are unable to do), an indirect cystogram using intravenous ^{99m}Tc mercaptoacetyltriglycine (MAG3) can demonstrate reflux without catheterisation and at a lower radiation dose.[9] It is useful for follow-up of VUR where milder grades may resolve spontaneously.[4] Practically, in South Africa, an ultrasound and MCUG are still the mainstays of investigation and should detect all the surgically treatable conditions. Most importantly, ensuring that the UTIs are

to page 8

Imaging strategy for South African children with their first proven UTI in a tertiary hospital setting

from page 7

microbiologically confirmed will reduce the number of unnecessary investigations.

Acknowledgements

We would like to thank Helen Tomazos, Helmien Growe, Sharon Arroun and Johan Venter for their help in the preparation of this article.

References

1. Craig J. Urinary tract infection in children: Investigation and management. *Modern Medicine of South Africa* 1998 (Nov): 14–25.
2. Smellie JM, Poulton A, Prescod NP. Retrospective study of children with renal scarring associated with reflux and urinary infection. *BMJ* 1994; **308**: 1193-1196.
3. Sreenarasimhaiah V, Alon US. Uroradiologic evaluation of children with urinary tract infection: Are both ultrasonography and renal cortical scintigraphy necessary? *J Pediatr* 1995; **127**: 373-377.
4. Pilling D, Postlethwaite R. *Imaging in urinary tract infection*. Publication by the British Paediatric Association Standing Committee on Paediatric Practice Guidelines. 1996 (June).
5. Mucci B, Maguire B. Does routine ultrasound have a role in the investigation of children with urinary tract infection? *Clinical Radiology* 1994; **49**: 324-325.
6. Fidler K, Hyer W. A strategy for UTI in children. *The Practitioner* 1998; **242**: 538-554.
7. Wennerström M, Hansson S, Jodal U, Stokland E. Disappearance of vesicoureteral reflux in children. *Arch Pediatr Adolesc Med* 1998: **152**: 879-883.
8. Larcombe J. Urinary tract infection in children. *BMJ* 1999; **319**: 1173-1175.
9. Feather S, Gordon I, Risdon RA, Woolf AS, Verrier Jones K. Vesicoureteric reflux: All in the genes? *Lancet* 1996; **348**: 725-728.
10. Smellie JM, Rigden SPA, Prescod NP. Urinary tract infection: A comparison of four methods of investigation. *Arch Dis Child* 1995; **72**: 247-250.
11. Smellie JM, Rigden SPA. Pitfalls in the investigation of children with urinary tract infection. *Arch Dis Child* 1995; **72**: 251-258.
12. Jee LD. Personal communication regarding unpublished data.

Home Cases News Community Search Help

Neuroimaging.org.za

New Web-site

A Web-site hosting neuroimaging cases from the Cape Town metropolitan teaching and private hospitals went on-line on 6 October 2000.

The site, at neuroimaging.org.za, was initiated at the Tygerberg Hospital Radiology Department with the intention of promoting local and national interest in the extraordinary neurological material available from contemporary scanners and at the same time promoting symbiosis of the neurodiagnostic expertise at these hospitals. Ultimately, it is hoped that cases will form an archive for teaching and meetings and could be used to improve patient management through consultation.

Immediate expected users include radiologists, neurologists and neurosurgeons, but teaching material for students, and possibly for an informed public, is envisaged.

The present organisers are Drs Stephan van der Westhuizen, Savvas Andronikou, Andy du Toit and Richard Hewlett, but a national panel of consultants will shortly be operating and a US academic connection is hoped for.

Current funding is personal and sponsorship is needed as a matter of urgency. If you are able to assist, contact Dr Andronikou on (021) 658-5422 (tel), (021) 658-5101 (fax) or docsav@mweb.co.za.

Software used on the site includes Macromedia Flash and Dreamweaver/Fireworks. The Web hosting is by Iafrica (Unix server).

Stephan van der Westhuizen