Abstract

Congenital anomalies of the kidney and urinary tract (CAKUT) are the leading cause of renal failure in children. Obstructive uropathies represent an important part of this group. Obstruction to urinary flow may occur at any level of the urinary tract and may have adverse consequences on the developing fetus. Such consequences include renal dysplasia and the effects of oligohydramnios on lung and skeletal development. Causes of obstructive uropathy may be detected on antenatal screening allowing early identification and intervention in the post-natal period and, in some selected cases, antenatal intervention. Hydronephrosis is detected in up to 2% of pregnancies, many cases will be transient but others will signify congenital pathologies of the kidney and urinary tract. The challenge is therefore to identify those who will require intervention to protect their renal function and doing so at the correct time.

Here we discuss important causes of congenital obstructive uropathy and review recent evidence and recommendations in this field. Vesicoureteric reflex is also discussed, as it is one of the commonest causes of paediatric renal problems, and is frequently diagnosed following an abnormal renal fetal scan.

Keywords: antenatal hydronephrosis, pelvi-ureteric junction obstruction, posterior urethral valves, megaureter, ureterocele, vesicoureteric reflux

Introduction

Key Points

- CAKUT is the leading cause of renal failure in children
- Hydronephrosis is detected in 1-2% pregnancies on routine antenatal scanning
- Most will be transient, others represent CAKUT
- Obstruction of flow of urine exerts a back-pressure on the developing kidney which can cause renal dysplasia
- In severe cases oligohydramnios can result with adverse impact on fetal lung and skeletal development

Obstruction of the developing urinary system may occur at any level of the urinary tract from a variety of pathologies. Impaired flow or reflux of urine leads to hydronephrosis with a spectrum of effects.

Hydronephrosis is detected in 1-2% pregnancies on routine antenatal scanning [1]. It may be the result of “impairment of urine flow or retrograde reflux of urine” [2]. The majority of cases will not be clinically significant and will represent a transient, physiological state, for others however, it will be the presentation of congenital anomalies of the kidney and urinary tract (CAKUT). CAKUT represents 20-30% of all antenatally detected anomalies, affecting up to 0.7% pregnancies [3]. CAKUT will generally be suggested on the 20 week anomaly scan at which point the kidneys and bladder should be visible. The fetal ureter should not be seen under normal circumstances, therefore if visualised this may indicate an underlying pathology (Fig. 1).

A number of grading systems for antenatal hydronephrosis exist. Although no consensus has been reached on which should be used, the most widely accepted is that of the Society for Fetal Urology whereby renal pelvic diameter (RPD) is used as a marker of severity [4].
Antenatal ultrasound image showing bilateral hydronephrosis in the fetus (coronal)

Generally speaking, the greater the degree of persistent hydronephrosis the more likely a significant CAKUT will be present. Impaired flow of urine may occur at any level of the urinary tract and can be unilateral or bilateral [2]. It is initially compensated for by dilation of the renal pelvis followed by the calyces. Persistence of obstruction exerts a backpressure on the renal parenchyma, where this happens during early development dysplasia of the renal tissue can result. Incomplete nephron differentiation occurs along with dilation of the renal tubules, which become lined with immature epithelial cells. With continued obstruction, tubular atrophy will occur with the development of interstitial fibrosis and ultimately glomerulosclerosis. In severe cases the glomerular filtration rate will reduce. A contralaterally normal kidney may compensate for this, however this will not be the case in those with bilateral disease or where outflow of fetal urine is severely impaired [1, 7].

During the second trimester the contribution of fetal urine to amniotic fluid levels rapidly increases, being responsible for >90% amniotic fluid by 20 weeks gestation. With severe impairment of fetal urinary flow, oligohydramnios will result [3]. Oligohydramnios results in mechanical compression of the fetus and inhibition of thoracic expansion. Lung hypoplasia results from low levels of fluid entering the airway and is a leading cause of early mortality and morbidity in patients with CAKUT [5]. Oligohydramnios also has adverse effects on the developing skeleton. For a small number of specially selected cases with bilateral renal involvement and oligohydramnios, fetal intervention may be considered. For those in whom hydronephrosis has been identified antenatally, evaluation in the postnatal period must be timed appropriately. Performing imaging within the first 48 hours of life may underestimate the degree of hydronephrosis due to physiological dehydration during this time. A multidisciplinary consensus published in the Journal of Paediatric Urology in 2014 has advised the first postnatal ultrasound be performed at >48 hours of age (but less than 1 month) [6]. Obstructive uropathy and the resultant renal dysplasia, and renal dysplasia associated with vesicoureteric reflux are the leading cause of renal failure in children. Early identification, intervention and prevention of decline through infection could improve outcome. The causes are discussed below.

**Pelvi-ureteric Junction Obstruction (PUJO)**

- **Key Points**
  - PUJO is the most common cause of pathological antenatal hydronephrosis
  - It is more common on the left side but is bilateral in 10-20% cases
  - May be suggested by an isolated dilated renal pelvis with normal ureter and bladder on antenatal scanning
  - May be intrinsic (due to abnormal peristalsis) or extrinsic (due to external compression)
  - Surgical intervention aims to relieve the obstruction at the PUJ.

Pelvi-ureteric junction obstruction (PUJO) is the most common cause of pathological antenatal hydronephrosis with an incidence of 1 in 2000 [7]. There is a male preponderance (male:female 3:1) and more commonly it affects the left side (left:right 11:2) but is bilateral in 10-20% cases [2]. Impaired drainage of urine into the ureter causes progressive dilation of the renal pelvis followed by the calyces which may cause dysplasia of the developing kidney [2]. An isolated dilated renal pelvis with normal ureter and bladder may suggest PUJO on antenatal scanning. An older child may present with loin pain or urinary tract infection. Initially, impaired drainage of urine is compensated for by dilation of the renal pelvis, thereby maintaining low pressure in the collecting system. With persistence of the obstruction this mechanism may be overcome permitting back-pressure to dilate the calyces and exert pressure on the renal parenchyma. If such decompensation occurs during renal development, a dysplastic kidney may result [2]. PUJO can lead to loss of function of the affected kidney. Congenital PUJO may be intrinsic or extrinsic.
Intrinsic PUJO results from abnormal peristalsis that may be due to abnormal fibromuscular and neural arrangements within the proximal segment of ureter at the PUJ level [2, 8]. Extrinsic PUJO is caused by external compression of the ureter, most commonly by an aberrant crossing vessel [2]. Postnatally an ultrasound scan of the renal tract is aimed to determine the renal pelvic diameter (RPD), presence and degree of calyceal dilation and assess the renal cortex. Doppler may also be used to identify aberrant crossing vessels. Patients may also undergo an MCUG to exclude bladder outlet obstruction and reflux. In very severely dilated systems a DMSA (dimercaptosuccinic acid) scan may be utilised to assess split function and provide evidence if considering pyeloplasty or nephrectomy [2].

The gold standard investigation for hydronephrosis is a MAG-3 renogram with diuretic. It gives an estimate of split or differential renal function (DRF) and assessment of the rate of clearance of the isotope from the blood. MAG-3 provides information on excretion and drainage though the elimination of the tracer [2]. In a number of cases an obstructed curve may not provide a true reflection of obstruction, but rather the filling of a very baggy system which results in delayed drainage. Renogram analysis is limited in cases of bilateral hydronephrosis, with management being decided on an individual basis.

Serial imaging and review is required to determine the need for intervention or conservative management. One might continue conservative management if: the patient is asymptomatic, the degree of renal pelvic dilation on serial USS is stable or improving and the differential renal function remains stable or improved. Indications for surgical intervention include: being symptomatic with pain or infection, worsening DFR, increasing RPD or development of calyceal dilation [2].

Options for surgical intervention: Dismembered pyeloplasty remains the gold standard treatment with removal of the obstructing segment of ureter and creating a tension free, funnel shaped anastomosis allowing dependent drainage of urine [2, 9]. Success is deemed as symptom resolution, stable or improved hydronephrosis and DRF, success rates for this procedure are > 95% [2]. Transposition of crossing vessels or vascular hitch is an alternative method for treating extrinsic PUJO. A study of long term outcomes has shown this to be a safe and reliable alternative to dismembered pyeloplasty in the absence of intrinsic obstruction [10]. Both can be safely performed open, laparoscopically or robotic assisted (Fig. 2).

Endourological management including endoscopic high pressure balloon dilatation or endopyelotomy has also been reported with diverse outcomes [11, 12]. Severely affected kidneys with limited function and a normally functioning contralateral side should be considered for nephrectomy.

**Posterior Urethral Valves**

**Key Points**

- Most common cause of bladder outflow obstruction in boys
- May be suggested on antenatal scanning with bilateral hydronephrosis, bilateral hydroureter and a distended thick walled bladder
- Presentation in early gestation is associated with poorer outcomes
- Oligohydramnios indicates severe disease and may result in lung hypoplasia
- Risk of postnatal electrolyte disturbance and post-obstructive diuresis
- Management includes decompression of the urinary tract with a catheter and subsequent ablation of the PUV

Posterior urethral valves (PUV) are the most common cause of bladder outflow obstruction in boys with an incidence of around 1 in 5000 live male births [13]. A thin membrane of tissue within the posterior urethra, most commonly at the level of the verumontanum [14] obstructs the flow of urine causing bladder outflow obstruction. It is thought that this most likely results from fusion of enlarged urethral folds secondary to abnormal insertion of the Wolffian ducts into the posterior urethra [14]. The consequences vary widely from mild to end stage renal failure. Up to two thirds of cases will be suspected from antenatal ultrasonography [13].
Features which may suggest the presence of PUV include:
- Bilateral hydronephrosis
- Bilateral hydroureter
- Distended, thick walled bladder with keyhole sign
- Severe cases: oligohydramnios and echogenic renal parenchyma which may have cystic change (suggested renal dysplasia)

Gestational age at diagnosis is an important determinant of renal outcomes [15]. Identification of these changes before 24 weeks gestational age is associated with poor prognosis [14]. A small number of children will present outside of the neonatal period, usually in infancy with a urinary tract infection, sepsis, poor urinary stream and occasionally in the older child with wetting [14].

A link has been shown between bladder outflow obstruction and renal dysplasia. Experimental models have suggested an element of reversal in this should the obstruction be relieved [13]. Antenatal intervention for PUV has been performed including vesico-amniotic shunt insertion and fetoscopic PUV resection, however the introduction of such procedures have not been shown to improve renal outcomes [16] and remain high risk for complications. In specially selected cases, some benefit has been shown in lung development by returning normal levels of amniotic fluid only. Current indications for fetal intervention include severe oligohydramnios in the presence of immature lungs [16, 7].

At delivery a global assessment of the neonate should be carried out with a focus on resuscitation and provision of respiratory support where needed. The urinary tract should be decompressed with placement of a urethral catheter. A suprapubic catheter will be required if it is not possible to place one urethrally. It is also recommended that the child also be commenced on prophylactic antibiotics. Polyuria and electrolyte disturbance (Na+, K+, bicarbonate) may follow relief of the obstruction. Close monitoring and replacement of a post-obstructive diuresis is therefore needed. This includes regular assessment of electrolytes and acid-base balance. Creatinine may initially be a reflection of maternal renal function, therefore true value should be considered over 48 hours postnatally. In cases with renal impairment, creatinine tends to be elevated in the first 7 to 10 days, before improving or stabilising.

Coleman et al. [17] have suggested nadir creatinine can be used as a prognostic indicator of CRI in PUV. Nadir creatinine <35umol/l is associated with a low risk, 35-75umol/l intermediate and >75umol/l high risk. They also found higher stages of CKD in the higher risk groups [17].

Investigations should then be carried out to confirm the diagnosis. This will include an ultrasound scan of the renal tract to assess the size and quality of the renal parenchyma, degree of hydronephrosis, bladder wall thickness and may show a dilated posterior urethra [13]. A micturating cystourethrogram (MCUG) remains the gold standard investigation to demonstrate PUV and may be performed once the neonate has been stabilised. In addition to demonstrating the valves, it may also show a dilated posterior urethra, bladder neck, a trabeculated bladder and the presence of vesicoureteric reflux [13] (Fig. 3).

Primary valve ablation is the definitive treatment for PUV and is performed once the child is well enough, level of renal function established (creatinine levels stabilised) and large enough to tolerate the passage of a resectoscope (generally >2.5kg [13]). An initial cystoscopy is performed to examine the urethra, bladder and ureteric orifices and to document the nature and position of the valves. Ablation can then be carried out using methods such as cold knife ablation or diathermy.

In neonates unfit for ablation and for whom catheterisation proves to be a persistent problem or suprapubic catheterisation not possible, a urinary diversion procedure may be considered.

A repeat cystoscopy to confirm complete ablation should be performed at 3 months post primary ablation. At this time parents may be offered a circumcision which has been shown to reduce the risk of urinary tract infection in
Figure 4. USS image of megaureter - behind bladder (b.i.)

PUV by >80% [13]. Long term prognosis is variable with up to 1 in 3 developing chronic renal insufficiency (CRI) (chronic kidney disease (CKD) stage 2 or greater) and up to 1 in 4 end stage renal failure [17]. For this reason children should remain under the care of a paediatric urologist/nephrologist and transition into adult care.

Long term management aims to protect renal function and prevent further decline through infection related scarring, management of associated bladder dysfunction and aims to achieve early identification and management of hypertension and proteinuria, ultimately allowing optimal detection and management of CKD [13].

Vesicoureteric Junction Obstruction and Megaureter

Key Points
- A megaureter is defined as a retrovesical ureter >7mm in diameter at >30 weeks gestation
- May be primary (due to an abnormality at the VUJ) or secondary (due to another anomaly, i.e. bladder outflow obstruction)
- Primary megaureter may be obstructed or non-obstructed and refluxing or non-refluxing as assessed on MAG-3
- Temporary stenting will drain the upper tracts
- Around 50% may resolve after stent removal, others may need intervention including endoscopic balloon dilatation of the VUJ or ureteric reimplantation

Obstruction of the flow of urine at the VUJ may cause dilation of the proximal ureter. This may be detected on antenatal ultrasound. The British Association of Paediatric urologists classifies a “retrovesical ureteric diameter ≥7mm from 30 weeks gestation onwards” as abnormal [18]. It is most commonly unilateral but can affect both sides.

Megaureter may be primary, caused by an abnormality at the VUJ or secondary, resulting from another anomaly, i.e. bladder outflow obstruction due to PUV. Primary megaureter is further classified pending the presence or absence of reflux, classification includes [19]:
- Refluxing, non-obstructed - common, related to high grade (IV-V) VUR. Most commonly due to an abnormal intravesical pathway of the ureter allowing retrograde passage of urine.
- Refluxing, obstructed - rare, usually related to an ectopic ureter.
- Non-refluxing, non-obstructed - common, also known as primary dilated megaureter.
- Non-refluxing, obstructed - rare, usually symptomatic with or without renal impairment. Primary megaureter is the second commonest cause of neonatal hydronephrosis with an incidence of 3.6 per 10000 live births [19]. It is twice as common in boys and more frequently affects the left side [20]. It is thought to be due to abnormal development of the distal ureteric muscle resulting in an aperistaltic segment which causes a functional obstruction.

Prognosis is good for unilateral VUJ obstruction with megaureter, therefore there is no indication for antenatal intervention. Severe bilateral VUJ obstruction may lead to oligohydramnios which may require intervention [19]. Initial assessment aims to determine the nature of the megaureter. VUJ obstruction is likely to require surgical intervention to prevent renal impairment. Assessment should include a post-natal USS of the renal tract (Fig. 4) and an MCUG to assess for the presence of reflux or bladder outlet obstruction. Diuretic renography (MAG-3 renogram) may also be used to assess renal function and excretion, this will also differentiate between non-refluxing obstructed and non-obstructed conditions [19]. Although there are no major randomised controlled trials to establish the optimal course of treatment [19], management of megaureter aims to establish flow of urine from the ureter into the bladder and to prevent further deterioration of renal function by decompressing the system and preventing urinary tract infection. Neonates may be commenced on prophylactic antibiotics after delivery.

In primary VUJ obstruction, the most recent evidence suggests that high pressure balloon dilatation of the VUJ can achieve temporary and long term effective treatment in patients of any age [12, 21]. A temporary ureteric JJ stent may be placed to bypass the aperistaltic segment. Stenting may safely decompress the upper tract allowing the child to grow until definitive surgery may be considered if their obstruction persists. Farrugia et al. reviewed long term outcomes of stenting for VJO in 16 infants, they
Figure 5. USS demonstrating a large intravesical ureterocele.

Figure 6. MCUG demonstrating an intravesical ureterocele and VUR

found 56% children who were stented did not require any further intervention after removal of the stent [22] (of note however one third of patients in this group were reported to have had stent related complications).

A refluxing ureterocystotomy or end ureterostomy may also be utilised where a dilatation or insertion of a stent cannot be achieved.

Definitive intervention may include excision of the abnormal segment and a tapered ureteric anti-reflux reimplantation. Success rates for this procedure are excellent (>90%) [19, 22, 23] and when performed in early life can prevent the development of renal damage.

Long term outcomes are positive. The majority of non-obstructive refluxing megaureters will resolve spontaneously in time.

**Ureterocele**

**Key Points**

- A ureterocele is a cystic dilation of the terminal ureter
- Commonly associated with a duplex system
- May be intravesical or ectopic
- May be detected antenatally if obstructing the ureter causing hydronephrosis
- In acute sepsis endoscopic puncture should be performed to decompress the upper tract
- Endoscopic puncture is a highly effective initial treatment for intravesical ureteroceles
- In some cases with persistent symptoms of clinically significant vesicoureteric reflux or incontinence, ureterocele excision and ureteric reimplantation may be required.

“A ureterocele is a cystic dilation of the terminal ureter”, 80% are associated with the upper pole of a duplex system [25]. The pathogenesis is not currently understood. Reported incidence rates vary widely up to 1 in 500. Ureteroceles are 4-5 times more common in females and are bilateral in 10% cases [25].

Ureteroceles are classified by their association with a simplex or duplex collecting system and by their location. They may be either intravesical (within the bladder) (Fig. 5) most commonly associated with a simplex system, or ectopic (extending beyond the bladder neck) more commonly associated with the upper pole of a duplex system.

The ureterocele may be identified antenatally if it is obstructing the ureter causing hydronephrosis. Postnatal ultrasound will identify a cystic structure within bladder and delineate a simplex or duplex system. An MCUG may be performed to demonstrate the presence of bladder outlet obstruction and vesicoureteric reflux that, in duplex systems, is common to the lower pole (Fig. 6).

Function should be assessed with renography, such as MAG-3, which will not only assess the differential function between the right and left kidney but can also delineate the split function of the upper and lower poles of a duplex system. The renal pole associated with the ureterocele commonly has very poor or absent function [25].

Initial surgical management consisting of endoscopic puncture is often required in patients who demonstrate bladder outlet obstruction, infective complications or deterioration of the upper urinary tract. This has been reported to be effective in up to 90% intravesical ureteroceles. Ectopic ureteroceles generally require more invasive surgical management. Intravesical ureteroceles can be managed with endoscopic puncture or endoscopic balloon dilatation of the ureterocele meatus [11].

Management of ureteroceles associated with a duplex system will depend on the function of
Figure 7. MCUG with grade 5 VUR into calyces

the associated pole and the presence or absence of VUR. If the associated pole is poorly functioning a heminephroureterectomy may be appropriate. Ectopic ureteroceles may require excision and re-implantation of the ureter with or without reconstruction of the bladder neck [25].

Outcomes are generally better with early identification and decompression [25].

**Vesicoureteric reflux**

**Key Points**

- Vesicoureteric reflux is the retrograde flow of urine from the bladder into the ureter and kidney
- Renal damage can be associated to VUR secondary to concomitant renal dysplasia or renal scarring following infection
- Primary vesicoureteric reflux tends to resolve with time, mainly when it is low grade, not associated with renal damage and asymptomatic
- VUR can be primary or secondary resulting from another bladder pathology
- Management aims to prevent further renal scarring through prevention or prompt treatment of UTI
- Management options include: antibiotic prophylaxis, STING procedure or ureteric reimplantation

Vesicoureteric reflux describes the retrograde flow of urine from the bladder into the ureters and in severe cases to the kidney. VUR can lead to scarring of the kidney and reduced parenchymal mass resulting in hypertension, proteinuria and chronic renal insufficiency. VUR is the most common reason for children to reach end stage renal failure [26]. Scarring has been historically attributed to damage caused through recurrent infection and pyelonephritis. New evidence has suggested that the presence of reflux antenatally may result in a degree of parenchymal maldevelopment causing hypoplasia or dysplasia of the kidney. Renal damage from VUR may now be classified as congenital or acquired [27].

Reflex affects 1-3% of all children [26] and is present in 38% who have antenatally detected hydronephrosis [7]. VUR is a risk factor for recurrent urinary tract infection.

VUR may be primary, where an abnormally short course of the intravesical ureter results in incompetence of the vesico-ureteric junction, or secondary, as a result of another bladder pathology causing raised intravesical pressures, such as PUV or a neurogenic bladder.

The severity of reflux is graded using the International Reflux Study Classification, grade 1 (mild) to grade 5 (severe) (Fig. 7). Low grade primary reflux commonly resolves with time as the intravesical portion of the ureter grows in length aiding the normal anti-reflux mechanism of the VUJ [27]. Estrada et al performed a retrospective review of 2,462 children with primary vesicoureteric reflux and found resolution of reflux in 51% patients by 2 years [28]. “Factors associated with spontaneous resolution included age under one year, lower grades of VUR, prenatal hydronephrosis and unilateral involvement. Rates of spontaneous resolution were 72%, 61%, 49% and 32% for grades I, II, III and IV/V respectively” [27].

Investigation should include assessment for the presence of proteinuria and infection. USS of the renal tract to exclude other causes of hydronephrosis should be performed along with an MCUG to determine the severity grade and assess for causes of secondary reflux and identify children with bladder and bowel dys-function [27]. A DMSA scan to determine the presence and extent of renal cortical scarring should also be undertaken.

A “top-down approach” in the diagnosis and management of VUR has recently been suggested. This is based on the fact that prevention of permanent renal scarring represents the ultimate goal of any management strategy for childhood with VUR. Is also known that is acute pyelonephritis, rather than VUR, is prerequisite...
for development of scarring. The goal of the “top-down” approach is be based on identifying renal scarring on DMSA and then screening for VUR [29, 30]. This approach is based on earlier reports of the high sensitivity of DMSA scanning in detecting high grade VUR [31]. Management of VUR ultimately aims to prevent pyelonephritis and further scarring of the renal parenchyma, thereby protecting renal function from further decline.

Management of VUR has classically been either medical or surgical. Medical management requires the use of daily prophylactic antibiotics with a view to maintain sterile urine, thereby reducing the risk of UTI and its sequelae [32]. Compliance with daily antibiotics is variable. A number of studies have recently attempted to determine whether long term antibiotic prophylaxis is superior to conservative watchful waiting with prompt treatment of any UTIs. Many are limited by heterogeneity of patients.

Notably, the Swedish Reflux Trial found reduced rate of UTI and renal scarring in children with high grade VUR (III-V) when treated with prophylaxis or STING procedure compared to observation [32, 33].

The RIVUR trial (Randomised Intervention for Vescoureteric Reflux) found a reduced risk of recurrent UTI with antibiotic prophylaxis when compared to placebo. This study also suggested prophylaxis was most effective for children with bladder/bowel dysfunction [32, 34]. They found children with high grade VUR (III-V) were more likely to suffer UTI that those with low grade (I-II). Prophylaxis for low grade VUR was associated with a significantly lower risk of UTI and also reduced the risk in higher grade reflux, however in this group did not reach statistical significance [34].

The RIVUR trial reported however, that antibiotic prophylaxis did not reduce the incidence of renal scarring on scintigraphy at two year follow up and was associated with an increase in Trimethoprim-Sulfamethoxazole resistant E.coli in some children. This study was limited by the duration of follow up, as benefit against renal scarring may become more evident over time. The authors also noted over all lower rates of renal scarring when compared to previous similar studies. This may be attributed to the prompt assessment and management of UTI in the placebo group [32].

Surgical intervention commonly begins with endoscopic subureteric transurethral injection (STING procedure) with a dextromer/hyaluronic acid co-polymer (e.g. Deflux®). This procedure is generally well tolerated as it is minimally invasive with few complications. Short- term rates of resolution of reflux have been shown to be on a par with open surgery [35]. High rates of success are reported, however repeated treatments may be required [36]. The Swedish Reflux trail assessed the long term outcome of children with higher grade reflux and found an initial resolution rate of 71% but 20% had recurred by 2 year follow up [32, 33]. Alternatively open ureteric reimplantation has excellent success rates of 95-99% despite severity grade [32]. This procedure may also be carried out via an open or laparoscopic approach or with robotic assistance. Initial studies suggested the outcomes of robotic procedures were on a par with the open procedure, however more recent evidence has suggested the success be less. Further studies are undergoing to evaluate this further [37].

Overall current guidance supports the use of antibiotic prophylaxis in children with moderate to high grades of VUR, at least until they achieve toilet training and the ability to communicate symptoms of UTI, or resolution of reflux occurs. Once toilet trained surveillance or ongoing prophylaxis may be appropriate. Surgical intervention should be considered for symptomatic high grade reflux, or in cases with poor compliance with prophylaxis or parents’ choice. There is limited data to determine when medical management may be safely stopped, some advocate continuing until resolution of reflux on MCUG, others may stop following a year free of infection.

Children with renal scarring should undergo long term follow up to include assessment of blood pressure and urinalysis allowing early identification of renal insufficiency [32].
REFERENCES