Vesicoureteric Reflux

- Etiology
- Pathogenesis
Def: Retrograde flow of urine from the bladder into the upper urinary tract.

Prevalence between 0.4 ~ 1.8% of pediatric populations.

30% in children with symptomatic UTI or bacteuria during screening program at age 2 ~ 18 years, 50% for neonates.
Males with VUR are likely to be identified in infancy most of them after prenatal detection.

Females are mostly detected between 2 and 8 years of age following UTI.
Normal ureter propels boluses of urine into the bladder in an antegrade fashion.

Require 3 criteria:

1) 3 muscular layers:
   I. Inner longitudinal
   II. Middle circular
   III. Outer longitudinal

2) Low pressure in bladder

3) UVJ must occlude the distal ureter with the increase pressure during bladder filling or contraction
Mechanism to prevent VUR

- Ureterovesical complex function as a single unit that exhibits both passive and active component.
Passive component:

“Flap-valve” effect:

- intravesical ureter ideally has an oblique course
- proper muscular attachment to provide fixation around posterior support to enable it’s occlusion, and adequate submucosal length
Active component:

- When bolus of urine approaches hiatus, the intravesical longitudinal muscle contract, pull the orifice towards the hiatus to shorten and widen the intravesical ureter thus reducing the resistance.
- After the ureter relaxes, it return to it’s normal position beneath the bladder mucosa, “flap-valve” mechanism prevents return during bladder filling.
Primary reflux

- Congenital anomaly of the UVJ wherein a deficiency of the longitudinal muscle of the intravesical ureter results in an inadequate valvular mechanism.

- Paquin-study, a 5:1 ratio of tunnel length to ureteral diameter was found in normal children without reflux

- Children with reflux had a ratio 1.4:1
Figure 59-1. A. Refluxing ureterovesical junction has same anatomic features as nonrefluxing orifice, except for inadequate length of intravesical submucosal ureter. Some orifices with marginal submucosal tunnels may reflux intermittently. (From Glenn] [ed]: Urologic Surgery, 2nd ed. New York, Harper & Row, 1975.) B. Ureterovesical junction in longitudinal section. 1. Photomicrograph. 2. Diagrammatic representation. The ureteral muscularis (u) is surrounded by superficial (ss) and deep (ds) periureteral sheaths, which extend in the roof of the submucosal segment and continue beyond the orifice into the trigonal muscle (t). The relationship of superficial sheath to the vesical muscularis (v) is clearly seen. Transverse fascicles in the superior lip of the ureteral orifice belong to the superficial and deep sheaths. No true space separates ureter from bladder. (From Elbadawi A: Anatomy and function of the urethral sheath. J Urol 1972;107:224.)

Table 59-2. MEAN URTERAL TUNNEL LENGTHS AND DIAMETERS IN NORMAL CHILDREN (IN MILLIMETERS)

<table>
<thead>
<tr>
<th>Age (Yr)</th>
<th>Intravesical Ureteral Length</th>
<th>Submucosal Ureteral Length</th>
<th>Ureteral Diameter at Ureterovesical Junction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>7</td>
<td>3</td>
<td>1.4</td>
</tr>
<tr>
<td>3-6</td>
<td>7</td>
<td>3</td>
<td>1.7</td>
</tr>
<tr>
<td>6-9</td>
<td>9</td>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>9-12</td>
<td>12</td>
<td>6</td>
<td>1.9</td>
</tr>
</tbody>
</table>

The vesicoureteric junction. (Left) The normal junction with a long submucosal tunnel compared with a refluxing ureteric orifice with a short submucosal tunnel (right). (Adapted from Hutch JA. Vesicoureteral reflux and pyelonephritis. New York: Appleton-Century-Crofts;1972.)

Causes of secondary vesicoureteric reflux:
- Posterior urethral valves
- Duplex systems
- Detrusor instability
- Neurogenic bladder
- Non-neurogenic neurogenic bladder
Secondary reflux

- Caused by bladder obstruction and the elevated pressure that accompany it
- Obstruction either anatomic or functional
Anatomic:

1) Posterior urethral valve: 50% of affected boys
2) Ureteroceles can block bladder outlet, distort anatomic relationship of trigone
3) Urethral stenosis
4) Meatal stenosis
Functional causes:

1) Neurogenic bladder e.g. spina bifida
2) Non-neurogenic neurogenic bladder
3) Bladder instability or dysfunction
4) Altered bladder dynamic
Reflux can also be associated with obstruction.

Reflux may also result from obstruction to the lower tract or a neuropathic bladder disorder, as seen here.
Pathophysiology of VUR

- Poor compliant bladder or abnormal interplay with the urinary sphincter can result in increased intravesical pressure, which can gradually weaken and overcome the ureteral sphincter mechanism at UVJ and cause reflux.
Young children, commonly demonstrate a labile, infantile type response to bladder filling in the form of uninhibited contractions.

The child who is in early stage of toilet training, and attempting to maintain continence, responses to this instability by contracting the external sphincter.

Continence can be maintained, but at the expense of abnormally increased intravesical pressure.
Complete emptying is seen at least initially but gradually incomplete emptying occurs. The residual that remain become an obvious risk factor for UTI.
In non-neurogenic neurogenic bladder, detrusor-sphincter dysfunction result gradual bladder decomposition and myogenic failure result from incomplete emptying and increasing amount of residual urine.

Decrease bladder wall compliance, detrusor decomposition, and incomplete emptying gradually damage the complex anatomic relationships required of the UVJ.
The development of reflux further impairs bladder emptying and amplifies resting and filling pressure thus initiating a self perpetuating cycle of upper and lower urinary tract damage.
Clinical correlations

1) Identify secondary causes of VUR
2) Symptoms of voiding dysfunction e.g. dribbling, urgency incontinence
3) Treat underlying bladder dysfunction and instability
4) Strong association between intravesical pressure >40 cmH\textsubscript{2}O and presence of reflux in patients with myelodysplasia and neuropathic bladder
5) Lower urinary tract infection (cystitis) can cause VUR by worsening compliance, elevating intravesical pressure, distorting and weakens the UVJ
Diagnostic of VUR

- Micturating cystourethrography is the standard investigation.

Reflux may occur in both ureters of a duplex system.

Reflux may also be secondary to iatrogenic damage to the ureteric orifices in endoscopic procedures and here followed endoscopic incision of a ureterocele. IVU showing right ureterocele; MCU after endoscopic incision.