Color duplex-Doppler: A useful tool in hydronephrosis evaluation

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Learning objectives

To demonstrate the applications of the Duplex ultrasound in the evaluation of hydronephrosis, as an adjuvant tool to conventional ultrasound.

Background

The ultrasound is a diagnostic tool for hydronephrosis evaluation, searching possible etiologic obstructive factors. The mapping with color doppler can help in the differential diagnosis of hydronephrosis, in a non-invasive way and requiring no administration of contrast medium. The following situations will be analysed with emphasis on acute hydronephrosis (kidney stones):

1. Differential diagnosis of pseudo-hydronephrosis. Prominent hilar vessels can mimic hydronephrosis in B mode but the color doppler differentiates, unequivocally, vascular structures from the collecting system. Similarly, aneurysms or pseudoaneurysms nearby the renal hilus may simulate extra-renal pelvis, hydronephrosis or cysts, but the intense signal at the color doppler mapping can easily make the distinction. (Figs. 1 e 2).

2. Patency ureteral flow: [1, 4, 5] Ureteral jets can be easily detected by placing the sample of the color doppler on the bladder floor, next to the ureteral meatus (Figure 3). This is one of the most well-known use of color doppler in the hydronephrosis study, however a factor that should always be considered is the lack of absolute symmetry in both jets. A recent study performed in our department showed that amplitude, frequency and frequency of ureteral jets are not absolutely equal. Therefore, the non observation of a ureteral jet may not confirm an obstruction, or the presence of a ureteral jet may not exclude an obstructive cause (e.g. a semi-obstructive stone). In the latter case, there is a significant decrease in the amplitude of the jet, compared to the non-affected side (Figure 4).

3. Study of amorphous formations within the bladder. Any amorphous hypoechogenic formation within the bladder imposes the differential diagnosis of an expansive process or a blood clot. Besides mobility, we can actively search for flow within the formation. If it is present at the doppler, a mass or bladder inflammation should be considered. (Figure 5)

4. Evaluation of posterior artifacts to the stones (twinkle artifact): [7] The color Doppler can produce a posterior artifact to calcium structures, characterized by a mosaic of colors in the region of posterior acoustic shadowing. This artifact is not unique to lithiasis, and should not be confused with situations such as vascular malformations or fistulas. Its application...
lies in the differentiation of intestinal gas and when the calculation is in
the ureteral path, known to one of the greatest difficulties in the research
of ureterolithiasis, and assist in the differential diagnosis of other calcified
structures in the pelvis. When the ureter were dilated, and elongated
structure tubuliforme, scanning with color Doppler region of the crossing with
the iliac vessels can also help, differentiating vascular structures (with color
Doppler) of the dilated ureter (without color Doppler). This can be particularly
useful in obese patients or with intense meteorism (Figure 6).

5. Study of the intra-vascular impedance in renal interlobar arteries. The
pressure increase in the collecting system during an acute mechanical
obstruction is well known. It leads to increased resistance to blood flow
and increased levels of interlobar arteries resistivity. This method should
be applied to both kidneys, one should seek a significant increase in the
obstructed kidney (normal RI 0.7), or a gradient greater than 0.1 when
compared to the contralateral kidney [4, 5, 8] Initially this method was
very promising, but soon a reduced sensitivity was observed due to false
negative factors: first if the caliceal fornix leaks, there is a decompression
and the interlobar arteries IR will return to normal levels.. Second, the rise
in the interlobar arteriesIR occurs only after 6 hours of obstruction, thus
making it a non reliable method in very acute pain. [2, 3, 6, 9]. Finally, in
semi-obstructive condictions, the changes in interlobar arteries IR are not
satisfactory for differential diagnosis.

studies have shown a characteristic presentation of the spectral curve
of a normal mean interlobar vein in a normal kidney. In the presence of
obstructive or semi-obstructive factors, there is a flattering in the usual
presentation curve (a phenomenon called portalization) (Figure 7). The
asymmetry between both kidneys should be analised as there is a great
variability in the populational spectrum of mean interlobar vein IR.In order
to minimize subjective criteria the measure of the mean interlobar vein
IR, should be applied as to an artery (markers at the highest and lowest
absolute velocity in the vein spectrum) (Figure 8). The IR shows significant
decrease in the affected kidney compared with contralateral normal one,
even in semi-obstructive condictions, leaking of the caliceal fornix and
vey acute renal pain (less than 6 hours history), even preceding the
hydronephrosis installation (Figs. 8-30 and 8-31). The bilateral examination
is necessary, as said because of the great variability in normal population
IR measurement , without a consensus cutoff value. In our department,
to evaluate a acute renal pain, we began with the characterization of
hydronephrosis and active lithiasis identification on the statistically more
frequent sites (UPJ, iliac vessel crossing and UVJ). The contralateral kidney
and bladder are carefully studied too. If there is no characterization of
obstructive factors after a detailed analysis, we proceed to carefully study
of the ureteral traject with patient decubitus mobilization . If there is still
no characterization of stones, we proceed to the analysis of the mean
interlobar vein IR curve. If negative the study is ended. If positive, the patient
will be reviewed a second time, after partially emptying the bladder. If no stone is detected, we consider it is in ureteral transit and other methods are suggested (spiral CT, X-rays) or the patient can be re-evaluated afterwards according to his physician.

Images for this section:

Fig. 1
Fig. 3
Fig. 7
Imaging findings OR Procedure details

Fig1. Aneurysm formation in the hilus, simulating extra-renal pelvis, with intense color Doppler mapping.
Fig2. Cystic formation adjacent to the renal sinus, which has a strong signal to the Doppler mapping and it is a renal artery aneurysm.
Fig3. Ureteral jets: Doppler on the floor of the bladder, close to the ureteral meatus.
Fig4. Semi-obstructive meatus calculous, with decreased ureteral jet when comparing to the other side.
Fig5. Study vegetative formations in the bladder: formation amorphous hypoechoic in light bladder down to the change in position, the flow inside the color Doppler, compatible with bladder mass. Search the artifact after the calculation (twinkle artifact): artifact after calculation, when applying color Doppler, characterized by a mosaic of color in the region of posterior acoustic shadowing.
Fig6. The "twinkle artifact": artifact after calculation, when applying color Doppler, characterized by a mosaic of color in the region of posterior acoustic shadowing.
Fig7. Study of intra-vascular impedance in renal interlobar veins averages: the curve is "flat", with loss of their usual physics in the presence of obstructive factor or semi-obstruction (ureteral calculus).

Fig8. Measure the IR vein interlobar mean, as applied to an artery (markers of the apparatus respectively at the highest speed and lowest absolute velocity spectrum vein).

Conclusion

The Doppler method, when combined with conventional ultrasound, helps in the evaluation of hydronephrosis, confirming its existence and establishing its etiological factor such as stones or tumors but mostly by differential diagnosis with local vascular structures.

Personal Information

References