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Original Research Article

Mean resistive index as a prognostic tool for hydronephrosis in patients with acute renal colic: a study in a tertiary care

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ABSTRACT

Background: Uretolithiasis is one of the most common cause of urinary tract obstruction which leads to the admission into the emergency ward. The detection of urolithiasis or acute renal colic is by the radiography, conventional ultrasonography (US) and intravenous urography (IVU). A colour Doppler USG measures this change as a resistive index (RI) of the arcuate arteries at the corticomedullary junction or the interlobar arteries.
Methods: 84 patients between the ages 15-50 years, who were admitted to the Emergency department of our hospital with unilateral renal colic were included into our study. Detailed demographic data was collected from all the patients and they were all subjected to a thorough physical and clinical examination. Bladder ultrasound was taken along with color Doppler for all the patients at the time of admission for every 6 hours. Thus, an increased RI index signifies an obstruction without a dilatation.
Results: Left flank pain was slightly more than the right flank pain, although this was not found to be significant. Most of the patients were presented with vomiting or nausea and dysuria was seen in 48 patients. there were 41 cases of hydronephrosis in total and all of them were positive for mean RI. The specificity with the mean resistive index with color Doppler was 90%, while the sensitivity was 100%. Around 95% of the prediction was accurate with mean resistive index, with more than 90% efficiency.
Conclusions: The mean resistive index is a very good tool for the diagnosis of hydronephrosis, with a very high level of specificity and sensitivity.

Keywords: Acute renal colic, Hydronephrosis, Mean resistive index, Urinary obstruction

INTRODUCTION

Uretolithiasis is one of the most common cause of urinary tract obstruction which leads to the admission into the emergency ward.[1,2] The most common symptoms include severe pain in the abdomen, decrease of urine flow and output, which can eventually lead to acute or chronic renal failure.[3] The renal colic basically begins with a lower flank pain radiating to the hypochondrium or he groin. It is known to come in waves due to the ureteric peristalsis, although at times the pain is constant. Although, this is one of the most severe pains known to man, there is no permanent damage. In severe cases, such as large stones, there may be a requirement of surgery.

The cause of the renal colic is mainly due to the presence of a kidney stone, although rarely a movement of a blood clot due to a trauma or neoplastic disease may also cause this pain. Other rare reasons can be urinary tract tumors or acute renal necrosis.[4,5] Whatever the cause of the renal colic, these patients are at risk for acute partial or complete renal obstruction which ultimately leads to hydronephrosis, which can cause deterioration of renal function over time.

The distribution of urolithiasis seems to be prevalent all over the world. The risk of developing the kidney stones seems to be higher in the Western hemisphere than in the Eastern hemisphere. It was reported to be 5-9% in Europe, 12% in Canada and 13-15% in the USA. In the eastern side it was found to be 1-5%, although in some Asian countries such as Saudi Arabia, it was as high as 20.1%.[6,7]

The detection of urolithiasis or acute renal colic is by the radiography, conventional ultrasonography (US) and intravenous urography (IVU).[8] However, obstruction without the dilatation of pelvicalyceal system may occur in around 35% of the cases and in many other cases, severe dilatation may occur without any obstruction. These cases are many times not detected by USG.[8] A colour Doppler evaluation is effective in such cases. In an acutely obstructed kidney, renal Doppler recording can demonstrate altered renal perfusion before pelvicalyceal system dilatation occurs.[9]

Vasoactive factors which cause initial vasodilatation and then vasoconstriction causes an increase of intrarenal resistance which eventually results in a decreased diastolic flow compared to the systolic flow. A colour Doppler USG measures this change as a resistive index (RI) of the arcuate arteries at the corticomedullary junction or the interlobar arteries.[10] Thus, an increased RI index signifies an obstruction without a dilatation.

In a normal person, the upper limit of the RI is 0.7. RI greater than 0.7 or the difference in RI between the obstructed and the normal kidney is greater than 0.08 is said to be indicative of renal obstruction.[11] This diagnosis helps the patient in avoiding other investigations such as IVU and CT, which requires exposure to a considerable amount of radiation and increase in expenditure as these investigations are expensive.[12]

This study was conducted with the aim to evaluate the use of mean resistive index as a predictor of hydronephrosis in patients admitted with acute renal colic.

METHODS

This study was conducted by the department of Radiology at Mediciti Institute of Medical Sciences for the period of 2 years. 84 patients between the ages 15-50 years, who were admitted to the Emergency department of our hospital with unilateral renal colic were included into our study. Due to the high risk of CT radiation on the young patients, those below 15 years of age were excluded from the study. Similarly, patients above 50 years were also excluded due to the increased risk of atherosclerosis. Patients with known renal problems, known cases of urolithiasis, pregnant women, patients with bilateral flank pain were excluded from the studies.

Detailed demographic data was collected from all the patients and they were all subjected to a thorough physical and clinical examination. Just before admission, blood was collected from the patients for routine biochemical analysis as well as for complete blood picture. Bladder ultrasound was taken along with color Doppler for all the patients at the time of admission. This was taken for every 6 hours till 8 hour and each time the resistive index was calculated as peak systolic velocity-end diastolic velocity/peak systolic velocity. A RI of above 0.7 was considered as an obstruction, and was referred to as mean RI+ (Figure 1 and 2). All the patients also underwent CT without contrast of the bladder as a reference technique.

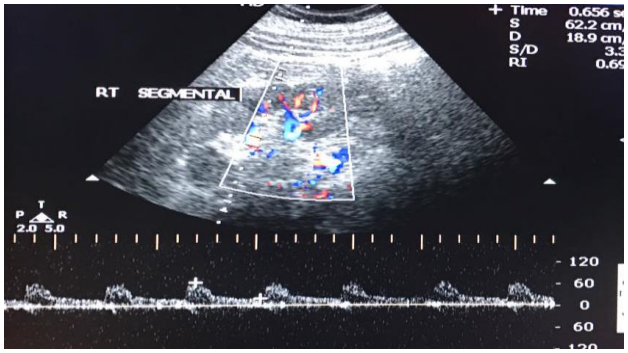

Figure 1: Colour Doppler with RI <0.7.

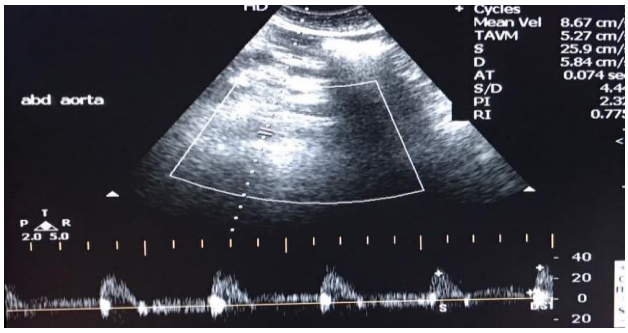

Figure 2: Color Doppler with RI > 0.7.

RESULTS

The common symptoms of the 84 patients is shown in the Figure 1. Left flank pain was slightly more than the right flank pain, although this was not found to be significant. Most of the patients were presented with vomiting or nausea and dysuria was seen in 48 patients. Very few (19) patients had fever as one of the symptom (Figure 3).

At the time of admission, none of the patients had a positive mean resistive index nor any prediction for hydronephrosis. However, eventually, there were 41 cases of hydronephrosis in total and all of them were positive for mean RI, although at different times. After 6 hours of admission, 9 cases were MRI positive, while no cases showed hydronephrosis. Most of the cases

developed hydronephrosis in the 18th hour at which time, they were positive by the MRI (Table 1).

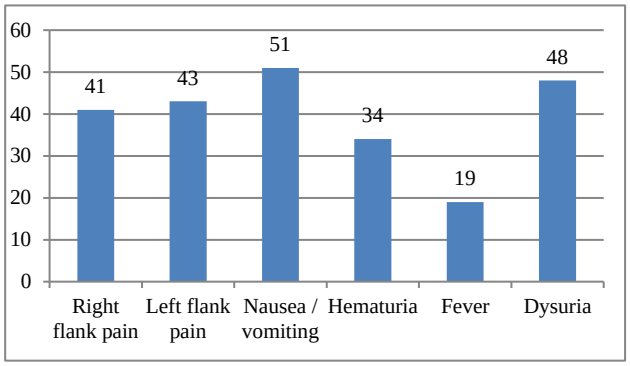

Figure 3: Common symptoms in patients.

Table 1: Number of hydronephrosis and MRI + at different time frames.

Time	Number of mean resistive index positives	Number of hydronephrosis
At admission	0	0
After 6 hours	9 (10.7%)	0
After 12 hours	18 (21.4%)	7 (8.3%)
After 18 hours	11 (13.1%)	21 (25%)
After 24 hours	2 (2.4%)	10 (11.9%)
After 36 hours	1 (1.2%)	3 (3.6%)
After 48 hours	0	0
Total	**41 (48.8%)**	**41 (48.8%)**

Ultrasound was highly sensitive (100%) and specific (100%) in the diagnosis of hydronephrosis, however the diagnosis of the renal calculosis was only around 65%, with very low efficacy and accuracy. With the mean resistive index, the specificity was 90%, while the sensitivity was 100%. Around 95% of the prediction was accurate with mean resistive index, with more than 90% efficiency (Figure 4).

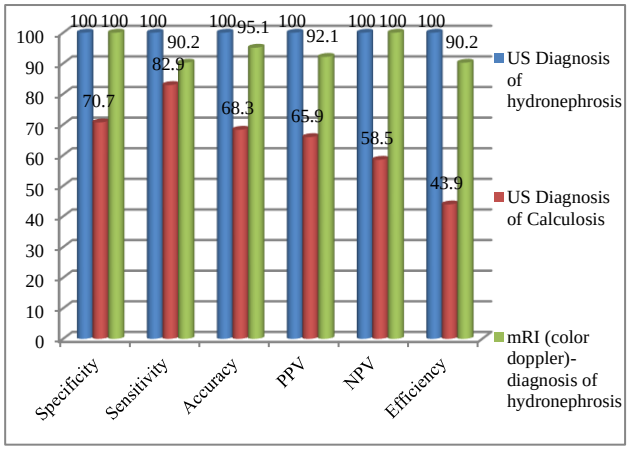

Figure 4: Comparison between diagnosis with ultrasonography and prediction with mean resistive index for hydronephrosis (in percentage).

DISCUSSION

Ultrasonography is one of the initial tools to diagnose a renal colic and renal obstruction. This method is mainly dependent on the anatomical criteria of dilatation of the PCS and the ureter which is proximal to the level of obstruction. However, the sensitivity and the specificity to detect a renal obstruction is said to be low. It has been reported in the earlier studies that the sensitivity of the USG is >90% while the specificity is only 65-84%.[13] This is because USG imaging may miss out the diagnosis of obstruction in a number of situations especially if the obstruction is very small or mild. In case of calyceal fornix or when the PCS system is filled with clot. A better and direct functional evidence of the obstruction is obtained by the more recent Doppler US techniques to gather more information on the level of obstruction.[14,15]

The response of the renal blood flow to the site of urinary obstruction is said to be phasic.[16-19] At the onset of the obstruction, there is an immediate increase in the renal pelvic pressure, which results in the vasodilatation caused by the vasoconstrictor factors.[20-22] As this obstruction continues, there is a vasoconstriction which is caused by the hormonal regulatory systems. Due to the vasoconstriction, there is a reduction of the renal blood flow to the site of obstruction, thereby decreasing the urinary filtration process. This the intra pelvic pressure returns to normalcy.[16,19,23]

The measurement of resistive index is very useful in the diagnosis of urinary obstruction in patients especially those with a recent onset of unilateral renal colic.[13,24-26] It is pretty easy to calculate the RI and at times, the same is given by the scanner itself. RI detects the indirect estimate of the resistance in the renal blood vessels. In the case of a renal obstruction, this resistance in increased due to the pressure within the blood vessels.[13,27] RI value >0.70 was found to be indicative of acute ureteral obstruction by Platt et al and Sauvain et al.[13,28] Since then, many studies have been performed and confirmed this finding.[13,24-26]

Elevated RI was observed in acutely obstructed kidneys as compared the unobstructed kidneys by Rodgers et al and Platt et al.[13,16] Also, it has been observed that there is an elevation in the RI within 6-48 hours of the admission to the hospital. All the cases of hydronephrosis showed an elevated RI within this time.

In the present study, 41 (48.8%) of the cases had hydronephrosis. However, at the time of admission, MRI for all of them was negative. By 18 hours, MRI was above 0.7 in 38 (92.7%) of the 41 cases, though hydronephrosis at this time was visualized only in 28 (68.3%) of them.

The diagnosis of hydronephrosis was 100% by ultrasound, which was highly sensitive and specific in all the cases. However, in the diagnosis of calculosis,

ultrasound was only 82% sensitive and 70% specific. MRI with color Doppler was highly specific (100%) for the diagnosis of hydronephrosis while it was 90% sensitive, with high accuracy.

There have been a few studies showing the MRI with color Doppler is very useful in the diagnosis of renal obstruction especially in the acute cases with unilateral obstruction within 6-48 hours.[13,24-26] RI gives an estimate of the resistance present in the renal blood vessels.[27] But, there have been a few contradictory studies. In a study by Tublin et al, the sensitivity and specificity of Doppler ultrasound was only 44% and 82% respectively. Yet in a study by deToledo et al, an increase in MRI was found, but after 24 hours of renal colic. This variation was said to be due to the clinical symptoms which may not necessarily correlate to the anatomical obstruction.[29]

Inspite of the above positive results, the diagnosis with MRI has a lot of limitations. It is influenced by factors such as age, plasma renin levels, presence of diabetes, hypertension or heart disease. Other renal disorders may also cause a rise in the resistive index, even if obstruction is not present.[30] MRI is also found to be less sensitive in partial obstruction in certain studies compared to the complete obstruction.[29,31]

It has also been reported that the increase in the MRI is dependent on the time following the obstruction. As seen in the present study, the rise in MRI is seen from 6-48 hours which is corroborated by other studies.[13,32] Opdenakker et al have found that the sensitivity of RI decreases after 48 hours of the onset of the symptoms, and Platt et al have reported that above 24 hours of the onset of the symptoms, the MRI is not significantly higher. However, de Toledo et al have reported the higher increased MRI lasts for 24 hours. All these variations depend on the clinical course of the obstruction.

CONCLUSION

The mean resistive index is a very good tool for the diagnosis of hydronephrosis, with a very high level of specificity and sensitivity. It is very simple, noninvasive and easy to calculate and can be routinely used as a predictor to hydronephrosis in patients with acute renal colic.

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REFERENCES

1. Hall J, Linton KD. Obstruction of the upper and lower urinary tract. Surgery (Oxford). 2008;26:197-202.
2. Pepe P, Motta L, Pennisi M, Aragona F. Functional evaluation of the urinary tract by color-Doppler ultrasonography (CDU) in 100 patients with renal colic. Eur J Radiol. 2005;53:131-5.
3. Rishi N, Anil KS, Kaza RCM, Anand VJ. The obstructed kidney. Indian J Surg. 2005;67:21-8.
4. Thomas A, Andrianne R. Excruciating flank pain: "acute renal colic". Rev Med Liege. 2004;59:215-20.
5. Fauci AS, Braunwald E, Isselbacher KJ, Wilson JD, Martin JB, Kasper DL, et al. Harrison's principles of internal medicine. 14th ed. New York, NY: McGraw-Hill Book Co; 1998.
6. Ramello A, Vitale C, Marangella M. Epidemiology of nephrolithiasis. J Nephrol. 2000;13:S65-70
7. Robertson WG, Hughes H. Epidemiology of urinary stone disease in Saudi Arabia. In: Ryall R, Bais R, Marshall VR, Rofe AM, Smith LH, Walker VR, eds. Urolithiasis 2. Plenum Press, New York: London; 1994:453–455.
8. Tamm EP, Silverman PM, Shuman WP. Evaluation of the patient with flank pain and possible ureteral calculus. Radiology. 2003;228:319-29.
9. Onur MR, Cubuk M, Andic C, Kartal M, Arslan G. Role of resistive index in renal colic. Urol Res. 2007;35:307-12.
10. Leipe K, Taut-Sack H. Can renal Doppler sonography replace diuretic radionuclide renography in infants with hydronephrosis? Turk J Pediatr. 2006;48:221-7.
11. Amin MU, Ghaffar A. Intrarenal and intravesical color Doppler sonography in patients with acute renal colic. J Surg Pak. 2004;9:40-2.
12. Saboo SS, Soni SS, Saboo SH, Chinapuvvula NR, Kaza S. Doppler sonography in acute renal obstruction. Indian J Radiol Imag. 2007;17:188-92.
13. Platt JF, Rubin JM, Ellis JH. Acute renal obstruction: evaluation with intrarenal duplex Doppler and conventional US. Radiology. 1993;186:685-8.
14. Platt JF, Rubin KM, Ellis JH, DiPietro M. Duplex Doppler US of the kidney: Differentiation of obstructive from non-obstructive dilatation. Radiology. 1989;171:515-7.
15. Webb JA. Ultrasonography and Doppler studies in the diagnosis of renal obstruction. BJU Int. 2000;86:25-32.
16. Rodgers PM, Bates JA, Irving HC. Intrarenal Doppler ultrasound studies in normal and acutely obstructed kidneys. Br J Radiol. 1992;65:207-12.
17. Moody TE, Vaughan ED Jr, Gillenwater JY. Relationship between renal blood flow and ureteral pressure during 18 hours of total unilateral occlusion: implications for changing sites of increased renal resistance. Invest Urol. 1975;13:246-51.
18. Ryan PC, Macer KP, Murphy B. Experimental partial obstruction: pathophysiological changes in upper tract pressures and renal blood flow. J Urol. 1987;138:674-8.

19. Lee HJ, Kim SH, Jeong YK. Doppler sonographic resistive index in obstructed kidneys. J Ultrasound Med. 1996;15:613-8.
20. Klahr S. Pathophysiology of obstructive nephropathy: a 1991 update. Semin Nephrol. 1991;11:156-68.
21. Croan JJ. Acute urinary tract obstruction in adults. In: RSNA Categorical Course in Genitourinary Radiology. Oak Brook, IL: Radiological Society of North America; 1994:103-108.
22. Platt JF. Urinary obstruction. Radiol Clin North Am. 1996;34:1113-29.
23. Vaughan ED Jr, Sorenson EJ, Gillenwater JY. The renal hemodynamic response to chronic unilateral complete ureteral occlusion. Invest Urol. 1970;8:78-90.
24. Shokeir AA, Abdulmaaboud M. Resistive index in renal colic: a prospective study. BJU Int. 1999;83:378-82.
25. Opdenakker L, Oyen R, Vervloessem I, Goethuys H, Baert AL, Baert LV, et al. Acute obstruction of the renal collecting system: the intrarenal resistive index is a useful yet time-dependent parameter for diagnosis. Eur Radiol. 1998;8:1429-32.
26. Shokeir AA, Abdulmaaboud M. Prospective comparison of nonenhanced helical computerized tomography and Doppler ultrasonography for the diagnosis of renal colic. J Urol. 2001;165:1082-4.
27. Rawashdeh YF, Djurhuus JC, Mortensen J, Hørlyck A, Frokiaer J. The intrarenal resistive index as a pathophysiological marker of obstructive uropathy. J Urol. 2001;165:1397-404.
28. Sauvain JL, Pierrat V, Chambers R, Bui Xuan P, Palascak P, Boursheid D, et al. Echography and pulsed Doppler of the arteries of the renal parenchyma in obstructive syndromes and dilatation of the excretory cavities of the kidney. J Radiol. 1989;70:389-98.
29. De Toledo LS, Martinez-Berganza AT, Cabrejas CR, de Gregorio AMA, Cortina PP, Saldias RL. Doppler duplex ultrasound in renal colic. Eur J Radiol. 1996;23:143-8.
30. Sayani R, Ali M, Shazlee K, Hamid RS, Hamid K. Functional evaluation of the urinary tract by duplex Doppler ultrasonography in patients with acute renal colic. Int J Nephrol Renovasc Dis. 2012;5:15e21.
31. Haroun A. Duplex Doppler sonography in patients with acute renal colic: prospective study and literature review. Int Urol Nephrol. 2003;35:135e40.
32. Piazzese EMS, Mazzeo GI, Galipo S, Fiumara F, Canfora C, Angiom LG. The renal resistive index as a predictor of acute hydronephrosis in patients with renal colic. J Ultrasound. 2012;15:239e246.

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