

Renal Doppler Ultrasonography: A Non Invasive Predictor of Kidney DysfunctionGihan Hasan Gamal¹ and Manar Ahmed Daoud²¹Radiology Dept. 6 October University²Tudor Belhars Institutedr.gh_006@yahoo.com

Abstract: Considering the fact that grey scale ultrasonography findings in patients with chronic medical diseases are non specific, this study was conducted to evaluate the relationship between RI of arterial Doppler wave form and degree of renal parenchymal damage as measured clinically by serum creatinine level. **Hung et al., 2011** stated that there is significant correlation between RI level and serum creatinine value and so RI may serve as an indication for predicting renal graft function after renal transplantation. **Bommart et al., 2010** concluded his study by the fact that there is good correlation between RI measured by Doppler ultrasound and kidney function and histology. **Material and Methods:** The study included 70 patients with chronic renal parenchymal medical diseases, grey scale ultrasonography was done for all cases to assess morphological renal changes include, kidney measurements and grade of renal echogenicity. Renal resistive index was measured by color Doppler sonography for 10 interlobar arteries, (5 interlobar arteries for each kidney). The ultrasonographic findings were correlated with serum creatinine levels for these patients. Renal biopsy reports, for 30 patients were within their files. **Results:** We proved that RIs were normal in non echogenic kidneys and were high in echogenic kidneys. The second fact that with increasing in RI levels, there was increase in serum creatinine levels. Patients with RI of (0.6) has normal serum creatinine level 1.4. Patients of average RI of 0.74 their serum creatinine levels were reached up to (1.9). Patients of grade 111 echogenicity recorded high RIs ranged from 0.97 up to 1.9. Serum creatinine levels in these cases reached 4mg /dl and more. The third important observation was that during and after medical treatment, there was progressive lowering in RIs accompanying by decreasing in serum creatinine levels. **Conclusion:** The study suggests that Doppler sonography may be helpful in evaluation of renal function status in patients of medical renal diseases with same sensitivity as serum creatinine RI. In addition can delineate prognosis and guide therapy over a long term follow up in patients with chronic renal diseases.

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1. Introduction:

Chronic renal diseases may be characterized by a progressive loss of renal function resulting in end stage renal failure. Predicting future decline in renal function is important for subsequent therapeutic decision. Progressive chronic renal diseases probably reflects a non specific renal scarring process, resulting in a reduction in the No and areas of renal vessels which in turn be responsible for increase intrarenal vascular resistance. Assessment of intra renal vascular resistance may therefore be helpful in determining the degree of intrarenal damage and may be useful in predicting the subsequent function of the diseased kidney. (Sebastian, 2002). Grey scale renal ultrasonography is still routinely performed during the initial evaluation of renal dysfunction. The results however often do not impact the differential diagnosis or management of renal disease. Only basic anatomy is obtained as renal length, cortical thickness and grade of collecting system dilatation. Although these findings may help in evaluating disease chronicity, often the findings of sonography are normal despite severe renal dysfunction (Mitchell et

al., 2003)

The Doppler Resistive index (peak systolic velocity – end diastolic velocity/ peak systolic velocity) was advanced as a useful parameter for quantifying the alternation in renal blood flow that may occur with renal disease (Ghaffori and Shiva 2007).

(Toshihiro, 2009) stated that resistive index could predict renal prognoses in chronic renal diseases, and could considered a good parameters reflecting renal haemodynamics and their correlation to the severity of renal medical diseases.

With introduction of wide band transducers and advanced in beam forms technology, the ultrasound imagings of the kidneys has greatly improved in recent years. RI as measured by doplex Doppler technology, has been established as a diagnostic tool for daily nephrologic workup. Extra and intra renal flow signal s are obtained for different indications. US Doppler sonography proved to be the best screening modality to evaluate patients with renal insufficiency and can give an effective assesstence in the differential diagnosis of its causes.

2. Patients and Methods:

70 patients diagnosed as chronic parenchymal diseases were included in this presented study through three years. 50 males and 20 females, their ages ranged from 21-60 years. Clinical examination, complete urine and blood analysis were recorded for all patients. Cases proved to have obstructed renal diseases or space occupying lesions were excluded from this study. All patients were subjected to grey scale ultrasound assessment for renal measurements and renal echogenicity, using real time US equipment with 3.5 MHz multiphase array sector transducer. Patients were classically examined in supine position, using sagittal and axial scans from an anterior approach, using liver and spleen as an acoustic windows. Left and right decubitus positions were needed in some cases. Both kidneys were assessed for their size, cortical thickness and relative cortical echogenicity with its grades (grade 1, grade II and grade III). Color Doppler ultrasonography was performed to all patients. Resistive index was calculated using high frequency probe supplemented by color Doppler US for vessels localization. Waveform was optimized for measurement using the lowest pulse repetition frequency without aliasing. In our study we tried all the vascular branches, but we find that inter lobar or segmental intrarenal arteries scan was more adequate and easy (measurement were performed on 10 interlobar arteries, 5 in each kidney). Three reproducible waveforms were obtained and RIs for these waveform were averaged to arrive to mean RI for each kidney. Serum creatinine was estimated for all patients. US guided percutaneous renal biopsy for 30 patients was done at urologic department, and their reports were within their files.

3. Results:

The grey scale ultrasonographic findings and

resistive index values measured by Doppler ultrasound for 70 patients with chronic renal parenchymal diseases included in this study were recorded and analysed. The results showed the following: Patients with grade I echogenicity recorded RI between 0.60 and to less than 0.70.

Patients of grade II echogenicity recorded RI between 0.70 and 0.84.

Patients with grade III echogenicity recorded RI between 0.84 and up to higher than 1.0, all kidneys of this last group were of small size.

Referring to the laboratory data of these 70 patients, it was found that serum creatinine levels of patients of grade I echogenicity were between 1.4 and 1.9 mg/dl, and were between 2.0 and 2.9 mg/dl with patients of grade II echogenicity.

Patients with grade III echogenicity recorded serum creatinine levels of 4.0 mg/dl and higher.

From the above results, we could conclude that, with increase renal echogenicity, the RIs increase. This means that, damage changes in glomerular, vascular and tubulointerstitial intrarenal tissue components, leads to increase in the arterial resistance in diastolic blood flow, which in turn causes increase intrarenal vascular resistance.

The results also proved that, there is correlation between RI of arterial Doppler wave form and serum creatinine levels, where with increase RIs, there were corresponding increase in serum creatinine values.

With referring to the biopsy reports of these patients, it was found that, kidneys with high RIs were of tubulointerstitial or mixed types of parenchymal renal diseases.

Follow up of these patients for two years, we found that patients with initial RI level higher than 0.7 show worse outcome, and so we could consider it as a risk factor level for worse renal function with low survival rate.



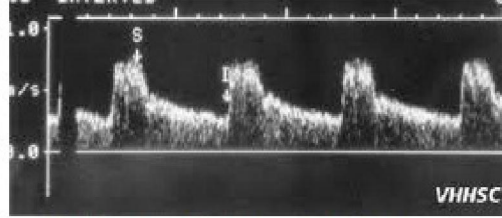
Gray scale ultrasonography
* Echogenicity GRADE 1



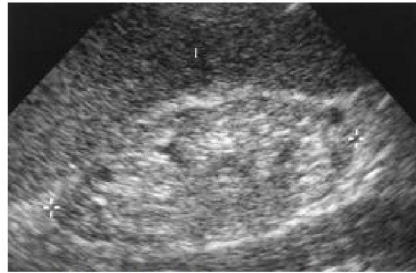
Duplex sonography
Spectral data mean RI = 0.67



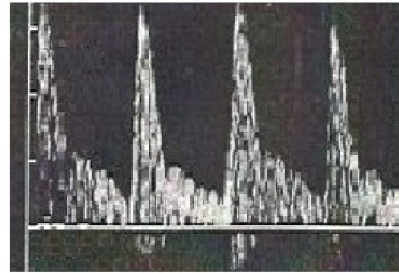
Grey scale ultrasonography
* Echogenicity Grade II



Color Duplex sonography
Spectral data mean R.I = 0.75



Grey scale ultrasonography
* Small sized kidney
* Grade III echogenicity



Duplex Doppler
Spectral data mean RI = 0.89

4. Discussion:

Krumme,2006 stated that although renal grey scale ultrasound is the most common initial imaging procedure performed in chronic renal parenchymal diseases, findings are usually non specific. Doppler ultrasound on other hand can provide a real time measure of hemodynamic status of the kidneys and is easily repeated to determine changes in RI so could help to predict the course of renal dysfunction and to select an appropriate management strategy.

Mitchell,2003 stated that results of grey scale ultrasound often do not impact the differential diagnosis or management of renal diseases. Only basic anatomic information is obtained with this modality (renal length, cortical thickness, collecting system dilatation and renal echogenicity). Although these findings may help in evaluating diseases chronicity, but often the findings of sonography are normal despite severe renal dysfunction,. More over clinicians and radiologist accept that even increase renal echogenicity that may be seen with renal parenchymal diseases lacks the specificity and sensitivity to be clinically relevant.He also stated that although collecting system dilatation is reliably detected, it is often not possible to differentiate obstructive and non obstructive pelvicaliectasis on grey scale alone. So the main objective of our study was to evaluate the value of Doppler ultrasonography with through light on the resistive index (RI) in diagnosis and management of the cases of chronic

renal diseases, and also to predict the relationship between serum creatinine and resistive index in evaluating renal damage. And to prove the clinical validity of RI to determine prognosis and guide therapy over a long term follow up.

This association had been proved in all previous studies. In a very similar study Sharlene and Teefrey in 2003 and Ikee et al., 2005 showed that there is a direct relationship between RI and damage in parenchymal renal diseases, and consider that RI is one of the prognostic markers for renal outcome where RI of 0.70 is suggestive of tubulointerstitial or vascular type of renal disease, where as patients of isolated glomerular disease often had a RI of less than 0.70, because an increase in RI value indicates irreversible renal scarring resulting in a reduction in the number and area of vessels which in turn be responsible for increase intrarenal vascular resistance.We found in our results that renal RI value of higher than 0.7. was in mixed type of renal disease (tubulointerstitial vascular damage)and in the follow up protocol was a good marker indicating the poor renal out come.

Quaia and Bertolotto, 2006 in a study concluded that follow up of acute renal failure, during and after medical treatment, is the most useful field of employment of color Doppler sonography, since a progressive lowering of RI is correlated to a progressive recovery of renal function.

Claudia et al, 2009 stated that recently, several

studies showed that doppler sonography, particularly RI calculated by peak systole – end diastole \ peak systole correlated with tubulointerstitial and vascular renal lesions where they divided patients of renal diseases into three types according to RI value (0.65-0.70 – and more than 0.70),and he compared between 0.65 and 0.70 which value would be more appropriate for evaluating the prognosis of chronic renal disease and they accepted RI of more than 0.70 as the good value in this purpose, our results exactly agree with this opinion.

Toshihiro, 2009 stated that Doppler ultrasonography has acquired an important value in diagnosis and management of various renal medical diseases, non invasively providing morphologic and vascular informations concerning the kidneys and RI allowed the early identification of patients with chronic tubulointerstitial nephritis, where interstitial fibrosis associated by the loss of tubules and capillaries is a common findings in essentially all progressive renal diseases. He also stated that renal biopsy with histopathological analysis, though an invasive procedure, still be the gold standard for differential diagnosis in medical kidney disease, and his study was an attempt to use RI to a certain extent as an indicator or worsening of renal and distinguish different types of medical renal diseases, where he proved that RI less than 0.70 indicated isolated glomerular damage and RI of 0.70 or higher indicated tubulointerstitial type of renal disease with vascular involved in renal tissue damage

Petrsen, 2000 precoded the change, stated that, there is a significant relationship between RI and serum creatinine, where decrease in renal function and increase serum creatinine are results of change in renal structures include, glomerular, blood vessels and interstitial tissue, as renal vessels become involved, the arterial resistance increase in diastolic blood flow which in turn would cause an increase in RI, this exactly agree with our results as proved by histopathological data recorded from renal biopsy report in the files of these patients, we observe that RI is increased in parenchymal renal damage involve particularly the blood vessels and interstitial tissue. Quiaia and Bertolotto, 2006 in a study, concluded that follow up of acute renal failure, during and after medical treatment, is the most useful field of employment of color Doppler sonography, since a progressive lowering of RI is correlated to a progressive recovery of renal function. Yoon and colleagues, 2008 concluded that the change in the RI precoded the change in serum creatinine levels in course of renal failure, so he considered that RI is a fair predictor of renal function. WE agree with this opinion and we add that Doppler ultrasonography is helpful in follow up and evaluation of renal

hemodynamic status and is easily repeated.

5. Conclusion:

Our results and several studies have suggested that Doppler sonography may be a useful clinical tool to evaluate renal dysfunction. A more sophisticated functional approach may allow radiologist to maintain a preeminent role in the imaging assessment of renal diseases. Further studies into this topic are suggested and strongly encouraged.

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