We are IntechOpen, the world’s leading publisher of Open Access books
Built by scientists, for scientists

3,800
Open access books available

116,000
International authors and editors

120M
Downloads

154
Countries delivered to

TOP 1%
Our authors are among the most cited scientists

12.2%
Contributors from top 500 universities

WEB OF SCIENCE™
Selection of our books indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com
The Evaluation of Renal Hemodynamics with Doppler Ultrasonography

Mahir Kaya

Department of Surgery, Faculty of Veterinary Medicine, Atatürk University, Erzurum, Turkey

1. Introduction

Gray-scale renal ultrasonography (US) is still performed as a matter of course during the initial evaluation of both native and transplant renal dysfunction. The results, however, often fail to impact on the differential diagnosis or management of renal diseases. Despite major technological advances, gray-scale renal US has remained largely unchanged since the 1970s. It provides only basic anatomical data, such as renal length, cortical thickness, and collecting system dilatation grades. While these may assist in the analysis of disease chronicity, ultrasonographic findings are often normal in spite of the presence of severe renal dysfunction. Clinicians and radiologists are agreed that even the increased renal echogenicity accompanied by renal failure (medical renal disease) requires greater specificity and sensitivity to make it clinically relevant. Collecting system dilatation detection is reliable, though it is not always possible to distinguish between obstructive and non-obstructive pelvicialiectasis on the basis of gray-scale US alone. This purely anatomic approach to renal US, combined with other improved and more economical modalities, has led to nephrologists, internists, and urologists becoming more involved in the field of radiology (Tublin et al., 2003).

Doppler ultrasonographic examination of vascular structures is a fundamental diagnostic technique and one that can also be used to examine organs. Doppler ultrasonographic examination of the kidney, a particularly highly perfused organ, increases the effectiveness of the technique. Color, power and spectral Doppler also supply additional hemodynamics data in addition to the morphological analysis. Renal and extrarenal pathologies as well as other factors also alter renal hemodynamics. Hemodynamic change can be distinguished by variation in intrarenal arterial waveforms. Color Doppler accelerates and facilitates imaging, while duplex Doppler US provides quantitative hemodynamic data. Diseases impacting on organ blood flow may be further characterized by duplex Doppler US. Quantitative Doppler ultrasonographic data include blood flow velocities and volumes. Semi-quantitative data include the indices calculated from blood flow velocities obtained from the spectral Doppler spectrum in renal vessels during the cardiac cycle. These establish resistance to blood flow in the vascular lumen and are a significant source of information about organ perfusion. Three major indices are used in clinical practice: the Systole - Diastole (S/D) ratio, the Pulsatility Index (PI) and the Resistive Index (RI) (also known as the Pourcelot index, resistivity index or resistance index).
S/D = Peak Systolic Velocity / End Diastolic Velocity

PI = (Peak Systolic Velocity – End Diastolic Velocity) / Mean Velocity

RI = (Peak Systolic Velocity – End Diastolic Velocity) / Peak Systolic Velocity

Under normal homeostatic conditions the renal circulation offers low impedance to blood flow throughout the cardiac cycle with continuous antegrade flow during diastole. However, during conditions associated with increased renal vascular resistance, the decrease in renal diastolic blood flow is more pronounced than the decrease in the systolic component. During extreme elevations of renal vascular resistance diastolic flow may be nondetectable or may even show retrograde propagation. Therefore, Doppler ability to characterize altered waveforms in response to elevations of renal vascular resistance may be used to calculate the RI and PI. They were initially introduced for the purpose of determining peripheral vascular diseases. They are also used for the analysis of pathological blood flow patterns and may possibly be used to discriminate among various pathophysiological conditions of the kidney. Resistive index is more widely used than the S/D ratio and PI. Doppler waveform studies are noninvasive, painless, readily available, and relatively easy to perform and learn. Moreover, Doppler ultrasound obviates the need for ionizing radiation and intravenous contrast material administration in situations in which they may be undesirable, such as pregnancy, allergy and renal insufficiency (Rawashdeh et al., 2001).

2. The renal doppler US technique

2.1 Human medicine

The patient has to fast for 8 h prior to the Doppler ultrasonographic examination of the native kidney. The transducer must be positioned so as to visualize the lateral or posterolateral aspect of the kidney. In this position, Doppler examination can be performed with the lowest appropriate angle (0-60°), establishing an appropriate approach toward vascular structures in the periphery of the hilus and permitting visualization of the kidney without obstruction by gases present in the segments of the intestine and causing artifact. Doppler analysis is then performed.

In intrarenal Doppler ultrasonographic examination, the majority of studies of the potential that have used Doppler US for renal disease evaluation emphasize the importance of applying the most careful technique. It is important to use the highest frequency probe gives that measurable waveforms, with the additional use of color or power Doppler US as appropriate for vessel localization. The arcuate arteries (at the corticomedullary junction) or inter pyelocaliectasic lobar arteries (adjacent to the medullary pyramids) are subsequently insonated with a 2-4 mm Doppler gate. The spectral samples/specimens from the arteries must be analyzed once they have been obtained from three different sites (the cranial, middle and caudal poles). Waveforms should be optimized for measurement by the use of the lowest pulse repetition frequency without aliasing (to maximize waveform size), the highest gain without obscuring background noise, and the lowest degree of wall filter. Three to five reproducible waveforms from each kidney are obtained. Subsequently, the renal Doppler values from these are averaged to establish mean RI and PI values for each kidney.


Hemodynamics is study of the mechanical and physiologic properties controlling blood pressure and flow through the body. The factors influencing hemodynamics are complex and extensive. In addition to systemic hemodynamic alterations, microvascular alterations are frequently observed in critically ill patients. The book "Hemodynamics: New Diagnostic and Therapeutic Approaches" is formed to present the up-to-date research under the scope of hemodynamics by scientists from different backgrounds.

How to reference
In order to correctly reference this scholarly work, feel free to copy and paste the following:
