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DIAGNOSTIC IMAGING WITH ULTRASOUND IN RENAL TRANSPLANT RECIEPIENTS

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Abstract

With steady improvement in graft survival due to improved efficacy of immunnosuppresion protocols, refinement in surgical technique, and the establisment of national system for coordination of organ distribution (United Network for Organ Sharing in USA), renal transplantation is increasingly the preferred treatment option for patients with end-stage renal disease. Organ availability remains a major rate-limiting factor.

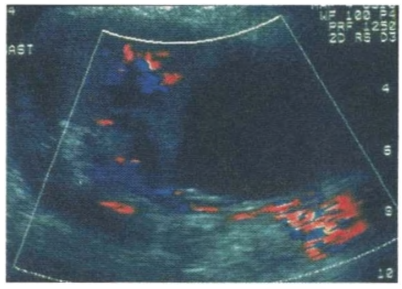
As the number of grafts lost due to rejection, infection and poor surgical technique has decreased, the relative clinical importance of graft loss due to vascular complications has been increasing. Real time ultrasound with power, color and duplex Doppler provides accurate, high-resolution images of vascular morphology and (likely) function. In an addition, serial exams can be performed without the risks associated with repeated use of intravenous contrast or exposure to ionizing radiation.

Ključne riječi: Diagnostic imaging, ultrasound, renal transplant

Introduction

At our institutions (Yale New Haven Hospital and Clinical Centre of Sarajevo) an initial is performed post–operatively in the recovery room to document vascular potency and to provide a baseline study. Intraoperative scanning may be helpful if the surgery has been complicated or if the kidney does not appear to be well perfused. In adults renal transplants are preferentially placed extraperitoneal in the right renal fossa. Real time images using a high frequenly (usually 5 mHz) curved array transducer should be obtained in both sagittal and transverse planes, and kidney size, cortical thickness, corticomedullary differentiation sinus fat, and collecting system evaluated (1). The baseline renal length is important, as an increase in renal size is an important finding in acute rejection, pyelonephritis, and renal vein thrombosis. Transient hydronephrosis may occur in the early post-operative period due to edema at the urethral anastomosis. Persistent mild dilatation of the collecting system may be either physiologic, as the single kidney handles a relatively large urine volume, or may be related to surgical loss of autonomic enervation (2). The size kidney and morphologic shell appearance in vascular complications diagnostic with **US (ultrasound)** of any **fluid collections (F.C.)** in the immediate post-operative period are common, typically hematomas or seromas which most often spontaneously resolve over several weeks.(**Fig.1**).

Fig.1. F.C. US Findings in renal graft



Limphoceles usually develop weeks to month post-transplant (less > 6 weeks). Drainage may be required to avoid extrinsic compression of the kidney or ureteral/vascular anastomoses or if superinfected. Urinomas are less common but similar in appearance in to other fluid colections, diagnosis requires aspiration.

Methodology of examination

Vascular evaluation of the renal allograft requires a clear understanding on the part of the sonographer of the surgical technique wich may vary depending upon donor and recipient anatomy. In particular, it is important to know the number of main renal arteries. With a cadaveric kidney, an aortic path (the Carrel path) is usually harvested at the origin of the MRA and used to form the arterial anastomosis with the external iliac artery. With living related donor grafts, the main renal artery must be attached either and to side to the recipient external iliac artery. Since multiple renal arteries may be present in up to 20% of kidneys, variations in tecnique are common. The ureter is connected directly to the bladder using the shortest adequate length to avoid kinking (3).

Optimization of technique and machine settings is crucial for a successful vascular Doppler study. The lowest possible wall filter should be used and the pulse repetition frequency set at the lowest possible value . Angle correction is employed when duplex studies are performed. A complete vascular study includes evaluation of the recipient iliac artery and vein as well as main renal artery and venous anastomosis (4).

Waveformes should also be obtained of the main renal artery (MRA), segmental and interlobar arteries in the upper and lower poles as well as main renal vein (MRV) and intraparenchymal renals veins. Peak systolic velocity (PSV) and resistive index (RI) should be measured. Evaluation of the arcuate arteries is optional (5).

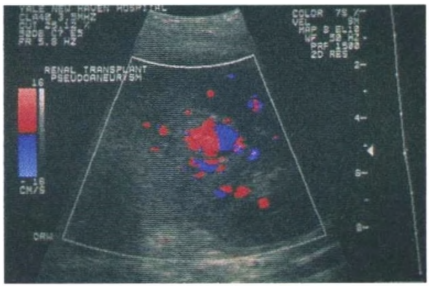
The normal arterial waveform will demonstrate continuous low impedance forward flow. Diastolic velocity should typically equal at least 25% of PSV with an RI of less than 0,7. In the immediate post-operative period, increased PSV at the MRA anastomosis and increased velocity at the MRV anastomosis site (or the abrupt angle of "take off" the donor vessel).

Power Doppler imaging may be helpful to judge cortical blood flow in terms of homogenity and possibility also to quantify blood flow. Color or power Doppler survey views of the entire kidney are helpful for post-biopsy arteriovenous fistulae and pseudoaneurysms.(6)

Results of examination in deranged-complicacated cases

Vascular complications are estimated to occur in up to 10% of renal transplant recipients. Renal artery thrombosis and renal vein thrombosis are the most common complications in the immediate post-operative period. Both are surgical emergencies and failure to revascularize the kidney will inevitably lead to graft loss. The most common delayed or late vascular complications are renal artery stenosis post biopsy complications such as arterio-venosus fistulae and **pseudoaneyrism (PSA)** formation.(**Fig.2.**)

Fig.2. PSA:US Doppler findings in renal graft



Renal artery thrombosis is a rare complication, occurring in < 1% of grafts, but will result in graft loss if not immediately corrected. The most common causes are belived to be faulty surgical technique (including embolus from the recipient iliac vessels), severe prolonged hypotension, or severe acute rejection. Redunddancy of the donor MRA may predispose to kinking wich may result in renal artery thrombosis (7). Complete absence of arterial and venous intraparenchimal flow as well as absence of flow in the MRA will be noted on Doppler examination.

However, it is critical that machine setting be optimized to detect low velocity, low volume flow to avoid false positive examinations. Hyperacute rejection, severe vasospazam, injury to recipient iliac artery, high-grade stenosis or faulty machine settings may mimic these Doppler findings (8). Renal artery and veins thrombosis (**RAT and RVT**) and renal partial thrombosis(**RPT**) is slightly more common occurring in 2-5% of renal are transplants. (**Fig.3, 4, 5)**

RVT typically occurs within the first three days of transplantation, and graft loss will occur if not immediately corrected. Patients present with graft swelling or tenderness, hematuria, and sudden oliguria. Faulty surgical technique, hypovolemia, hypercoagulable states, compression of the renal vein by a fluid collection, or kinking of a redundant vessel are the most common precipitating factors.

Fig 3.Renal artery thrombosis(RAT)

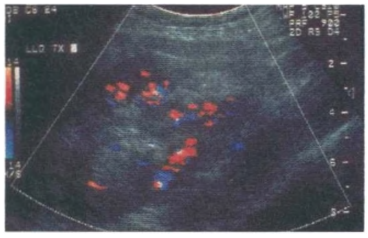
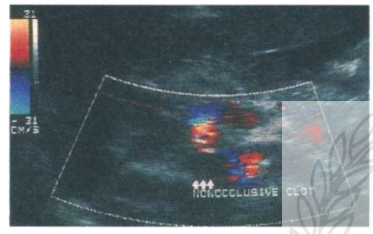


Fig.4. Renal vein thrombosis(RVT)



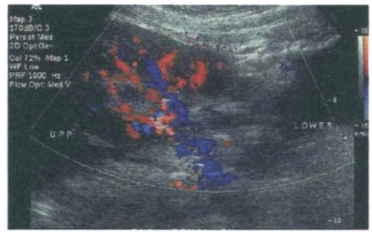
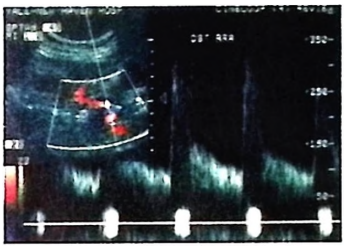


Fig. 5. Partial renal thrombosis(PRT) in renal graft

On real-time imaging the graft by vascular complications and hidronephrosis in renal transplants will be enlarged and hypoechoic Doppler findings are characteristic: absence of flow in the main renal vein (on both color and pulse Doppler examination) and high impedance arterial waveform with reversal early diastolic flow .(9). Reversed early diastolic flow has also been reported in patients with hyperacute rejection.

Renal artery stenosis (RAS) is the most common late vascular complication seen in renal allografts with estimated incidence of approximately 10%.(**Fig.6. RAS US Doppler Findings)**

Fig.6. RAS US Doppler Findings in renal graft



Patients present with severe or uncontrolled hypertension, renal insufficiency or flank bruit. Stenosis occurs most commonly at the anastomosis and are due to faulty surgical technique, fibrosis or chronic vascular rejection. More distal stenosis may be caused by chronic rejection arterial trauma from the perfusion cannula. RAS is more common in living related donor transplants than in cadaveric transplants as the Carrell' pacth makes the MRA anastomosis much easier to create (10).

Patients may be treated surgically or by angioplasty. Doppler US or MRA are the best non-invasive means of making this diagnosis. However, the Doppler criteria are somewhat controversial. On pulse Doppler interrogation a PSV<200-250 cm/sec, PSV ratio > 2 or 3,5:1, poststenotic turbulence, and the presence of a distal intraparenchimal arterial tardus parvus waveform (or RI<0,5) have all been suggested as criteria. However, false positive examination are common, likely due to the acute angle of the anstomosis and ensuing poor angle insonation. Therefore, clinical correlation is extremely important. In the immediate post-operative period, transient elevation of PSV in the MRA at the anastomosis is often observed, postulated to occur secondary to edema or vasospasm (11).

Discussion and Conclusion

It is important to note that an elevated RI (normal <0.7) is non-specific finding and is not always indicative of vascular complication or rejection. Elevated RI can also be seen in the clinical setting of hydronephrosis, ATN, pyelonephrithis, or in the presence of a large fluid collection compressing the kidney.

Arterio-venous fistulae (AVF) or pseudoaneurysms (PSA) occur relatively commonly post biopsy. The incidence of AVF's post biopsy may be as high as 17%, but is clearly lower if US guidance (to avoid the larger vessels in the renal sinus) in used. Most are small and asymptomatic and resolve spontaneously. A large AVF may result in I bruit, renal insufficiency, or hematuria. An AVF may be recognized on color Doppler as a focal area of color feeding artery and or draining vein. Large legions may demonstrate an associated soft tissue bruit seen on color Doppler examination. On pulse Doppler ultrasound the feeding artery will demonstrate a high velocity, low resistance waveform (increased diastolic flow) and the draining vein will demonstrate high velocity pulsatile flow. Arterial and venous waveform will be normal elsewhere in the venal parenchyma (12). Pseudoaneurysms are much less common occurring in <2% of biopsied renal transplants.

Generally, only large (>2 cm), symptomatic, or extra renal lesions require intervention. On real time imaging a PSA will appear as a cyst which will fill in on color Doppler interrogation. Pulse Doppler interrrogation will reveal a "to and fro"(ying-yang) waveform pattern in the neck with blood flow going towards the PSA in systole and away from the PSA in diastole (13,14).

Apstrakt

DIJAGNOSTIKA SA ULTRAZVUKOM U PRIMALACA BUBREŽNOG TRANSPLANTATA

Vaskularne komplikacije prisutne su kod manje od 10 % transplantata, i odnose se na aterosklerotske promjene arterije ilijake eksterne, stenozu renalne (akces) arterije, moguću ekstravazalnu kompresiju , kao i kinking fenomen. Ove komplikacije, u pravilu, su ozbiljne i vezane za visoki mortalitet. Ukoliko se na vrijeme identificiraju moguća je prevencija daljeg slijeda dogadjaja. Pored sve prednosti koju ova tehnika ima autori izvještavaju da je tačna detekcija renalne stenoze renalne arterije efikasna u 70% slučajeva. Autori izvjestavaju da je senzitivnost metode 60-90% a , kod nekih centara i manja.

Ostečenja renalnog parenhima fokalnog tipa, posebno kod hroničnog odbacivanja bubrega, u pravilu dovode do gubitka kolor signala i to u formi trokuta sa bazom prema kori bubrega. Prikazom power Dopplerom ove se promjene mogu najjasnije uočiti. Doppler sonografijom kod veoma malog procenta slučajeva može postaviti definitivnu dijagnozu odbacivanja. Korisna je metoda u skriningu transplantata u postoperativnom periodu.

Ključne riječi: dijagnostika, ultrazvuk, bubrežni transplantat

References:

1. Snider JF, Hunter W, Moradion GPet al: Transplant renal artery stenosis:evaluation with duplex sonography. Radiology. 172: 1027-1030,1989.

2. Hubsch P, Mostbeck G, Barton Pet al: Evaluation of arteriovenosus fistulas and pseudoaneurisms in renal transplants following percutaneous biopsy. J Ultrasound Med. 9:95,1990.

3. Grenier N, Douws C, M orel D, Ferriere JM, LeGuillou M, Potaux L, Brusin J. Detection of vascular complications in renal allografts with color Doppler flow imaging. Radiology 178:217-223,1991.

4. Deane C, Cowan N, Giles J et al.: Arteriovenous fistulas in renal transplants :Color Doppler ultrasound observations. Urol Radiology. 13:211-217,1992.

5. Bach AM, Merton DA, Burke JF, Halpern EJ: Anographic diagnosis of arteriovenous fistula and psedoaneurysm after biopsy of a transplntated kidney.J Ultrasound Med.12:545-547,1993.

6. Loubeyre P, Cahen R, Grozel F, Trolliet P, Pouteil-Noble C, Labeeuw M, Tran-Minh VA: Transplant renal artery stenosis. Transplantation. Vol.62. 446-450, No.4, 1996.

7. Nilsson A, Loren I, Persson NH, Nilson P: Color Doppler energy: Detection of hypoperfused areas in renal transplants. J.Ultrasound Med 17:153-155,1998.

8. Kaveggia LP, Perella RR, Grant EG, Tessler FN, Rosenthal JT, Danovitch GM: Duplex Doppler sonography in renal allografts: The significiance of reversed flow in diastole. AJR 155:295-298,1990.

9. Hanto DW, Gajl–Pecsalska KJ, Frizzera G et al: Epstein Barrov virus induced policlonal and monoclonal B-cell limphoproliferative diseases occurring after renal transplantation. Clinical pathologic,and virologic findings and implications for therapy. Annals of Surgery l98: 356-369,1983.

10. Kew CE II, Lopez-Ben R, Smith JK et al: Post-transplant lymphoproliferative disorder localized near the allograft in renal transplantation. Transplantation. 69:809-14,2000.

11. Gottlieb RH, Lieberman JL, Pabico RC, Waldman DL: Diagnosis of renal artery stenosis in transplantes kidneys: Value of Doppler waveform analysis of the intrarenal arteries. AJR. 165:1441-46,1995.

12 Isiklar I, Aktas A, Akgun S, Karakayali H: From Donor to Recipient: Doppler US, Power US and Scintigraphy of kidney perfusion before and after transplantation 41:285-287,2000

13. Karamehic J, Dilic M et al: Transplantacija organa: Kolor Dopler dijagnostika renalnih arterija transplantiranog bubrega. Printcom. Tuzla.. pp.263-280,2002

14. Karamehic J.,Dilic M.,et al.Transplantation of Kidney: Chapter: US diagnostic in Kidney Transplantation :359:391;2004