Standard B presentation *vs.* contrast-enhanced ultrasound (US-CE). A comparison of usefulness of different ultrasonographic techniques in the evaluation of the echo structure and size of haematomas in post-renal transplant patients: A preliminary report

Piotr Grzelak[1], Ilona Kurnatowska[2], Michał Nowicki[2], Janusz Strzelczyk[3], Michał Sapieha[1], Michał Podgórski[1], Magdalena Marchwicka-Wasiak[1], Ludomir Stefańczyk[1]

[1] Department of Radiology and Diagnostic Imaging, Medical University of Łódź, Łódź, Poland
[2] Department of Nephrology, Hypertension, and Kidney Transplantation, Medical University of Łódź, Łódź, Poland
[3] Department of General and Transplant Surgery, Medical University of Łódź, Łódź, Poland

Author's address: Piotr Grzelak, Department of Radiology and Diagnostic Imaging, Medical University of Łódź, Kopcińskiego 22 St., 90-159 Łódź, Poland, e-mail: piotr.grzelak@umed.lodz.pl

Summary

Background: During routine ultrasonographic examination in B presentation, performed as a standard diagnostic procedure during the early post-operative period, the most important problem with the interpretation of the images of perirenal haematoma is their ability to change in time. The aim of this work was to assess the echogenicity and the size of perirenal haematomas in patients after kidney transplant during routine examinations in B presentation and during examinations enhanced with a contrast medium (CE-US).

Material/Methods: Thirty-seven patients after kidney transplant were examined using standard examination in B presentation. Sixteen patients (7 women and 9 men) with isoechogenic and hypoechogenic areas visualized within the renal parenchyma, who were suspected of perirenal haematoma, underwent a CE-US examination after intravenous administration of sculpture hexafluoride (dose: 2.4 ml/examination). Using time-intensity curves (TIC), changes in the values were analysed for two areas of interest (ROI): in the renal parenchyma and in the areas identified during standard US as haematomas. Identical examination protocols and dynamic data loops allowed the acquisition of identical kidney cross-sections and enabled measuring the echogenicity and thickness of the abnormalities at the same location.

Results: During the routine B presentation examination, the average difference between haematoma and the renal cortex was 5 dB. When performing US-CE examination, a significantly greater difference in echogenicity was observed and reached 31 dB. In six patients, the size of haematomas was comparable using both techniques, whereas in ten patients lesions visualized in B presentation were smaller than in the US-CE examination.

Conclusions: The US-CE examination demonstrated a greater, statistically significant, difference in the echogenicity of perirenal haematomas compared to the routine examination in B presentation. This method enabled a more detailed assessment of the size of haematomas in the perirenal space that appeared during early post-operative period.

Key words: contrast-enhanced ultrasonography • kidney graft • perirenal haematoma

PDF file: http://www.polradiol.com/fulltxt.php?ICID=883369

Background

Haematomas are some of the most common complications that appear in the early period following kidney biopsy, radiofrequency ablation of kidney tumours and kidney transplantation (KTx) [1,2]. Other perirenal collections of fluid, such as cisterns of lymph, abscesses, or collections of urine are found later in the post-operative period. Haematomas located in the area of the hilum can compress renal vessels and the ureter causing dysfunction of the graft. During examinations in B presentation, routinely used in early post-surgical diagnostics, the most important problem with the interpretation of the images of perirenal haematomas is their changeability in time, which significantly delays the diagnostics in early post-operative period [2–6].

One of the areas, in which contrast ultrasound is currently being used, is the monitoring of recently transplanted organs, including the kidneys [7–9].

The aim of this study was to compare the echogenicity and size of perirenal haematomas in patients treated with kidney transplantation, which were assessed both in standard B presentation and examinations enhanced with a contrast medium (CE-US).

Material and Methods

In a group of 37 patients with first, deceased-donor KTx, baseline US examinations were performed during early post-operative period (1–3 days) as a part of routine post-surgery monitoring. After a standard B examination, sixteen patients suspected of having haematoma around the kidney undergone CE-US. The analysed group comprised 7 women and 9 men whose mean age was 48.3 years (SD 9.9). During the transplantation procedure, in half of the cases anastomoses between the end of renal artery and the external iliac artery were created. In the other 8 patients, anastomoses were done between the end of renal and hypogastric arteries. Ureteroneocystostomy was performed in all patients using McKinnon's technique. After transplantation, each patient was subjected to standard triple immunosuppressive therapy (steroids, ciclosporin A or tacrolimus, and mycophenolate mofetil). No antibody induction was applied. Three patients, in whom the size and localization of perirenal lesions significantly influenced graft function (pressure on the ureter and/or vessel peduncle), were re-operated and the presence of haematomas was confirmed. In other four patients, the presence of haematomas was confirmed by needle aspiration of haematoma content.

The examinations were performed using the GE Vivid 7 device and a convex probe (type 3.5C). All examinations, both in routine B presentation and CE-US, were recorded following the same protocol that consisted of acquisition in two perpendicular planes (long and short axis of the transplant). Acquisition area included the kidney and its surroundings with a margin of 40–50 mm. The data were saved in the memory of the device in the form of two dynamic loops, each 15 seconds long. CE-US examinations were performed after intravenous application of SonoVue Diagnostics manufactured by the company Bracco Int. (Milan, Italy). Contrast medium dose was 2.4 ml per

examination. Saving of the dynamic loops in memory was started 30–40 seconds after contrast introduction. This enabled visualisation of the saturation of the renal parenchyma and surrounding tissues with the contrast agent (contrast medium flow was monitored at the level of the renal sinus) [10,11]. In all examinations, preset options for kidney assessment recommended by the manufacturer in routine B presentation and the protocol with low mechanical index (MI 0.1) for the CE-US examination were used.

Images were analysed retrospectively on a workstation (EchoPack, GE) using software (Q-analyze) dedicated to quantitative analysis of ultrasound signal intensity [12–14]. Based on time-intensity curves (TIC), changes in the values for two regions of interest (ROI) were analysed. ROI were located in the renal parenchyma and in the area indicated as haematoma by the examination in B presentation. The intensity of contrast medium inflow to the transplanted kidney was monitored based on the third ROI located at the level of the sinus vessels. Saving the loops enabled us to visualize identical cross-sections and perform analyses and measurements in the same location (Figures 1, 2). Additionally, measurements of haematoma thickness, perpendicular to the surface of the kidney, were performed (Figure 3).

All results were expressed as a mean, range and SD. The normality of data distribution was assessed with the Shapiro-Wilk test. Intergroup comparisons were performed using the t-test for independent samples. Statistical analysis was performed using Statistica for Windows (version 6.0, StatSoft, Tulsa, OK, USA). Statistical significance was defined at $p < 0.05$.

All subjects granted their written informed consent for the participation in the study and the study protocol was approved by the university bioethics committee.

Results

During the analysis of the images from the B presentation technique, perirenal isoechogenicity and/or hypoechogenicity areas in the renal parenchyma were identified as haematomas. In such areas (during routine B presentation), the values of ultrasound signal ranged from –50 dB to –64 dB (average –60.6; SD 4.5). The values obtained from CE-US for the corresponding perirenal areas did not differ significantly and were at the level of –53 dB to –65 dB, (average –60.5; SD 3.9).

During typical B presentation, ROI located in the renal parenchyma was characterized by low echogenicity, from –46 dB to –64 dB. The results obtained during US-CE for this area were significantly greater and ranged from –23 dB to –36 dB. Comparing average differences of signal intensity between the examined areas using both techniques, we found that signal intensity was significantly greater in the US-CE technique (–55.5, SD 5.4 dB *vs.* –29, SD 3.5 dB; $p < 0.001$).

In routine B presentation examinations, the difference in echogenicity between a perirenal haematoma and the renal parenchyma was 0 to –12 dB, whereas in the US-CE examination the difference ranged between –22 dB and –40 dB
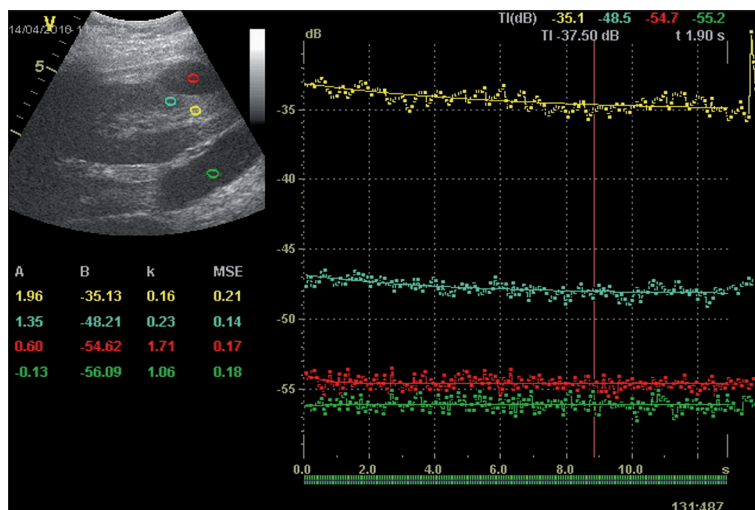
Figure 1. Standard B mode. The example of small difference in signal intensity (approx. 6–8 dB) in perfusion curves (TIC) between the kidney parenchyma and the area of perirenal haematoma (red and green ROI – area identified as haematoma, light blue ROI – area located in the renal parenchyma, yellow ROI – area of sinus vessels).
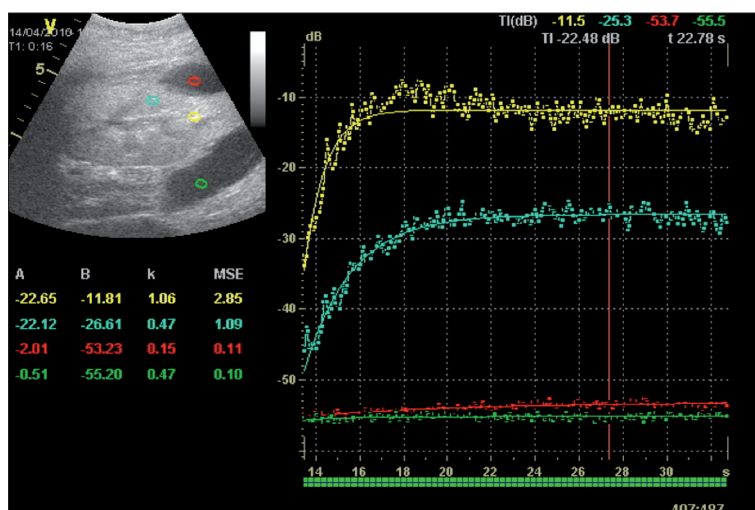
Figure 2. CE-US study. Example of the large difference in signal intensity (approx. 28–30 dB) in perfusion curves (TIC) between the renal parenchyma and the area of perirenal haematoma (red and green ROI – area identified as haematoma, light blue ROI – area located in the renal parenchyma, yellow ROI – area of sinus vessels). Red vertical line marks the moment of maximum saturation of the blood cavity.
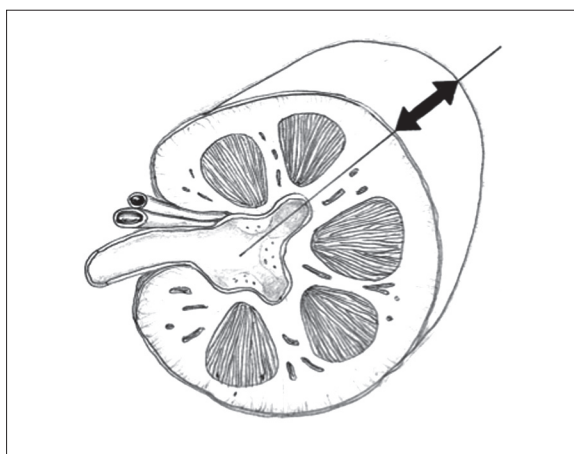
Figure 3. The cartoon presents the method of measuring the thickness of haematoma in B mode and CE-US.

(Figure 4). Those differences were statistically significant (–5.0, SD 3.2 dB *vs.* –31.0, SD 4.4 dB; p<0.001).

The thickness of the visualized perirenal haematomas was from 4 to 30 mm in B presentation and from 7 to 38 mm in US-CE (Figure 5). The size of the lesions was comparable in

six cases. In ten cases, lesions visualized in B presentation were smaller than in the US-CE examination. Significantly larger sizes of haematomas (p<0.001) were found in CE-US (20.7; SD 8.5 mm), in comparison to the standard B presentation (12.1; SD 7.3 mm). The results are presented in Table 1.

Discussion

Using a contrast medium for the visualization of haematomas in parenchymal organ diagnostics has become a standard technique in diagnostic imaging (CT, MRI) [15,16]. The development of ultrasonographic contrast media and rapid progress of acquisition techniques have enabled application of US-CE in new areas of diagnostics, e.g., transplanted kidneys [17,18].

The most important problem in the routine examination in B presentation, used for post-operative diagnostics of transplanted kidneys, is the interpretation of images in time [19]. It is evident that haematomas rapidly evolve changing their echogenicity from protein-rich fluid into solid or solid-fluid structure. Furthermore, haemolysis may transiently change the structure of haematoma [18,19]. These changes are accompanied by significant
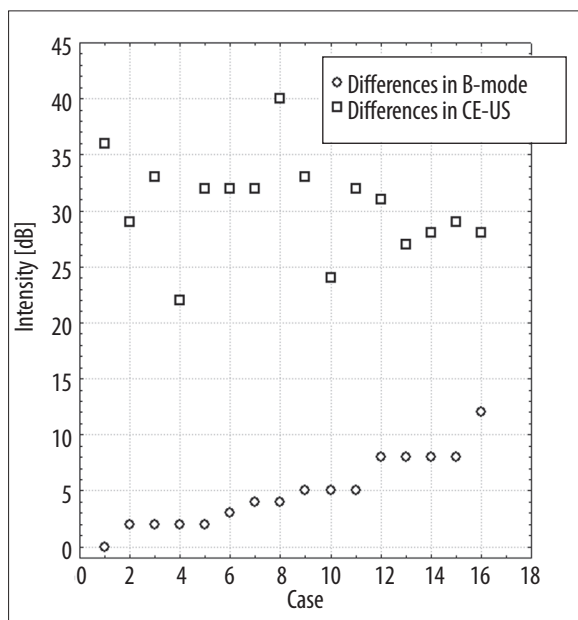
Figure 4. The differences in signal intensity occurring between the perirenal haematoma and the renal parenchyma in B mode and CE-US.
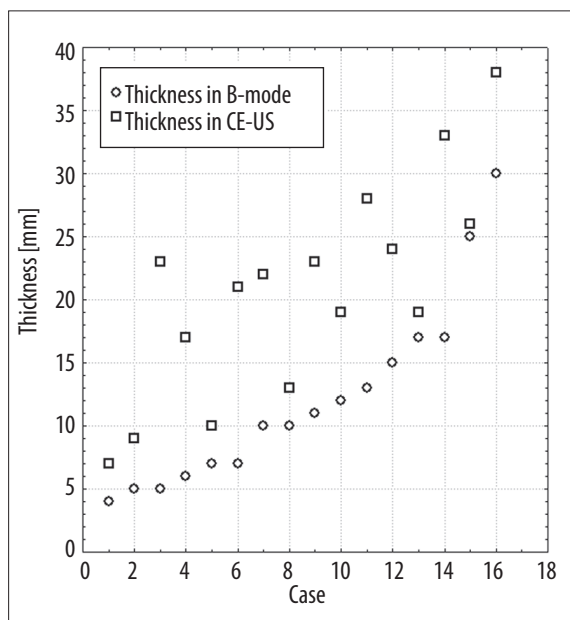
Figure 5. Thickness of the perirenal haematoma in B mode and CE-US.

Table 1. Signal intensity and size of the examined areas (mean, SD).

Mode	Signal intensity [dB]			Thickness of the haematoma [mm]
	Kidney paerenchyma	Perirenal space	Difference in intensity	
B-mode	−55.5 SD 5.4	−60.6 SD 4.5	−5.0 SD 3.2	12.1 SD 7.3
CE-US	−29 SD 3.5	−60.5 SD 3.9	−31.0 SD 4.4	20.7 SD 8.5

alterations in the echogenicity and ultrasonographic pattern of haematomas from low echo, typical for fluid-filled spaces, to solid (tissue-like) echogenicity and then again back to low echo for fluid-like pattern. The sequence of the changes is not clearly defined in time and during early post-operative period all patterns of echo structures may be encountered. The transformation of new haematomas in the routine examinations in B presentation makes haematomas difficult to separate from the surrounding tissue [20–22]. Visualization of haematomas is even more difficult because of intestinal content, and the oedema of surrounding tissues and the omentum. The big difference in acoustic impedance between the analysed areas during the US-CE examination was caused by the increase of signal from tissues rich in vessels (the transplant and perirenal tissues) and steady, low signal from perirenal collections of fluid. The difference in echogenicity in the US-CE examination allows a better separation of haematomas without consideration of the haemolysis process and its internal organization.

In our examinations, the magnitude of the recorded changes in standard B presentation was comparable or smaller than in the US-CE examination. This may suggest that only a part of the perirenal lesions represents an ultrasonographic pattern that allows a complete diagnosis during early post-operative period. The majority of the changes that were found in this period were at different stage of haemolysis and had uneven structure, usually solid-fluid, which only allowed the visualization only partial of pathological foci in routine B presentation. Particularly important is the fact that haematomas that were considered small and clinically irrelevant during the initial diagnostics and assessed following a standard protocol, were significantly bigger in the US-CE examination. This observation led to the discussion of whether parts of the growing haematomas in the early post-surgery period may have larger dimensions from the start. Their growth might be illusionary and is caused by progressing haemolysis which influences the initial assessment of the lesion size during routine B presentation and might have significant influence on therapeutic decisions. The significant influence of perirenal lesions on the function of the transplant might be caused by their size and the degree of pressure exerted on the parenchyma of the transplant, and its localization in relation to the hilum [23,24]. Even in the case of small changes located in the neighbourhood of the renal hilum, serious vascular complications (renal vein compression or thrombosis, flexions, narrowing or thrombosis of renal artery) or compression of the ureter are possible. Therefore the information even about the smallest fluid collections around the transplant, especially near the renal hilum, visualized during contrast examination may be significant for clinical management.

Conclusions

In conclusion, US-CE demonstrated a statistically significant increase in the difference in echogenicity of perirenal haematomas compared to the standard B examination, during early post-transplant period. The US-CE examination enabled a more detailed assessment of the size of haematomas in the perirenal space that appear shortly after surgery. Based on our experience, the CE-US examination may be considered as a more detailed assessment of the renal graft in early post-operative period.

References:

1. Głowacki J, Legaszewski T, Hyla-Klekot L et al: The diagnostic value of ultrasound examination in cases of diagnostic kidney oligobiopsy in children. Pol J Radiol, 2009; 74(3): 7–11

2. Salagierska-Barwińska A, Salagierski M, Salagierski M: 4-year experience with percutaneous US-guided radiofrequency ablation of kidney tumors. Pol J Radiol, 2007; 72(2): 32–35

3. Bach D, Wirth C, Schott G et al: Percutaneous renal biopsy: three years of experience with the Biopty gun in 761 cases – a survey of results and complications. Int Urol Nephrol, 1999; 31(1): 15–22

4. Doust BD: Abscesses, haematomas and other fluid collections. (In): Goldberg BB (ed.), Abdominal Grey Scale Ultrasonography. Wiley, New York, 1977; 231–59

5. El Atat R, Derouiche A, Guellouz S et al: Surgical complications in pediatric and adolescent renal transplantation. Saudi J Kidney Dis Transpl, 2010; 21(1): 251–57

6. Quintela J, Aguirrezabalaga J, Alonso A et al: Portal and systemic venous drainage in pancreas and kidney-pancreas transplantation: early surgical complications and outcomes. Transplant Proc, 2009; 41(6): 2460–62

7. Grzelak P, Kurnatowska I, Sapieha M et al: Disturbances of kidney graft perfusion as indicators of acute renal vein thrombosis in contrast-enhanced ultrasonography. Transplant Proc, 2011; 43(8): 3018–20

8. Fischer T, Ebeling V, Giessing M et al: A new method for standardized diagnosis following renal transplantation. Ultrasound with contrast enhancement. Urologe A, 2006; 45(1): 38–45

9. Grzelak P, Kurnatowska I, Sapiecha M et al: Ultrasonographic evaluation of disturbances in the perfusion of renal graft parenchyma as a result of acute occlusion of supernumerary arteries – a new application for contrast-enhanced ultrasonography. Ann Transplant, 2011; 16(3): 23–29

10. Albrecht T, Blomley M, Bolondi L et al: Guidelines for the use of contrast agents in ultrasound. January 2004. Ultraschall Med, 2004; 25(4): 249–56

11. Benozzi L, Cappelli G, Granito M et al: Contrast-enhanced sonography in early kidney graft dysfunction. Transplantation Proc, 2009; 41(4): 1212–15

12. Cosgrove DO, Chan KE: Renal transplants: what ultrasound can and cannot do. Ultrasound Q, 2008; 24(2): 77–87

13. Fischer T, Ebeling V, Giessing M et al: A new method for standardized diagnosis following renal transplantation. Ultrasound with contrast enhancement. Urologe A, 2006; 45(1): 38–45

14. Fischer T, Filimonow S, Rudolph J et al: Arrival time parametric imaging: a new ultrasound technique for quantifying perfusion of kidney grafts. Ultraschall Med, 2008; 29(4): 418–23

15. Wegener OT: Whole Body Computed Tomography. Blackwell Scientific Publications, Boston, 1992; 394–95

16. Marchal G, Vogel TJ, Heiken JP et al: Multidetector-Row Computed Tomography. Springer Milan, 2005; 79–89

17. Fischer T, Mühler M, Kröncke TJ et al: Early postoperative ultrasound of kidney transplants: evaluation of contrast medium dynamics using time-intensity curves. Rofo, 2004; 176(4): 472–77

18. Fischer T, Dieckhöfer J, Mühler M et al: The use of contrast-enhanced US in renal transplant: first results and potential clinical benefit. Eur Radiol, 2005; 15(Suppl.5): E109–16

19. Burgos Revilla FJ, Marcen Letosa R, Pascual Santos J et al: The usefulness of ultrasonography and Doppler ultrasound in renal transplantation Arch Esp Urol, 2006; 59(4): 343–52

20. Irshad A, Ackerman S, Sosnouski D et al: A review of sonographic evaluation of renal transplant complications. Curr Probl Diagn Radiol, 2008; 37(2): 67–79

21. Manno C, Strippoli GF, Arnesano L et al: Predictors of bleeding complications in percutaneous ultrasound-guided renal biopsy. Kidney Int, 2004; 66(4): 1570–77

22. Fischer T, Filimonow S, Mutze S et al: Renal transplant: color duplex ultrasound and contrast-enhanced ultrasound in the evaluation of the early postoperative phase and surgical complications. Rofo, 2006; 178(12): 1202–11

23. Whittier WL, Korbet SM: Timing of complications in percutaneous renal biopsy. J Am Soc Nephrol, 2004; 15(1): 142–47

24. Król R, Cierpka L, Ziaja J et al: Surgically treated early complications after kidney transplantation. Transplant Proc, 2003; 35(6): 22–41