THE EMPROVEMENT OF PERCUTANEOUS PUNCTURE CORE RENAL BIOPSY IN DIFFUSE DISEASES

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We developed methods to improve ultrasound-guided percutaneous renal puncture core biopsy in diffuse diseases. The use of semi-automatic needles True-Cut, caliber 14G, with harpoon-type mandrin, which enables to obtain high-quality tissue samples, up to 2 cm in length and up to 1.2 mm in thickness that makes it possible to perform a single tissue retrieval (2–3 — in exceptional cases). 40 patients underwent "free hand" biopsy using semi-automatic needles. The peculiarity of the suggested technique of biopsy needle visualization improvement is in the creation of induced anechoic space in paranephral cellular tissue by means of tissue infiltration by 0.25% novocaine solution. It helps to localize the tip of a mandrin immediately close to the renal surface and enables its controlled introduction into the selected biopsy area. To avoid the calices-pelvis system or vessel damage, the approach is along the line going obliquely superiorly down through parenchyma of the middle third of the kidney towards the lower pole at sufficient distance from the renal sinus echostructures. Informative material for histological study was obtained without complications in all cases. The optimized biopsy technique permits early activization of patients and their reduced (up to one day) stay in hospital.

Key words: renal diagnostic ultrasound; ultrasound-guided renal biopsy; puncture core biopsy; cutting biopsy needles True-Cut.

Percutaneous puncture core biopsy of the kidney is an invasive diagnostic manipulation, which allows the physician to obtain a fragment of renal parenchyma for histological study in the form of the tissue column, cut with a special needle over the recess in the retractable mandrin. Of all kinds of the thick-needle biopsy it enables one to obtain the longest and the least deformed piece of tissue (when it is necessary to make a morphological diagnosis with the evaluation of the degree of severity of inflammatory and sclerotic changes of glomerular apparatus, tubulointerstitial component and arterioles). Biopsy acquires special significance in such diseases as systemic necrotizing vasculitis, amyloidosis of the kidneys, acute tubular necrosis and tubulointerstitial nephritis, some hereditary nephropathies [1, 2].

An accurate morphological diagnosis is necessary to determine the treatment tactics, first of all the necessity of immunosuppressive therapy with high doses of corticosteroids and cytostatics. Harm made by unreasonable administration of immunosuppressive therapy, which, on the one hand, can radically improve prognosis of nephritis, and, on the other hand, cause serious side-effects, significantly exceeds the risk of probable complications after the biopsy procedure itself, provided it is technically made correctly [3]. Experience of the leading clinics where morphological verification is being systematically carried on, shows that the finding of renal biopsy critically changes clinical diagnosis in 20% of cases in differential diagnosing of diffused parenchymatous pathology of the kidneys. In 30% of cases renal biopsy, without changing clinical diagnosis, influences essentially the therapeutic tactics, revealing steroid-resistant forms of glomerulonephritis [4, 5].

However, the traditional technique made with the apparatuses of the middle class not always allows the needle to be clearly visualized, increasing the risk of damaging the kidney structure.

The aim of investigation was to improve and standardize the technique of performing percutaneous puncture core biopsy of the kidney in diffused renal diseases.

Materials and Methods. For the last 4 years 40 ultrasound-controlled puncture biopsies of the kidneys have been performed in the in-patient short-term staying department of Nizhny Novgorod Regional Clinical Diagnostic Centre (Russia). Semi-automatic cutting needles of True-Cut model (caliber 14G) with a harpoon-type mandrin were used to obtain tissue columns up to 2 cm long and 1.2 mm thick. Tissue samples were of a good quality, eligible for histological investigations with the structure well seen all

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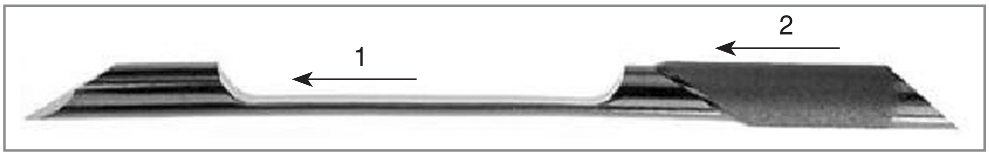

Fig. 1. Semiautomatic Needle True-Cut; mandrin (arrow 1) is manually pushed out, retraction of the needle (arrow 2) is done automatically by a spring mechanism

along the sample. In the columns of material taken by the needle of 14G caliber, in contrast to 16G and 18G needles, glomeruli were positioned in two rows, which made the columns more informative and limited the procedure to only one specimen in the majority of cases. On the average, the tissue column, taken by the needle of 14G caliber, contained 14 glomeruli (from 6 to 24) and 1 to 3 columns sampled.

Material containing not less than 8–10 (optimally not less than 20) glomeruli was considered sufficient for morphological diagnosing. According to the data published, sampling of two tissue columns from one pole of the kidney is standard (without microscopy of the native specimen during biopsy procedure) [6, 7]. In our practice the morphologist always performed visual control of the unstained material during nephrobiopsy and signalled to finish interaction when a sufficient quantity of it has been obtained. In half of all cases only one tissue column was required, more than three columns from one pole have never been withdrawn.

Biopsy was performed using a “free hand“ method and semiautomatic needles, the mandrin in which was moved out manually with the following automatic retraction by a spring mechanism. We refused from using automatic needles as they do not allow to move the mandrin forward in parenchyma under visual control and to reposition the needle along the axis in the course of material sampling. True-Cut needles are currently the best type of needles for renal biopsy enabling physicians to cut quickly and safely a thick and long enough tissue sample in parenchyma under the capsule (Fig. 1).

Results and Discussion

Preparation for biopsy. Preparation for biopsy required taking complete blood test with thrombocyte count, evaluation of blood coagulation system: coagulogram, time of clotting and bleeding, as well as blood group and Rhesus-factor. If a patient received anticoagulants, they were stopped for some time before biopsy and continued the next day after it in case of no complications. Two days before the procedure a diet containing no products increasing gas-formation in the intestine was administered. The manipulation was carried on fasting, and shortly before the bladder was emptied. Half an hour before the puncture medications improving blood coagulation were introduced (Dicynone or Etamsylate in a standard dosage 250 mg intramuscularly). They were given intramuscularly every 4 hours during 24 hours after the manipulation. In case of urine syndrome one IV injection of epsilon-aminocaproic acid was instituted. Biopsy was preceded by ultrasond examination to assess the position of the kidneys, dimensions, parenchyma thickness, as well as access to the lower pole, usually, of the left kidney [8].

Biopsy technique. Ultrasound-controlled biopsy was performed in the operating room. Immediately after the manipulation the microscopic assessment of the obtained native tissue column without staining was made in the next room. If the material was informative enough after the first withdrawal, the procedure was finished, if not, one more or (maximum) two columns were taken from the same pole.

A patient was laid in a prone position on the operating table with a cushion under the abdomen, if possible. Before the biopsy the patient was explained how to behave himself and to breathe during the procedure: movements are allowed only on the doctor’s permission, manipulations are made holding the breath at inhalation to avoid marginal cutting of the capsule and parenchyma of the kidney. At the very beginning of the procedure any advances of the needle are made in the phase of breath holding at inhalation in order to train the patient. First of all, a place of access is determined in unsterile conditions. Material was usually taken from the lower pole of the left kidney. The right kidney was punctured only when the thickness of parenchyma in the lower pole on the left was significantly less than on the right.

The operation field was treated in a standard way: first with a solution of iodopironum, and a second time with 5% alcohol solution of chlorhexidine. A significant length of the ultrasond probe cable, previously disinfected with sidex solution, was sterilizes with chlorhexidine solution. Local anesthesia with 0.25% of novocain solution was given under ultrasound control. The needle was introduced from the lower edge of the XI–XII rib downward to the lower pole of the left kidney from the end of the probe under its aperture. While giving anesthesia the end of the injection needle was often badly visualized in the echogenic cellular tissue. Its position was judged by introducing anesthetic fractionally while advancing the needle: splitting of the tissues by the anesthetic solution and its centrifugal movement from the tip of the needle were well seen.

After surface anesthesia the standard needle from the syringe was changed for the long injection one, which in the similar way was introduced from the same edge of the probe and advanced deeply in such a way that the beveled part of it be all the time in the plane of scanning under visual control. In addition to the short-amplitude reciprocating tremor-like movement by the needle, the control of its travel was facilitated by the introduction of the anesthetic solution during its advancement.

To avoid the damage of the caliceal-pelvic system or vessels the access was made along the line going obliquely downward through the parenchyma of the middle third of the kidney towards the lower pole at a sufficient distance from the echostructures of the renal sinus [6, 9]. Such a path is the safest one preventing the penetration of the needle into the sinus: in case of excessive introduction the needle punctures the parenchyma without damaging sinus structures and comes out from the kidney to the paranephral tissue rather than to the adjoining organs. Besides, this path makes movement of the needle through the renal parenchyma rather extensive for obtaining the maximum length of its tissue column (Fig. 2).

Preintroducing anesthetic, the injection needle advances into paranephral cellular tissue at a level of a middle and lower third of a kidney. Once a cellular tissue is reached, the movement of the needle stops for a while and 70–150 ml of novocain is injected, depending on the patient's weight and quality of ultrasond image of the kidney. Novocain spreads in the cellular layer, mainly downward towards the lower kidney pole, forming actually a stiff novocain Wishnevsky's infiltrate. It results in formation of un- or hypoechogenic space near the kidney surface 10–15 mm thick, splitting the echogenic adipose tissue and making better visualization of the kidney fibrous capsule and the tip of the needle in immediate proximity to it (Fig. 3).

The needle tip is clearly located in the center of the infiltrate in the form of hypoechogenic signal. Thus, generating in the paranephral cellular tissue an artificial unechogenic space by infiltrating the tissue with anesthetic solution enables one to localize the biopsy needle tip better, improving considerably visualization during biopsy.

Creation of paranephral novocain infiltrate allows not only to see the needle better, but also gives some other advantages. A good anesthesia excludes painful sensations during material sampling, the patient does not react to manipulation, which allows the physician to work calmly. Paranephral blockade removes probable vegetative vessel reactions of the kidney to the interaction. Additionally, increased pressure of the tissue liquid in the paranephral space is believed to contribute to a shorter period of bleeding from the punctured kidney capsule and biopsy channel.

Infiltrate is a sufficiently dynamic structure as it starts to resolve soon after formation. Visually its boarders become less clear in 2–3 min after introduction, and in 5–7 min it acquires sufficient echogenicity, making visualization of the needle tip difficult. In 10–15 min the area of injected anesthetic presents simply a hypogenic zone in paranephry. Such a short duration of optimal visualization conditions requires quick actions from the whole personnel, performing punctional biopsy.

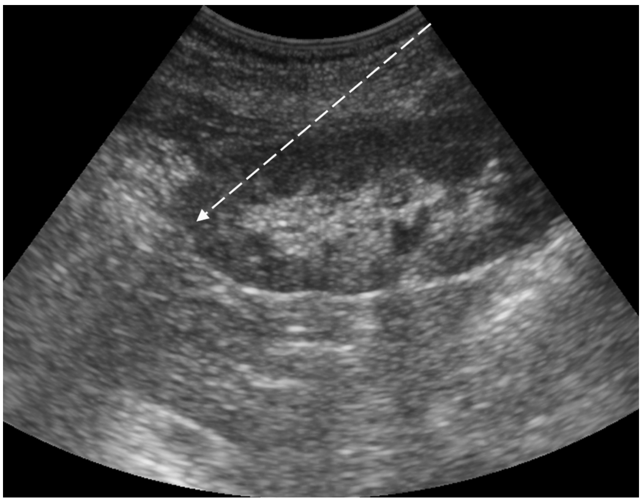

Fig. 2. The path of the needle movement through the parenchyma in puncturing using "free hand" method

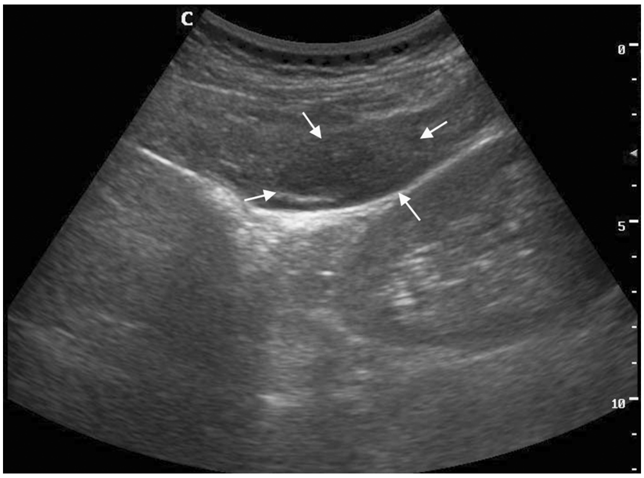

Fig. 3. Novocain infiltrate near the lower pole of the kidney in the form of hypoechogenic space with an unclear outline (arrows)

It is necessary to note, that while taking the anesthetic and connecting the syringe to the injection needle cannula it is advisable to avoid getting air bubbles into the solution, which interfere with needle visualization in the soft tissues. Immediately before the connection of the syringe novocain is dropped on the cannula to form a drop of liquid in which the syringe is inserted. When introducing the anesthetic, the syringe is held vertically with cannula down in order to remain the tiny bubbles near the plunger, while the syringe itself is never emptied completely.

Once the infiltrate is formed, the injection needle is removed, and semiautomatic biopsy needle True-Cut (Quick Core) of guillotine-type is introduced in this site. The mechanism of the needle is preset to a maximum cutting depth of 2 cm. The needle is lead along the same path as a long injection needle, i.e. in the direction of the boarder of the middle and lower third of the kidney. The moment of entry of the biopsy needle tip into the unechogenic infiltrate is well seen (Fig. 4). And here one more positive moment of creation of an artificial acoustic window in the paranephric tissue should be noted — the possibility to advance the needle in two steps: first, up to infiltrate, when it is not necessary to follow the pathway, and then, after getting into infiltrate, movement of the needle is precisely corrected. After visualization of the needle tip in the infiltrate the physician determines the final place of the kidney capsule puncture.

Directly before sampling the material from the kidney the patient takes a deep breath and holds it. The needle advances forward till the kidney capsule at a boarder of its middle and lower third. The capsule is pricked by the needle tip. The moment of moving through the capsule is, as a rule, well seen. The capsule at first bends down

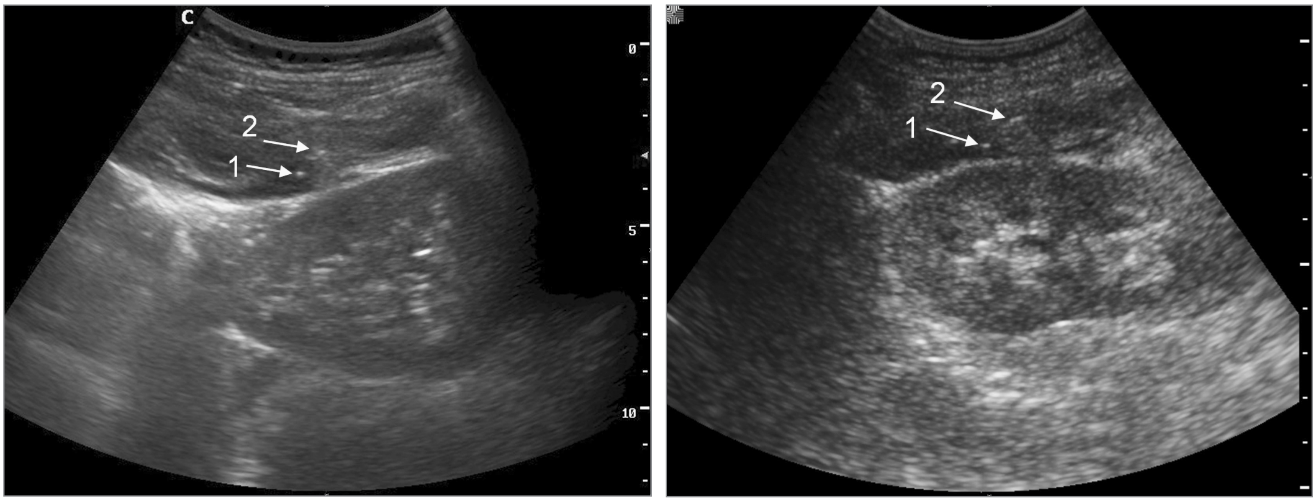

Fig. 4. Visualization of the mandrin tip (*1*) and a marker cuff (*2*) of the biopsy needle in the center of the novocain infiltrate before pricking the kidney capsule

under the needle pressure, but at the moment of puncture it displaces backward. The mandrin is pushed out (it is advisable to control the direction of mandrin's movement in the kidney parenchyma visually). The needle can be moved back and forth along the entrance line, positioning the mandrin window in the parenchyma. If mandrin is not clearly seen, withdrawal can be continued, as the oblique path is potentially not dangerous for the vessels and calices-pelvic complex. At the proper moment the triggering mechanism is pressed and the needle is activated, cutting out a column of renal tissue. The needle is removed and the patient is allowed to breathe.

Our experience shows that the dimensions of the visible central echo-complex of the kidney slightly exceed real dimensions of the anatomical sinus corresponding to it. We came to such a conclusion, when in the series of biopsies, performed along the oblique path through the edge of the central echo-complex, no adipose sinus tissue or its other elements were revealed in the obtained material. In such path the obtained specimens contained much medullar substance, while morphological elements of the cortical layer, as a rule, were present in the form of fragments between the pyramid substance. However, such marginal path is nevertheless dangerous, as the sinus may be damaged in case of unclear visualization of the needle tip or by an accidental movement of the patient.

When the morphologist confirms obtaining of the sufficient quantity of the material, biopsy is considered to be over. Ultrasound examination of the punctured pole is made once again with the patient still on the table. Aseptic plaster bandage is applied and the patient returns to the ward, where he follows a strict bed regimen for 4 hours and the next 24 hours — a partially bed regimen. In addition to the medications increasing blood coagulation, a course of antibiotics and a single dose of corticosteroids are obligatory administered, since in 7 patients (17.5%) exacerbation of glomerulonephritis was observed after nephrobiopsy which made us perform biopsy under the protection of antibiotics and steroids. On the day of biopsy the patient himself controls visually the color of his urine for macrogematuria, and the next morning a clinical urinalysis is taken. If there are no complaints and changes in the urine the patient is discharged for out-patient treatment.

No complications after nephrobiopsy performed according to our technique were noted. Postbiopsy microhematuria in patients with nephritic syndrome was not also observed: 1–2 erythrocytes in the field of view in these patients we did not consider to be statistically significant. In patients with urine syndrome microhematuria remained at a level of 4–5–10 erythrocytes in the field of view which corresponded to the prepunctural level. Formation of arteriovenous fistulas in the parenchyma of the lower pole of the punctured kidney long after the intervention was not noted either.

After biopsy 24 patients (60%) felt discomfort in the lumbar area while bending, which lasted for a week, and sometimes a month. Usually such complaints presented women with an insufficient body and cellular tissue mass. Probably, it is the effect of the introduced liquid on the adipose tissue and is the consequence of its "hydraulic preparing", when rupture of the interstitial cellular fibers occurs influenced by the action of the injected anesthetic.

In 10 patients (25%) during control ultrasond examination in 1–3 weeks after biopsy paracapsular hypoechogenic zone 3 cm long and 1 cm thick was determined, being, probably, edema of the cellular tissue in the site of novocain infiltrate formation. These remnant phenomena are believed to be insignificant in comparison with the evident advantages of creating an effective ultrasound window for performing biopsy.

Conclusion. In contrast to a common ultrasond-guided nephrobiopsy, which is always associated with some risk of damaging the vessel system or the calices-pelvis kidney complex, the ways of optimizing kidney biopsy technique developed by us, reduce significantly the risk of possible complications due to creation in the paranephric zone of a good acoustic window by introduction of anesthetic solution in the paranephral cellular tissue. The section of needle is clearly visualized in the obtained unechogenic space, which makes it easier to control its position and timely change the direction of movement before the puncture of the capsule for targeted withdrawal of parenchyma from the appropriate site. Technically correct performance of biopsy permits early activization of patients and reduces their stay in hospital to a day.

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