The affected and contralateral kidney morphological changes in course of one-sided rat pyelonephritis model

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Abstract

Introduction and objectives. Exceptionally clinically important is clear understanding of the pathophysiological mechanisms for the intact kidney involvement of in course of the unilateral inflammatory process. The study aimed to identify the presence and severity of the intact kidney tissue changes in course of rat acute unilateral kidney inflammation.

Materials and methods. The experiment was carried out on 52 mature nonlinear white rats Rattus Norwegicus. In 32 animals (main group) an acute unilateral kidney inflammation has been modeled. For modeling of the acute unilateral kidney inflammation in experimental rats, an *E.Coli* strain was injected in the kidney parenchyma according to our own method. The pathogen was previously isolated from urine in patients with the diagnosed urinary tract infection. The control group consisted of 20 animals, the same amount of sterile 0,9% NaCl was injected in the kidney. The observation period lasted 10 days.

Results. Starting from the 3rd day, signs of hematogenous dissemination of infection / inflammation into contralateral kidney were registered. Starting from the 5th day urinogenous dissemination process was observed. By the 3rd day of study a cortical hyperemia in contralateral kidney was seen, which possibly was of compensatory origin.

Conclusions. Consequently, a primarily unilateral urinary tract inflammation / infection turned into bilateral between 3rd and 5th day of the disease in rats.

Keywords: bacterial contamination, contralateral kidney, Escherichia coli, intact kidney, kidney inflammation, nephrectomy, pyelonephritis.

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Introduction and objectives

Currently the problem of acute kidney inflammatory diseases remains of high interest for clinicians. A variety of causes and forms of the disease require precise understanding of disease pathogenesis which determines clinical approaches for the diagnosis and treatment [1,2,3,4]. About 35% of serous pyelonephritis cases overgrow into purulent forms (apostematous nephritis, kidney abscesses or carbuncles etc.) with having possible consequent extension beyond the renal capsule and perirenal abscess formation [5,6]. The affected and contralateral kidney tissue changes in course of the unilateral pyelonephritis are not entirely understood, whereas the mechanisms of the intact kidney pathologic inclusion and festering progress are not clear at all [7,8]. Clinical evaluation of the dynamic tissue changes does not appear to be possible to perform; therefore an experimental rat unilateral pyelonephritis model study was conducted.

Materials and methods

The experiment was carried out on 52 mature nonlinear white rats Rattus Norwegicus. All of those were male, aged 18-20 weeks, of 180-205g weight. The core group consisted of 32 rats, where a disease has been modeled based on own method.

For modeling of the acute unilateral kidney inflammation in experimental rats, an E. Coli strain was used. The pathogen was previously isolated from urine in patients with the diagnosed urinary tract infection. The strain had a number of features letting him be easily distinguished from other E. Coli strains (autologous) which could get into the research material (kidney tissue) from the intestine of animals by the hematogenous, lymphogenous or ascending routes [9, 10]. The strain we used was lactose negative and had the ability to grow on Simmons medium. Based on the combination of other biochemical tests it was confidently identified as E. Coli [11]. A 4.05-6.55 x 10^7 per 1 ml colony-forming units suspension was prepared. 0.1 ml per 100 g rat mass was injected in kidney parenchyma unilaterally in combination with the incomplete ureter ligation in its lower third on the affected side, for the purpose of partial reducing the urine passage. Partial ureteral obstruction intended to ensure the adequacy of the experimental pyelonephritis model.

Control group consisted of 20 animals, where the sterile 0.9% NaCl solution was injected instead of bacterial culture in the same quantities, using the same method. Pathological evaluation was performed 3, 5, 7 and 10 days after disease modeling in rats. Animals were distributed equally.

Results

On the 3rd day of the experiment the affected kidney has shown signs of the diffuse inflammation in all tissue layers: hyperemia, swelling, multiple small hemorrhagic foci were visualized. Accumulation of mature white blood cells was present mostly perifocal to the infectious agent injection (Fig.1, A). An intact kidney parenchyma showed signs of congestion, which was more relevant in the cortical layer. An interstitial edema, small peritubular polymorphic cell infiltration and tubular epithelium hydropic vacuolization were also seen (Fig.1, B). Revealed changes can be regarded as a manifestation of compensatory reflex hyperemia of the intact kidney of possible congestion due to bacterial embolism.

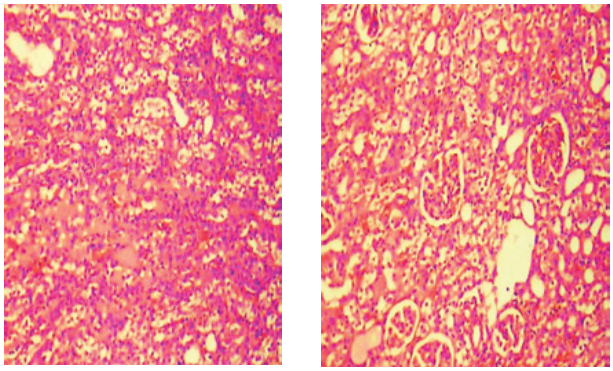


Fig. 1. The core group's kidneys on the 3rd day of experiment: A – infected kidney: focal leukocyte infiltration of the stromal component, hydropic swelling and vacuolization of the tubular epithelium; B – intact kidney: congestion of the renal cortex, hydropic dystrophy of the tubular epithelium. Hematoxylin and eosin. Magnification x100.

On the 5th day of experiment in the core group's infected kidney the signs of tissue destruction were observed. Multiple small abscesses, sometimes with a tendency to merger had been registered, having the visual progression of purulent inflammation in all layers of the kidney on the background (Fig.2). The edema, hemorrhagic foci with signs of diapedesis, abundant polymorphic cell infiltration of stromal component, hydropic vacuolization and desquamation of epithelial tubules with the formation of dense eosinophilic masses in their gaps had place in all fields of vision. Pathological picture of the intact kidney on the 5th day of infection was characterized by total edema, hyperemia of the tissue, more relevant in the renal medulla,

the presence of multiple small cortical abscesses, elongated massive peritubular polymorphic cell infiltrates, depositions of the neutrophilic leukocytes, desquamous epithelial cells in the lumen of tubular structures and signs of pyelitis (Fig.3, A, B).

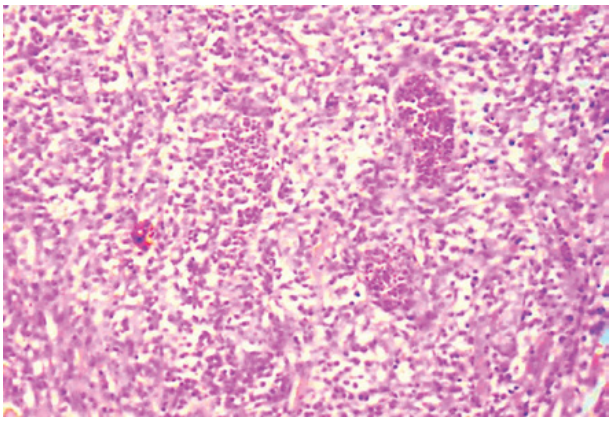


Fig. 2. The core group's infected kidney on the 5th day of experiment: abscesses formation, desquamation of the tubular epithelium, presence of eosinophilic masses in the lumen, diffuse leukocyte infiltration. Hematoxylin and eosin. Magnification x100.

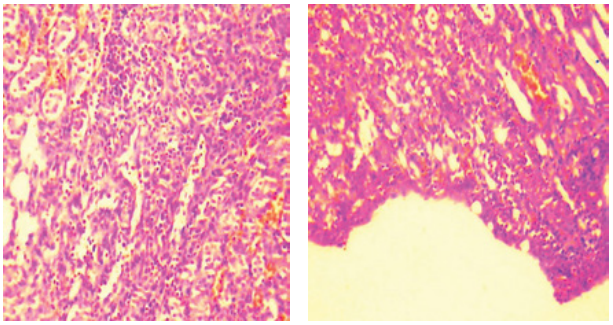


Fig. 3. Theinoculated kidney on the 5th day of experiment: A – abscesses on the background of kidney tissue hyperemia. B – intense polymorphic cell infiltration of renal medulla, signs of pyelitis. Hematoxylin and eosin. Magnification x100.

The inoculated kidney of the control group animals showed signs of interstitial edema, peritubular polymorphic cell infiltration and tubular epithelium hydropic vacuolization on the 3rd day of the study (Fig.4). Intact kidney of the control group showed no relevant changes. The pathologic features of the inoculated kidney of the control group, starting from the 5th day included decrease of hyperemia, interstitial edema, peritubular polymorphic cell infiltration and hydropic vacuolization of the tubular epithelium which suggested of the decline in the tissue reaction to the sterile 0.9% NaCl injection and operative stress.

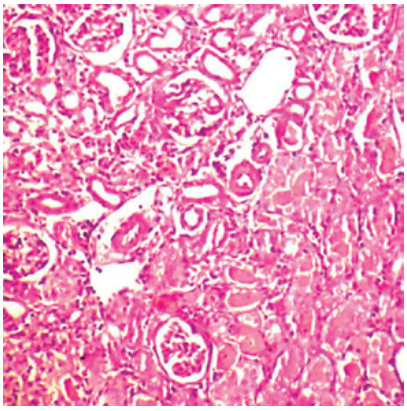


Fig. 4. Thecontrol group's inoculated kidney on the 5th day of experiment: interstitial edema, peritubular polymorphic cell infiltration and tubular epithelium hydropic vacuolization. Hematoxylin and eosin. Magnification x100.

In the animals of the core group on the 7th day of the experiment, a purulent inflammation of the originally intact kidney tissue was found. It was characterized by the presence of small foci of necrosis with abscesses formation on the background of diffuse inflammatory infiltration and edema of all kidney layers. However, the formation of colonies of microorganisms was not registered. The degree of tissue destruction was medium, in comparison with the infected kidney. Albeit a tendency to perivascular and peritubular inflammatory cell infiltration was kept (Fig.5).

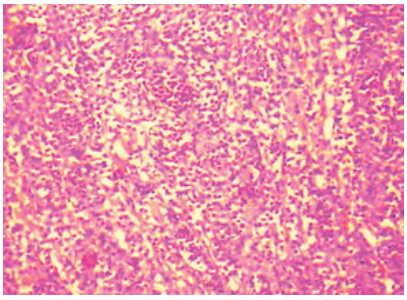


Fig. 5. The core group's intact kidney on the 7th day of experiment: small foci of necrosis, surrounded by the segmented neutrophils. Hematoxylin and eosin. Magnification x100.

The observation of pathologic changes in core group's both infected and intact kidneys on the 10th day of the experiment revealed progression of total destruction of organ's tissue. The diffuse purulent and haemorrhagic permeation with the spread of purulent inflammation towards the perirenal fat was found.

The evaluation of nature and sequence of the infected and intact kidney pathologic changes in course of the experimentally modeled rat acute unilateral kidney inflammation led us to several conclusions.

Conclusions

1. The dynamic study of the acute unilateral kidney inflammation showed prevalence of the hematogenous dissemination of the pathogen during the

first three days of experiment with the following affiliation of the urinogenic mechanism for the intact kidney contamination on the 5th day of the study.

2. During the first three days after inoculation, the intact kidney develops severe cortical hyperemia, which suggested of the possible functional compensation mechanism. However, failure to eradicate the pathogen leaded to the progression of purulent destructive process in the inoculated kidney and the necrobiotic changes of tubular epithelial structures in the intact kidney. The listed conditions may cause acute renal failure as process progresses.
3. Based on the results of the research, the originally unilateral untreated acute renal infection with impaired urodynamics became bilateral on the 5th day.

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