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The morphological changes in renal proximal tubules during E. Coli endotoxemia – electron microscopic study

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Abstract

E. coli is a gram-negative bacterium, which is present in normal intestinal microflora and indicates the toxic influence to many cells of the body as well as renal vascular endothelial cells in the kidneys and epithelial cells of proximal and distal renal tubules. The toxic effect of E. coli is related to lipopolysaccharide containing endotoxin placed in their wall. The needle biopsy had been taken from 10 patients (7 females, 3 males) complicated by pain in kidneys and nephrotic syndrome in anamnesis during the E. coli endotoxemia. The Araldite-Epon blocks had been prepared from biopsy materials. The semi- and ultrathin sections obtained from these resin blocks were examined by JEM-1400 Transmission Electron Microscope and the electron micrograms were taken. The titer of E. coli endotoxin was high in the microbiological analysis of the urine of the 10 patients with kidney disease (7 of them were female and 3 – male). The mixed infection of E. coli and Salmonella were found in bacteriological analysis of 1 female. Upon the result of toxemic influence of E. coli endotoxin to the epithelial cells of renal tubules, the severe structural abnormalities and necrosis were found. The different results of morphological research of renal structures during the E. coli endotoxemia pointed that there aren't same findings in epithelial cells of renal tubules in all patients. Finally, our findings can create a morphological basis for the future molecular investigations of acute endotoxemic kidney injury.

Keywords: Renal tubules, E. coli endotoxemia, electron microscopy

Introduction

E. coli is a gram-negative bacterium, which is present in normal intestinal microflora and indicates toxic influence to many cells of the body as well as renal vascular endothelial cells in kidneys and epithelial cells of proximal and distal renal tubules. The toxic effect of E. coli is related to lipopolysaccharide (LPS) containing endotoxin placed in their wall.

The toxic influence of LPS endotoxin to organs and cells haven't been yet completely studied in ultrastructural level, although 200 years passed from its discovery [1]. There aren't any consistent renal histopathological changes in human and experimental septic acute kidney injury [2;3]. Our research is about the electron microscopic study of E. coli bacilli influence in the renal tubules. The biopsies were performed from the patients with complication of nephrotic syndrome and were examined in light and electron microscopes to determine the pathomorphological changes.

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Material and Methods

The needle biopsy had been taken from 10 patients (7 females, 3 males) with complicated pain in kidneys and nephrotic syndrome in anamnesis during the E. coli endotoxemia. The kidney needle biopsies were performed in the Nephrology Department of Educational-Therapeutical Clinic of the Azerbaijan Medical University. The Araldite-Epon blocks had been prepared from bioptats. The semi- and ultrathin sections obtained from these resin blocks were examined by JEM-1400 Transmission Electron Microscope and the electron micrograms were taken.

Results

The titer of E. coli endotoxin was high in the microbiological analysis of urine of the 10 patients with kidney disease (7 of them were females and 3 –males). The mixed infection of E. coli and salmonella were found in bacteriological analysis of 1 female. The thickening of the basal membranes (in 2 patients), the shrinking in size of cells (in 3 patients), the disappearance of brush borders (in 4 patients) and the loss of nucleus (in 1 patient) of the epithelial cells of proximal renal tubules were observed in semithin sections. These morphological changes are related with chronic inflammatory process (Fig. 1; 2).

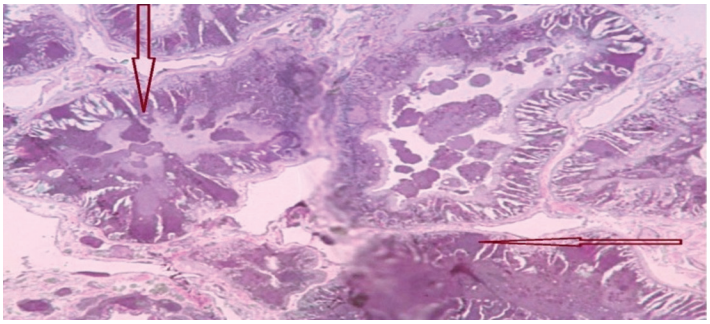

Figure 1. The pathomorphological changes in the epithelial cells of proximal renal tubules during E. coli endotoxemia. The basal membrane of epithelial cells (arrow sign). Stain: methylene blue + Azur II. x40

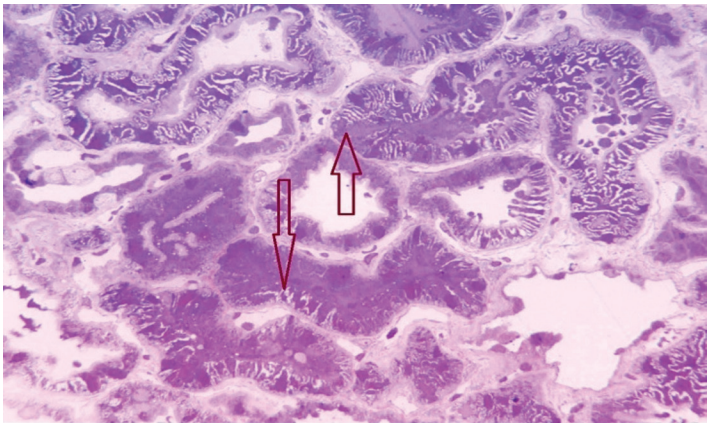

Figure 2. The pathomorphological changes occurred in the epithelial cells of proximal renal tubules during E. coli endotoxemia. The nuclei are not observed (arrow sign) in necrotic cells. Semithin section. Stain: methylene blue + Azur II. x40

The smoothing of cisterns of Golgi apparatus and mitochondrial crysts, the disappearance of smooth endoplasmic reticulum, the homogenization of lysosomes and karyopyknosis are indicated in the epithelial cells of proximal renal tubules in 2 patients.

The abundant vacuoles in the cytoplasm, the homogenization of mitochondria, the decreasing of volume of Golgi apparatus are found in the epithelial cells of proximal renal tubules in 2 patients. The vacuoles were indicated only in 2 patients. (Fig. 3; 4;5; 6).

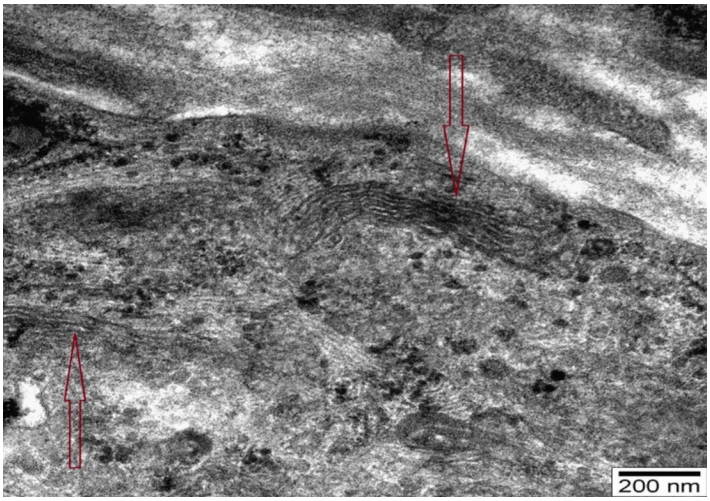

Figure 3. The disappearance of smooth endoplasmic reticulum of the epithelial cells of proximal renal tubules. Electron micrograph

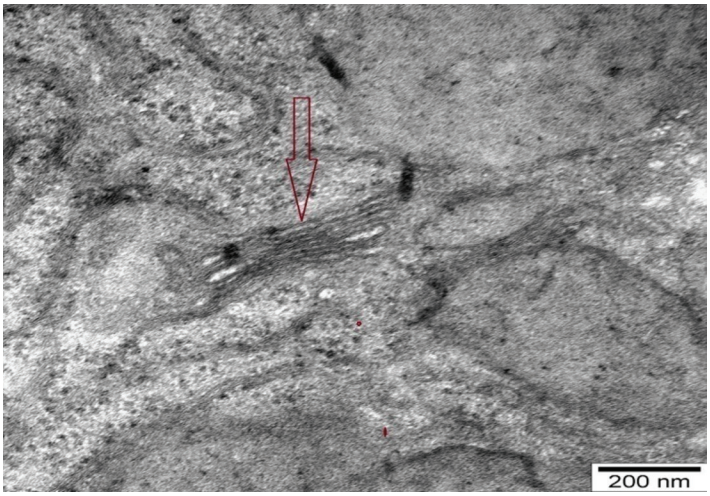

Figure 4. The smoothing of mitochondrial crysts and cisterns of Golgi apparatus (arrow sign) of the epithelial cells in proximal renal tubules. Electron micrograph

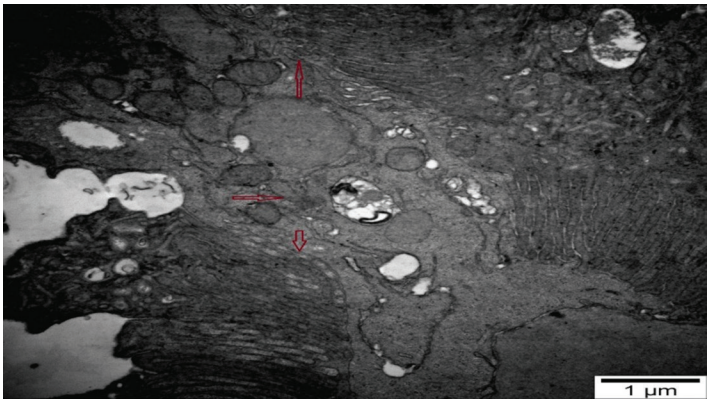

Figure 5. The disappearance of granules of the rough endoplasmic reticulum of epithelial cells of proximal renal tubules. Electron micrograph

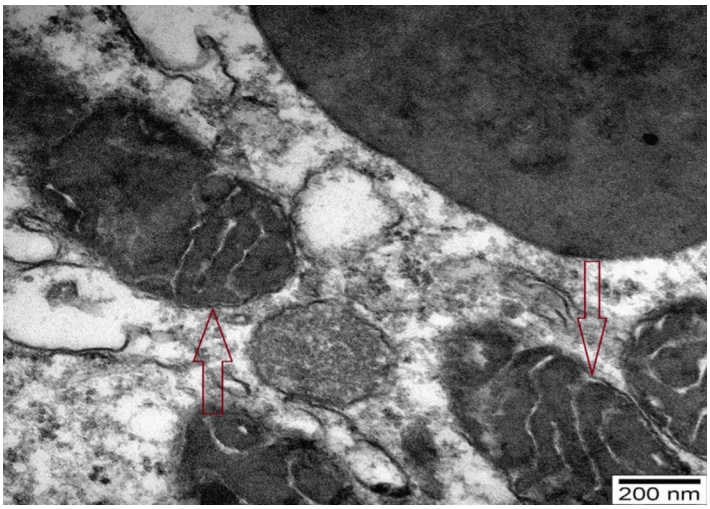

Figure 6. The swelling of mitochondrial crysts of epithelial cells of proximal renal tubules. Electron micrograph

There are tight junctions and desmosomes which are present between the epithelial cells of the renal tubules in normal conditions. During the endotoxemia, one of the main morphological signs of cell damage is the disappearance and disregularity of intercellular junctions. In ultrastructural examination of the biopsy material taken from 1 patient with nephrotic syndrome, we are observed

the destruction and disappearance of desmosomes (Fig. 7).

As a result of toxemic action of E. coli endotoxin to the epithelial cells of renal tubules, the severe structural abnormalities and necrosis were found.

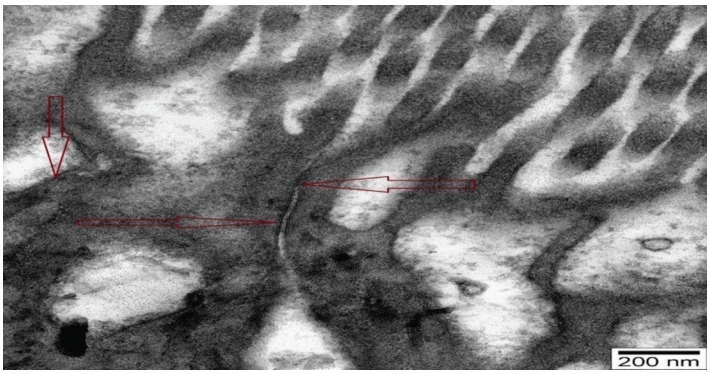

Figure 7. The pathomorphological changes of the desmosomes. Electron micrograph

Discussion

The analysis of data showed that there are a few papers about the histopathological and ultramicroscopical investigation of the renal structures during the E. coli endotoxemia. M. Diaz de Leon and colleagues showed the non-specific histopathological features in the renal tubules and glomeruli in 12 patients [4]. Hotchkiss and colleagues histopathologically noted the acute tubular necrosis in 1 patient [5]. According the data of Welty-Wolf, the acute tubular damage and classic histopathologic changes were examined in all experimental 6 samples during endotoxemia [6]. On the contrary, Carraway and colleagues did not observe any tubular damage in 6 experimental samples [7].

The results of our investigation showed that the smoothing of mitochondrial cysts, loss of the granules of rough endoplasmic reticulum, homogenization of lysosomes and karyopyknosis in 2 patients. Considering these changes, the cell nuclei was not observed and underwent to necrosis in 1 patient. Despite the temporary increasing of the volume of creatinine and urea in blood, the acute tubular injury did not cause any acute renal failure.

Conclusions

The different results of morphological research of renal structures during the E. coli endotoxemia pointed that there aren't same findings in epithelial cells of renal tubules in all patients. Finally, our findings can create a morphological basis for the future molecular investigations of acute endotoxemic kidney injury.

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