Introduction

Pregnancy has several effects on the normal kidney. These include alterations in glomerulotubular balance; dilation of the renal calyces, pelvis and ureter; increases in the glomerular filtration rate and renal plasma flow due to chronic renal vasodilation; and increases in aldosterone and renin production and proteinuria (1-3). However, in unilaterally nephrectomized animals, in addition to these findings, a compensatory growth was observed in the remaining kidney during pregnancy (4-6).

Although there are many studies in the literature related to uninephrectomy and pregnancy, none of them have examined the single kidney during pregnancy at the electron microscopic level (7-12). Additionally, there are no studies in the literature related to the single kidney of unilateral nephrectomized rats during mid-term pregnancy. Therefore, in this study, the light microscopic and ultrastructural changes observed in the single kidney of pregnant rats were detected during mid-term pregnancy and after parturition and the results were compared with those of pure nephrectomized rats.
Materials and Methods

The experimental studies were performed on 24 female virgin Sprague-Dawley rats. Their ages varied between 4 and 6 months. All these rats were subjected to unilateral nephrectomy. During the operations, the animals were anesthetized by ketamine hydrochloride (Ketalar) 30 mg/kg intramuscularly. For muscle relaxation, 6 mg/kg xylasine (Rompun) was used. The left kidney of each animal was excised as atraumatically as possible and the incisions were closed with sutures. Then, following nephrectomy, the rats were divided into three groups (eight animals in each group). The animals in group I remained virgins throughout the study. Seven days after nephrectomy, the rest of the animals were put for 72 h with adult male rats. Sets of three females and one male were put into separate cages, but in one of the cages there were four females and one male. After this procedure, the male rats were removed from the cages. These 16 animals were divided into two groups (groups II and III). The animals in group II were caged from day one of their pregnancy (which was established by the detection of spermatozoa in the morning vaginal smear) up to day 11 of their pregnancy. Then their solitary kidneys were excised surgically and the tissue samples were put into 2.5% gluteraldehyde (group II: mid-term pregnancy group). The animals in group III were caged until the end of their pregnancy and, following the delivery of the litters, their solitary kidneys were excised surgically. The single kidneys of rats in group I were excised surgically together with this group and all the tissue samples were put into 2.5% gluteraldehyde for fixation.

The specimens, which were taken from the cortex and medulla of each kidney, were fixed in 2.5% gluteraldehyde for 24 h, washed in phosphate buffer (pH 7.4), post-fixed in 1% osmium tetroxide in phosphate buffer (pH 7.4) and dehydrated in increasing concentrations of alcohol. Then the tissues were washed with propylene oxide and embedded in epoxy-resin embedding media. Semi-thin sections about 2 µm in thickness and ultrathin sections about 60 nm in thickness were cut with a glass knife on a LKB-Nova (Sweden) ultramicrotome. In this study, five semi-thin and five ultrathin sections were taken from the cortex, and five semi-thin and five ultrathin sections were taken from the medulla of each kidney. All of these sections were examined under a light microscope and transmission electron microscope. Semi-thin sections were stained with methylene blue and examined under a Nikon Optiphot (Japan) light microscope. Ultrathin sections were collected on copper grids, stained with uranyl acetate and lead citrate and examined under a Jeol JEM 1200 EX (Japan) transmission electron microscope.

Results

Pure nephrectomized group: No pathology was observed in the light microscopic examination of the tissue specimens in this group (Fig. 1A). In the transmission electron microscopic examination of the kidneys, glomerular basement membranes and podocytes were normal (Fig. 1B). However, cell swellings were observed in the endothelial cells of the interlobular
arteries and arterioles (Fig. 1B). The tubules were found to be normal, ultrastructurally (Fig. 1C). In addition, a mild cell swelling was observed in the cytoplasm of a few of the mesangial cells (Fig. 1D). The present cell swellings were seen in every section in this group.

Mid-term pregnancy group: No pathology was observed in the light microscopic examination of the tissue specimens in this group (Fig. 2A). In the transmission electron microscopic examination of the kidneys, the glomerular basement membranes were normal (Figs. 2B and 2C). However, a mild cell swelling was observed in the cytoplasm of the podocytes (Fig. 2B). A more prominent cell swelling was seen in the endothelial cells of the interlobular arteries, arterioles and in some of the mesangial cells (Fig. 2C). The tubules were found to be normal, ultrastructurally (Fig. 2D). The present cell swellings were seen in every section in this group.

Post-parturition group: No pathology was observed in the light microscopic examination of the tissue specimens in this group (Fig. 3A). In the transmission electron microscopic examination of the kidneys, focal thickenings were observed in the glomerular basement membranes (Fig. 3B). Cell swellings were present in the cytoplasm of the podocytes (Fig. 3C), endothelial cells of the interlobular arteries and arterioles (Fig. 3D), and in
some of the mesangial cells (Fig. 3E). The tubules were found to be normal, ultrastructurally (Fig. 3F). The present cell swellings were seen in every section in this group.

**Discussion**

The clinical features of patients with solitary kidneys were studied by Rugiu et al. (13). In their study, they observed proteinuria, hypertension, hyperuricemia and deterioration of renal function. In one patient, focal glomerular sclerosis was seen. Following ablation of renal tissue, Gutierrez-Miller et al. (10) reported focal glomerular sclerosis and proteinuria in patients with solitary kidneys. In rats with surgically induced reduction of renal mass, a syndrome of proteinuria and progressive renal failure occurred, usually associated with focal glomerular sclerosis (14,15). However, Baylis and Rennke (16) found no histological abnormalities in the glomeruli of rats at the end of five consecutive cycles of pregnancy and lactation. Similarly, in the study of Averbukh et al. (7), the glomeruli of the mice were normal on light microscopy at the end of a continuous period (19 weeks) of a dual challenge for glomerular hyperfiltration induced by uninephrectomy and repetitive pregnancies.
The light microscopic results of the present study are in accordance with the studies by Baylis and Rennke (16) and Averbukh et al. (7). However, the transmission electron microscopic results of the present study are of great importance, as there are no ultrastructural studies in the literature related to uninephrectomy and pregnancy. Additionally, this is the first study reporting the light microscopic and ultrastructural changes in the kidneys of uninephrectomized animals during mid-term pregnancy. In conclusion, cell swellings were observed in the endothelial cells and mesangial cells in the pure nephrectomized group. Additionally, cell swellings were observed in the podocytes in the mid-term pregnancy group. In the post-parturition group, in addition to all these findings, focal thickenings were observed in the glomerular basement membranes and these focal thickenings occurred during the second half of the pregnancy.

References


