MORPHOMETRY OF THE JUXTAGLOMERULAR APPARATUS OF THE ALLOGRAFTED HUMAN KIDNEY

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A karyometric study was made of the juxtaglomerular apparatus of 17 allografted human kidneys at different times after transplantation. Kidneys of persons dying from head injuries or acute heart failure were used as the control. In the early periods (up to 2 months) there was a significant increase in volume of the nuclei of the epithelioid-modified cells of the afferent arteriole and of Goormaghtigh's cells. A tendency also was observed for the volume of the cell nuclei of the macula densa to increase. At the late stages the juxtaglomerular apparatus still remained in allografted kidneys with a slightly damaged parenchyma. If sclerosis and atrophy of the parenchyma of the graft was marked, the juxtaglomerular apparatus was reduced.

KEY WORDS: allografting of the kidney; juxtaglomerular apparatus; karyometry.

There is evidence of changes in the structure and ultrastructure of the juxtaglomerular apparatus (JGA) in some diseases accompanied or not by the development of hypertension [1, 2, 4-10]. The JGA must presumably play a definite role in the transplanted kidney also.

However, the structure of the JGA in allografted human kidneys has not yet been studied. This was the object of the investigation described below.

EXPERIMENTAL METHOD

The material studied consisted of 17 allografted cadaveric kidneys taken from the recipient between 4 days and 4 years after transplantation, and also nine control kidneys (six kidneys taken from the cadavers of persons dying from head injury and three from persons whose immediate cause of death was acute heart failure). Pieces of kidney were fixed on 10% neutral formalin or Bouin's mixture and embedded in paraffin wax. Sections were cut to a thickness of 4-7 μ and stained by various histological methods. The PAS and Feulgen reactions also were carried out. A karyometric investigation of the JGA of the allografted and control kidneys was carried out by Khesin's method [3]. In each case 100 nuclei from each of the three main components of the JGA – epithelioid-modified cells (EMC) of the afferent arteriole, Goormaghtigh's cells (GC) forming the so-called lacis, and the epithelium of the macula densa (EMD) – were studied separately.

EXPERIMENTAL RESULTS AND DISCUSSION

The logarithms of the volume of the nuclei of EMC in the afferent arterioles in the control series varied from 1.701 ± 0.01315 to 1.788 ± 0.01464. The weighted mean was 1.764 ± 0.004491 (Table 1). In the early periods after transplantation of the kidney the logarithms of the nuclear volume of EMC in the

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TABLE 1. Mean Logarithms of Nuclear Volumes of Three Components of JGA in Control Kidneys (M ± m)

No. of control kidney	EMC	GC	EMD
1	1,766±0,01523	1,871±0,01643	2,055±0,01448
2	1,701±0,01315	1,789±0,01984	1,950±0,01273
3	1,748±0,01559	1,823±0,01190	2,171±0,01201
4	1,768±0,01509	1,795±0,01051	2,027±0,01047
5	1,788±0,01464	1,782±0,01448	2,092±0,01112
6	1,770±0,01273	1,825±0,02125	2,074±0,01045
7	1,780±0,0086	1,800±0,01175	2,073±0,01008
8	1,769±0,01094	1,865±0,009418	2,080±0,008185
9	1,784±0,01160	1,771±0,01287	2,109±0,01087
Weighted mean	1,764±0,004491	1,811±0,004645	2,07±0,004153

TABLE 2. Mean Logarithms of Nuclear Volumes of JGA Cells of Allografted Human Kidneys in the Early Stages after Transplantation (M ± m)

Recipient	EMC	t	GC	t	EMD	t
M.	1,939±0,01529	10,9	1,984±0,01521	18	2,229±0,0129	11
P.	1,812±0,01344	3,2	2,150±0,01738	18	1,987±0,01547	4,9
R.	1,900±0,01794	7	2,120±0,01726	17	2,093±0,01538	1
K.	2,051±0,01517	18	2,145±0,01871	18	2,103±0,01356	2,3
N.	1,919±0,01474	10	1,960±0,01808	8	2,094±0,01128	2
Ya.	1,854±0,0109	8	1,935±0,01926	6	2,090±0,01179	1,7
P-Kh	1,929±0,01977	8	2,070±0,01597	14	2,179±0,01499	7
K-v	1,874±0,0139	7	2,028±0,02249	9	2,086±0,01563	1
Sh.	1,877±0,01696	6,2	1,995±0,01527	18	1,933±0,01428	6
Weighted mean	1,906±0,003148	20	2,043±0,006484	30	2,094±0,005853	3,4

afferent arterioles in the allografts varied between 1.812 ± 0.01344 and 1.939 ± 0.01529. The weighted mean was 1.906 ± 0.003148 (Table 2).

As Table 2 shows, the increase in nuclear volume of EMC of the JGA of the allografted kidneys was highly significant ($t > 3$ in all cases). In precisely the same way, highly significant differences were found between the nuclear volumes of GC of the control and allografted kidneys. In the first case the logarithms of the nuclear volumes varied from 1.771 ± 0.01287 to 1.871 ± 0.01643 (Table 1), and in the second case they varied from 1.935 ± 0.01926 to 2.150 ± 0.01738 (Table 2). The weighted mean in the control was 1.811 ± 0.004645 (Table 1) and for GC of the allografts 2.043 ± 0.006484 (Table 2). The mean logarithms of the nuclear volumes of EMD in the control kidneys varied from 1.950 ± 0.01273 to 2.109 ± 0.01087 (Table 1). The mean logarithms of the nuclear volumes of EMD in the allografted kidneys in the early periods after transplantation varied from 1.983 ± 0.01428 to 2.229 ± 0.0129 (Table 2). The weighted mean in the control for these cells was 2.07 ± 0.004153 (Table 1) and for the allografts it was 2.094 ± 0.005853 (Table 2).

In the early period after allografting of the human kidney (up to 1 month after transplantation) the nuclei of all components of the JGA thus increase significantly in size: EMC of the afferent arteriole and GC with their important role in renin synthesis and the perception of changes in the electrolyte balance.

Meanwhile the nuclear volumes of EMD in five of the nine cases did not differ significantly from those in the control (in all these five cases $t < 3$).

In the late periods after allografting of the human kidney, a certain parallel was observed between the structures of JGA and the microscopic structure of the tubules of the grafted kidney. If the parenchyma of the allograft was well preserved, the dimensions of the nuclei of GC and EMD did not differ significantly from those of the nuclei of these kidneys in the control ($t < 3$). Meanwhile the dimensions of the nuclei of EMC in the afferent arteriole remained larger than in the control ($t > 3$).

When the structure of the grafted kidney was severely disturbed, for example, when pyelonephritis of the graft developed, differences in the nuclear volume of EMC of the afferent arterioles from the control were not significant ($t < 3$), whereas dimensions of the cell nuclei of EMD and GC were reduced ($t > 3$).

If sclerosis of the graft was severe, the JGA disappeared completely and this was accompanied by sclerosis of the afferent arteriole.

No information on the cytological structural changes in JGA of allografted human kidneys could be found in the accessible literature. In particular, no karyometric investigations of this problem have yet been undertaken.

The results show that in the early periods after transplantation the nuclear volume in JGA of allografted human kidneys increases. These results must be compared with the general conclusions, based on an extensive literature, regarding the functional role of changes in the dimensions of nuclei. An increase in nuclear volume is regarded by most workers as a morphological expression of cell activation [3].

Consequently, activation of JGA of the allografted kidney can be postulated in the early periods after transplantation. Possible causes of the activation and hyperplasia of JGA include ischemia of the cadaveric kidney before allografting and disturbances of the hemodynamics and electrolyte balance arising in the grafts during the first 1-2 months after transplantation.

Changes in the structure of JGA in grafts in the late period after transplantation, as was stated above, are connected with the state of their parenchyma.

The facts described above thus indicate that JGA performs an important functional role even in the grafted kidney. Meanwhile a further and comprehensive study of the structure of JGA of the grafted kidney is necessary.

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