Histological Features of Stored Kidneys after Simple Hypothermic Perfusion with Preserving Solutions of Different Types

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Four different preserving fluids were studied for protective effect in a total of 33 isolated canine kidneys. The preservation method consisted in initial perfusion followed by 24 hours of hypothermic storage. Two electrolyte and two non-electrolyte solutions were tested. One of the electrolyte solutions was of the extracellular, the other of the intracellular type. The two non-electrolyte solutions were 5% human albumin and 10% Rheomacrodex.

On the evidence of serial microscopic studies the Collins-4 solution of intracellular type allows the best viability: even the 24-hour specimens exhibited a normal renal structure. Of the non-electrolyte solutions Rheomacrodex revealed an adequate protective effect despite the production of a marked interstitial oedema and signs of dehydration involving the tubular cells. The 5% human albumin solution failed to preserve the integrity of renal structure for 24 hours. The electrolyte solution of extracellular type proved still less satisfactory, the glomerular loops and the tubular epithelium revealing signs of autolysis by the end of the 24-hour period.

Adequate organ preservation is essential for successful transplantation. Although renal transplantation has become clinical routine, the search for perfusates of appropriate composition and for the ideal technique of preservation still continues [1–3, 5, 6, 12–14, 18, 19, 23, 27, 28].

It is one of the basic methodical problems whether it is preferable to apply continuous perfusion in pulsatile or non-pulsatile form [3, 4, 11, 13, 14, 16, 22, 30] or whether the far simpler and cheaper initial perfusion also affords adequate protection for 24-hour hypothermic storage [3, 5, 18, 21, 24, 27, 31].

The solution for the initial or continuous perfusion may be cellular (whole blood or diluted blood) or acellular. The acellular perfusates include electrolyte solutions (extra- or intracellular type) and solution of non-electrolyte composition (dextran, plasma cryoprecipitate, plasma protein fractions, human albumin).

Whichever the procedure used for preservation, the criterion of successful transplantation is whether the kidney begins functioning immediately after the intervention. Adequately preserved renal structure is a prerequisite of good function.

In the serial experiments to be reported here canine kidneys stored at 4 °C after initial perfusion with solutions of different compositions were examined for morphological changes to assess the protective value of this simple preservation technique.
Material and method

Thirty-three mongrel dogs were used. The left kidney was exposed from midline incision under sterile conditions. The perihilar structures were infiltrated with a 2% Lidocaine solution before proceeding to preparation to block the possible vasoconstriction. 5000 I.U. heparin was injected into the renal artery prior to removal of the kidney. After transection of the vascular structures a polyethylene catheter was inserted into the renal artery and the kidney was perfused with 500 ml hypothermic (+4°C) solution from a height of 1.5 m. When 250 ml had been allowed to flow, the fluid returning from the kidney was already approximately bloodless, the second 250 ml served for ensuring a rapid and uniform cooling of the kidneys.

The kidneys were weighed before and after perfusion, then stored in the respective solution at 4°C for 24 hours. Tissue specimens for microscopic study were taken immediately after perfusion (0 hour), and 1, 2, 3, 4, 5, 6 and 24 hours later. The samples were embedded in paraffin. Sections of 4 to 5 μm thickness were cut and stained with haematoxylin-eosin, Krutsay's periodic acid-trichrome and toluidine-blue. Four different perfusates were used, viz., Largiadèr's extracellular electrolyte solution (Group I); intracellular electrolyte solution Collins-4 (Group II); 10% Rheomacrodex (Dextran) in 5% dextrose (Group III); 5% human albumin in Ringer's solution (Group IV).

Results

Group I

Eight kidneys were perfused with Largiadèr's solution. An increase in weight averaging 8.1% (3.8 to 12%) was found after perfusion in all organs.

The 0-hour specimen after perfusion exhibited interstitial oedema though the renal structure was practically unaffected (Fig. 1a). The specimens taken in the first 5-hour period revealed progressive cellular swelling parallel with the emergence of more and more distinct large, pale intranuclear nucleoli (Fig. 1b). Occasional 6-hour specimens showed minor glomerular changes, in the 24-hour specimens, however, glomerular abnormalities marked by necrosis and homogenization of the loops were prevalent (Fig. 1c). There was distinct swelling of the tubular epithelium and disruption of numerous tubules. In the proximal tubules the phenomenon of "epithelial reflux" to Bowman's capsule was also demonstrable (Fig. 1d).

Group II

Seven kidneys were perfused with the electrolyte solution of interstitial type. The organs increased in weight by 4 to 5% during perfusion.

In the 0-hour specimen there was but insignificant interstitial oedema and the appearance of both the glomerular system and the tubular epithelium was