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Renal Preservation With Phosphate Buffered Sucrose: Comparison With Hyperosmolar Citrate in a Prospective Trial

N. Ahmad, H. Kashi, H. Helmy, J. Hadingham, D.J. Potts, and J.P.A. Lodge

PHOSPHATE buffered sucrose (PBS140) was developed and tested at Leeds for kidney preservation. Coffey and Andrews[1] described excellent morphologic preservation of the kidney using a sucrose-based solution. It was later shown at our centre that PBS140 (sodium phosphate 69 mmol/L, sucrose 140 mmol/L) provided effective preservation of the function of isolated perfused rabbit proximal tubules.[2] Later development showed this solution to be effective in protecting rat kidney against warm ischemia,[3] kidney transplantation in pigs[4] and dogs,[5] and kidney transplantation in human.[6] The effectiveness of PBS140 in human kidney preservation is now widely recognized.[7]

Introduction of the University of Wisconsin (UW) solution by Belzer and colleagues[8] has set a new standard in multiple organ preservation. However, it was later shown that many of the components of UW were indeed not necessary for short-term kidney preservation. A simplified UW and other more simple and inexpensive solutions were shown to be as effective for this purpose. One such solution, hyperosmolar citrate (HOC) described by Marshall et al[9] in 1976 remains the most commonly used solution for kidney preservation in the United Kingdom (Table 1). We have evaluated prospectively the comparative effectiveness of PBS140 and HOC in kidney preservation in terms of early renal function and graft survival at 1 and 4 years.

Kidneys from 92 donors (Table 2) during 1988 to 1989 were perfused with either PBS140 (46 donors) or HOC (hyperosmolar citrate, 46 donors). One hundred four kidneys were transplanted locally (56 PBS140 and 48 HOC), whereas 76 kidneys (34 PBS140 and 42 HOC) were exported following the organ sharing protocol of the United Kingdom Transplant Services. Four kidneys were unusable. Prior to harvesting, all donors received gentamicin 80 mg, methyl prednisolone 500 mg, heparin 10,000 IU, and mannitol 0.5 g/kg intravenously. Recipients were treated according to local intravenous fluid regimen and immunosuppression protocols. Both groups were closely matched for donor age, recipient age, HLA mismatch, and cold ischaemia time. Average cold storage time was 22.9 ± 0.9 hours and 20.3 ± 0.9 for PBS140 and HOC, respectively.

Four-year follow-up for 82 patients in the PBS140 group and 78 patients in the HOC group are presented. Most of the data loss was for patients transplanted at other centres and was beyond our control. Primary function (as judged by the immediate production of urine and reduction of serum creatinine by 50 μmol/L in the first 24 hours) was found in 66% in PBS140 group and 62% in HOC group. One graft in the PBS140 group and three grafts in the HOC group never functioned. Twenty-one percent of patients in the PBS140 group and 28% patients in the HOC group required dialysis. One and 4 year graft survival was 85% and 74% for PBS140 compared to 85% and 71% for HOC in the locally transplanted group. Survival rates were higher in both

Table 1. Solution Composition

	PBS140	HOC
Na	120	84
K		84
Phosphate	69	
Citrate		56
Magnesium		40
Sulphate		40
Sucrose	140	
Mannitol		186
Osmolality	304	400
pH	7.0	7.1

Concentration = mmol/L, osmolality = mosm/L.
Abbreviations: PBS, phosphate buffered sucrose; HOC, hyperosmolar citrate.

Table 2. Donor Details

	PBS140	HOC
Number of donors	46	46
Mean age	37.5 ± 1.7	31.0 ± 1.6
M:F ratio	2.2/1	2.0/1
Hypotension (minutes)	79.4 ± 3.6	144.5 ± 26
Grafts perfused	90	92
Grafts not usable	2	2

Mean ± SEM.
Abbreviations: PBS, phosphate buffered sucrose; HOC, hyperosmolar citrate.

From the Department of Organ Transplantation, St. James's University Hospital and Department of Physiology, University of Leeds, Leeds, United Kingdom.

Address reprint requests to J.P.A. Lodge, Department of Organ Transplantation, St. James's University Hospital, Leeds LS9 7TF, United Kingdom.

0041-1345/97/$17.00
PII S0041-1345(96)00305-3

groups for the grafts that exhibited primary function. Mean hospital stay was 20.1 ± 1.0 months and 22.1 ± 1.6 for PBS140 and HOC, respectively. Early (1 year) and late (4 year) graft function expressed as median and interquartile range of serum creatinine was 135/55 (n = 63) and 130/49 (n = 56) μmol/L for PBS140 and 130/58 (n = 63) and 124/78 (n = 54) μmol/L for HOC, respectively. Overall, there were no statistically significant differences between the groups at any point.

The quality of preservation achieved by PBS140 was at least as good as that obtained using HOC. PBS140 is a simple solution containing only sodium phosphate and sucrose. The solution is inexpensive and is easy to produce and for that reason can be recommended for use in kidney preservation, especially in developing countries. This simplicity also allows room for improvement by simple alteration of components to meet the specific needs of various organs and the effect of such alterations can be directly interpreted.

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