Improved Immediate Renal Allograft Function After Initial Simple Cold Storage

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IMMEDIATE renal allograft function has been identified as being an important variable in ultimate graft survival.[1] Simple cold storage, particularly if preserved for longer than 24 hours, can have a high incidence of early dysfunction (ED) when cyclosporine is used as immediate posttransplant immunotherapy.[2] Because of the importance of immediate function (IF) and our prejudice toward pulsatile perfusion (PP), we began to place all imported kidneys previously preserved by simple cold storage onto the PP machine for preservation before transplantation at our center. The following is a description of the outcomes of this trial.

MATERIALS AND METHODS

From April 1986 through July 1989, all imported renal allografts previously preserved with simple cold storage were cannulated and placed on the pulsatile perfusion machine (Mox 100, Rochester, MN). All renal allografts thus preserved were subsequently successfully transplanted. These grafts were then analyzed for the length of iced preservation, pulsatile preservation, total preservation time, renal resistance, and the incidence of early dysfunction posttransplant. The Belzer solution for PP[3] was used in all grafts, with the albumin-based solution used in the first 27 and the hydroxyethyl starch (HES) based solution in the last 10.

The control group used for this study is a series of 140 consecutive renal allografts, procured locally and transplanted at The Ohio State University Hospitals. All were primarily preserved with PP, using the Belzer pulsatile perfusate with albumin or HES for oncotic support. This group of primarily perfused allografts was studied in relation to the same variables as noted above. Statistical analysis was performed using Chi-square method and the Fisher's exact test.

Early dysfunction is defined as the necessity for dialysis in the first posttransplant week regardless of etiology of early dysfunction. Renal resistance was calculated by dividing the mean pulsatile pressure by the measured flow per minute.

RESULTS

No significant differences in donor or recipient characteristics between the two groups were found when analyzing for donor age, recipient age, and the percentage of primary retransplant recipients. Ninety-eight percent of kidneys primarily perfused (1° perfused) functioned immediately, and 92% of those secondarily perfused (2° perfused) were noted to have IF, not statistically different ($P > .10$). If one examines only kidneys preserved longer than 24 hours, again there is no difference between those primarily perfused versus those initially cold stored and secondarily perfused regarding IF (97% versus 91%, $P > .10$).

Perfusion characteristics were different between the two groups. Renal resistances of the 1° perfused kidneys were 0.204 ± 0.083 and were 0.288 ± 0.105 in the 2° perfused groups ($P < .000001$).

Total perfusion time differed significantly between the two groups ($P < .000001$). The 1° perfused grafts were preserved for a mean of 19.7 ± 5.5 hours. The 2° perfused kidneys underwent a very similar length of initial cold storage (17.6 ± 5.7 hours), and the average extension of preservation by pulsatile methods in the 2° perfused groups was 13.9 ± 5.9 hours for a total of 31.3 ± 6.6 hours.

DISCUSSION

Simple cold storage of renal allografts has been demonstrated in many trials[4,5] to be inferior to pulsatile preservation as it pertains to immediate renal allograft function. Increasing preservation times following procurement have also been associated with poor immediate function posttransplant, particularly in the cyclosporine era.[6] We postulated that one could take a previously cold stored kidney, cannulate the renal artery, and preserve it with pulsatile perfusion in an effort to improve its immediate function.

Immediate renal allograft function is clearly multifactorial. Optimization of donor and recipient hemodynamics, meticulous care in dissection of donor organs, and an immunosuppressant protocol withholding cyclosporine initially are all important in improving early graft function. In addition, we believe that preservation techniques using the Belzer preservation solution and pulsatile cold storage have maximized early graft function at our institution.

This study demonstrates the efficacy of the combined use of this solution and machine preservation. It is unlikely that early dysfunction rates of 2% in primarily perfused organs can be improved. These successes prompted us to secondarily perfuse previously simple cold-stored kidneys that we projected to have prolonged storage times in an effort to optimize immediate function posttransplant. Indeed, these 2° perfused kidneys functioned well (8% ED incidence) and were not statistically different in early

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function as compared to those 1° perfused. If only kidneys perfused over 24 hours are examined, both 1° perfused and 2° perfused grafts have similar incidences of ED (3% and 9%, respectively), and again, these are not statistically different.

Secondarily perfusing kidneys may improve the metabolic integrity of a previously simple cold-storage organ. Iced stored kidneys have been demonstrated to rapidly lose cortical ATP levels, notably more so than those preserved by machine perfusion.[7] It is interesting to postulate that secondary machine perfusion may rescue these organs from a metabolic standpoint and provide for excellent reperfusion characteristics after being maintained on the pump.

Although it is important to realize that many factors are important for immediate renal allograft function, the combined use of the Belzer perfusate and pulsatile cold storage can provide an excellent incidence of immediate function. Initially cold-stored renal allografts, secondarily perfused with this same perfusate, also demonstrate these same characteristics.

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