Influence of Graft Perfusion Pressure on Graft Viability After Small Bowel Preservation and Transplantation

Y. Kobayashi, F.H.F. Galvao, M. Nomoto, N. Murase, I. Takeyoshi, T.E. Starzl, and S. Todo

THERE have been conflicting reports on the effectiveness of University of Wisconsin (UW) solution for experimental small bowel preservation.[1-4] The source of variation in these conflicting studies may be technical differences in the perfusion of UW solution through the graft. Inadequate graft perfusion may cause destruction of the microcirculation and destruction of cellular integrity. In this study, we evaluated the role of graft perfusion on graft viability and outcome after syngeneic small bowel transplantation in rats.

MATERIALS AND METHODS

Orthotopic functional small bowel transplantation was performed using Lewis rats.[5] Grafts were perfused with 10 mL of UW solution using a Harvard pump under either under low (Lw) or high (Hi) pressure. After perfusion, the grafts were either transplanted immediately [0 hours] (n = 10) or transplanted after 12 hours of cold preservation (n = 12). Tissue samples were taken from both the ileum and jejunum at the end of preservation, 1 hour after reperfusion, and at sacrifice for electrophysiologic (Ussing chamber) and histologic assessment. Electrophysiologically, potential difference, short circuit current, and resistance were measured to assess basal function, and glucose stimulation and theophylline stimulation were measured to assess enterocyte and crypt cell function. Histology samples were scored using Park's classification (Grade 0–8).[6]

RESULTS

Thirty-day animal survival of the immediate high pressure group (Hi-0) and the immediate low pressure group (Lw-0) were similar (100% versus 90%), but survival in the Hi-12 group was significantly better than the Lw-12 group (66.7% versus 16.7%). Histologic and electrolophysiologic studies at the end of preservation and 1 hour after reperfusion showed that graft function and morphology were significantly better preserved in the Hi-12 group than in the Lw-12 group for both the ileum and jejunum (Table 1). While the ileum tended to show more damage than the jejunum in the low pressure group, graft function and morphology of the ileum was similar to the jejunum in the high pressure group.

DISCUSSION

UW solution has been shown to be superior to other preservation solutions for extended organ preservation. However, neither the maximum cold ischemia time nor optimum preservation conditions have been clearly defined for the small bowel. Because UW solution has a higher viscosity than other conventional preservation solutions, the problem of inadequate perfusion may occur if perfusion pressure is not sufficient. Our results show that high perfusion pressure is needed to obtain better graft viability, graft function, and morphology after prolonged preservation. The improved outcome of the high pressure grafts correlated with the protection of crypt cell function and morphology. Our results suggest that graft viability and integrity are well maintained after 12 hours of preservation using high pressure perfusion of the graft with UW solution. Our

Table 1. Electrophysiologic and Pathologic Result In 12-Hour Preservation Model

		Base PD	Base Isc	Base R	Glu-Isc	Theo-Isc	Path Grade
				12-Hour End Preservation Period [End-12]			
Jej	Hi	0.63 ± 0.14*	10.94 ± 1.40*	85.12 ± 6.99*	5.72 ± 0.66*	13.80 ± 3.16*	1, 1, 1, 1, 1, 1*
	Lw	0.22 ± 0.05	3.65 ± 0.66	61.23 ± 6.46	2.08 ± 0.52	5.47 ± 1.38	1, 1, 2, 2, 3, 4
Ile	Hi	0.67 ± 0.08*	11.72 ± 1.47*	61.65 ± 2.75*	7.29 ± 1.74*	20.57 ± 3.06*	1, 1, 1, 1, 1, 1*
	Lw	0.28 ± 0.07	5.21 ± 1.12	45.23 ± 5.11	1.04 ± 0.66	1.30 ± 1.02	1, 1, 2, 3, 3, 4
				1 Hour After Reperfusion Period [Rep-12]			
Jej	Hi	0.17 ± 0.06*	6.51 ± 1.17*	34.56 ± 2.80*	2.87 ± 1.36	16.41 ± 5.13*	3, 4, 4, 4, 5, 6
	Lw	0.02 ± 0.02	2.87 ± 0.48	20.27 ± 2.57	0.26 ± 0.26	3.13 ± 1.40	4, 5, 5, 5, 6, 6
Ile	Hi	0.38 ± 0.08*	9.64 ± 2.63*	40.11 ± 4.34*	1.30 ± 0.48	19.97 ± 3.06*	4, 5, 5, 5, 5, 6
	Lw	0.05 ± 0.04	0.78 ± 1.19	24.96 ± 3.78	0.31 ± 0.31	1.30 ± 1.02	4, 6, 6, 6, 6, 6

Electrophysiologic results were expressed by mean ± SE, PD: (mV), Isc: (mA/cm^2), R: (Ω· cm^2).
P.D: potential difference, Isc: short circuit current, R: resistance, Glu-Isc: glucose stimulation isc, Theo-Isc: theophylline stimulation isc
Pathologic Grading followed by Park's classification.
* P < .05 versus Lw Group.

results also suggest that differences in perfusion pressure may account for the conflicting results on the effectiveness of UW solution for experimental small bowel preservation.

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