Hydrodynamic and Biochemical Effects of Isolated Hypothermic Renal Perfusion Depending on the Pump Model and Perfusion Solution

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ABSTRACT

Objectives. To evaluate hydrodynamic, biochemical, and histological consequences of hypothermic isolated renal perfusion using a new computerized perfusion system.

Materials and Methods. The device that allowed us to obtain on renal hydrodynamics during perfusion included multiple parts. The organ was perfused at 4°C with a constant flow either using a classic roller pump or a pump designed in our laboratory to employ vacuum or atmospheric pressure sequentially to achieve a truly pulsatile wave (vacuum-powered tubular pump). The study included 16 minipigs with Eurocollins or Belzer perfusion solutions sampled at predefined interval and histological studies of the organs performed.

Results. There was a significant difference in weight increase between the two types of pumps; those perfused with Eurocollins showed greater values than those with Belzer solution. Onset of nitric oxide (NO) in the perfusion solution increased inversely with the renal vascular resistance. The highest NO levels were observed with the Belzer solution and vacuum pump.

Conclusions. Changes in renal hydrodynamics, as induced by perfusion wave form and solution type, may be recorded in real time using a computerized system. A vacuum pump with the Belzer solution achieved the best experimental results.

PRESERVATION of kidneys with continuous machine perfusion (MP) has been a research tool in physiology for more than 100 years. Some devices have been proffered as "pulsatile,"[1] although their flow waveforms are not similar to physiologic pulse waves, because they are usually generated by rolling pumps.

In this experimental work we compared 2 perfusion systems. The classic roller pump (RP), which is widely used in hemodialysis circuits, and a vacuum-powered tubular pump (VPTP) with active valves as developed by our group to produce flow patterns similar to the pulse waves in the human circulatory system.[2] We constructed a computer-controlled perfusion system that allowed isolated kidney perfusion at constant pressure and temperature, which both could be selected by the user. The system continuously recorded mean perfusion pressure, mean flow, and intrarenal resistance (RVR). The objectives of this work were as follows: (1) to evaluate the influence of the pump type and perfusion solution on renal hydrodynamics. (2) to evaluate nitric oxide (NO) generation in the perfusion solution; and (3) to study the histological consequences of the perfusion method.

MATERIALS AND METHODS

The systems (Fig 1) include either a roller pump obtained from a dialysis machine (Fresenius MT A2008C, Fresenius Medical Care, Bad Homburg, Germany), or a Vacuum pump, which is a true pulsatile pump controlled by a computerized console. The pump chamber is an elastic tube with thin walls, located within a rigid chamber. To this rigid chamber we apply a vacuum via a source controlled by a console. The vacuum forces the elastic tubular chamber to expand. At a given time, the console stops the vacuum,

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