

## AN EVALUATION OF PERFUSION CONSTITUENTS IN LIVER PRESERVATION

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A TECHNIQUE has been presented (1) which, if used in the optimum way, always permitted successful preservation of dog livers for 8 to 9.5 hr. and often for as long as 24 hr. The test system involved orthotopic transplantation to mongrel recipients. The best preservation technique was with a combination of hypothermia ( $4^{\circ}$  C.), hyperbaric oxygenation (40 pounds per square inch gauge), and perfusion (6 ml./gm. tissue/hour.) with diluted blood. Exactly the same method has been used in the successful conservation of human livers which were transplanted orthotopically after a postmortem interval of more than 7 hr. (2, 3). However, the need for homologous fresh blood in the system was an inconvenience. Therefore, perfusates were evaluated in the present study which contained either plasma instead of whole blood or hemoglobin which was added to a balanced electrolyte solution containing low molecular weight dextran (LMDX).

### METHODS

The decompression schedule, temperatures, flow rates, and other details of procedure were identical to those used with the best homol-

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ogous blood technique (1) Immunosuppression with azathioprine, prednisone, and heterologous antilymphocyte globulin (ALG) was the same as in the earlier studies. Only the perfusate constituents were changed. Three different solutions were tested.

Group A: Hemoglobin solutions were prepared by Folkman's modification of Pennell's technique (4). A hemoglobin concentration of 5 to 7 gm.% was obtained by adding a balanced electrolyte solution (containing 5 gm.% LMDX) in a one part electrolyte to three parts hemoglobin solution volume ratio. Group B: Unaltered pooled fresh plasma was added to an equal volume of balanced electrolyte solution containing 5 gm.% LMDX. Group C: Pooled fresh plasma was frozen for 12 hr. or longer. The lipoprotein flocculate was then removed as described by Belzer (5) and the plasma used in undiluted form.

#### RESULTS

Group A: The five livers which were preserved for 8 to 10.5 hr. had an average weight loss of  $-0.7\%$  (range  $+5.4\%$  to  $-7.9\%$ ). Four of the dogs which received these organs as orthotopic homografts died within 24 hr. of hemorrhage and hepatic insufficiency. The fifth dog died on the fifth postoperative day of intussusception; he nevertheless had good hepatic function.

Group B: The organs lost an average of  $-0.9\%$  of their weight (range  $+12.2\%$  to  $-6.6\%$ ) during preservation of 9.5 to 10.45 hr. Two of the recipients died on the first day, one dog of uncontrolled hemorrhage and the other with massive ascites and atelectasis. Another dog died after two days of acute hepatic insufficiency and hemorrhage. Both the 19 day survivors had good early function. One dog later developed fatal homograft rejection; the second died from a perforated duodenal ulcer despite excellent hepatic function.

Group C: Preservation was 9.25 to 11 hr. There was an average weight loss of  $-9.4\%$  (range  $-5.4\%$  to  $-16.3\%$ ). All five recipients died within 24 hr. with hemorrhage and ascites which were thought to be expressions of acute hepatic insufficiency.

#### CONCLUSION

Experiments have been done reaffirming the effectiveness of the homologous blood perfusion technique in 8 to 12 hr. preservations. None of the deviations in the present study worked as well. This was a particularly disappointing finding since the perfusate used in Group C was the same as that shown by Belzer to be of value for kidney storage (5). However, other aspects of the method were different than that of Belzer who has not used hyperbaric oxygenation. In addition, his system contains a membrane oxygenator and employs a pump which provides a more physiologic pulse contour.

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