EFFECT OF COLLOID OSMOTIC PRESSURE AND PULMONARY CAPILLARY WEDGE PRESSURE ON INTRAPULMONARY SHUNT

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Application of the Starling equation to fluid dynamics within the lung suggests that a significant decrease in the plasma colloid osmotic pressure (COP) or an increase in the pulmonary capillary wedge pressure (PCWP) resulting in a net decrease in the gradient COP-PCWP would cause an increase in pulmonary extravascular water (PEVW) and intrapulmonary shunt (Qs/Qt). The relationship between changes in COP-PCWP and Qs/Qt was studied in 43 patients undergoing abdominal aortic surgery.

METHOD

Forty-three patients undergoing hemodynamic resuscitation with various fluids, including crystalloid and colloid (5% albumin) solu-

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tions, during and following abdominal aortic surgery were studied. These fluids were given at rates such as to maintain preoperative levels of pulmonary capillary wedge pressure and cardiac output. Each patient had a pulmonary artery catheter (Swan-Ganz) placed percutaneously for measurement of pulmonary capillary wedge pressure and sampling of mixed venous blood. Intrapulmonary shunt was calculated while the patient was breathing 45% oxygen, by using the measured oxygen contents of arterial and mixed venous blood samples. COP was measured on plasma by a transducer membrane system as previously described (1). One hundred fifty-seven simultaneous determinations of PCWP, COP, and Qs/Qt were performed prior to, during, and for 48 hr following surgery.

RESULTS

The mean age of the patients was 59 ± 2.6 yr. The mean values, standard errors, and (extremes) for each of the measured and calculated variables were PCWP 10 ± 0.4 torr (0-30), COP 19 ± 0.3 torr (8-28), COP-PCWP 9 ± 0.4 torr (-11-1+23) and Qs/Qt 15 ± 0.4% (7-26). Regressions of Qs/Qt on COP (y = 21.37-0.291X) and on COP-PCWP (y = 18.01-0.275X) (Fig 1) revealed neither COP nor COP-PCWP to be a predictor of intrapulmonary shunt (P > .1).

DISCUSSION

Two patients demonstrated clinical and radiographic evidence of pulmonary edema. They had normal COPs but elevated PCWPs following resuscitation with colloid solutions. There was not a single example of pulmonary edema in the absence of an elevated hydrostatic pressure. In fact, when PCWP was maintained at preoperative levels, even a negative COP-PCWP gradient (-10 torr) secondary to hemodilution (COP 8 torr) with crystalloid solution failed to produce either clinical or radiographic evidence of increasing PEVW, in spite of marked peripheral edema and weight gain. Our laboratory work (2) would suggest that this phenomenon of pulmonary protection results from increases in the rate of pulmonary lymph removal and increases in the clearance of pulmonary interstitial albumin. An additional factor could be an increase in pulmonary interstitial pressure. These changes would tend to counteract the increase in capillary filtration brought about by decreases in serum COP.

CONCLUSION

The lack of correlation between decreases in COP-PCWP, secondary to decreases in colloid osmotic pressure, and increases in Qs/Qt suggest that the use of oncotic agents such as albumin during resuscitation to minimize pulmonary insufficiency is unnecessary.
Fig 1. Intrapulmonary shunt (Qs/Qt) vs gradient between colloid osmotic pressure and pulmonary capillary wedge pressure (COP-PCWP).

REFERENCES