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Intravenous Infusion of Hyperosmotic NaCl Solution Induces Acute Cor Pulmonale in Anesthetized Rats

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Summary

Rapid intravenous infusion of hyperosmotic NaCl solution is used for resuscitation of circulatory shock. Infusion of hyperosmotic NaCl solution at 2–5 mL/kg/min has been used for therapeutic purposes. However, this infusion rate occasionally induces hypotension in animals and humans. Although the hypotension is transient and recovers within 2 min without detrimental consequences, it is important to understand the associated hemodynamics and mechanisms. In the present study, we induced severe hypotension by very rapid intravenous infusion of hyperosmotic NaCl solution (9% NaCl) to investigate this response, as the hypotension occurs in a rate- or concentration-dependent manner. In order to evaluate the specific effects of infusion on the systemic and pulmonary circulations, 9% NaCl solution was infused into the inferior vena cava or the ascending aorta. To evaluate the systemic circulation, we measured left ventricular pressure, arterial pressure, central venous pressure, myocardial blood flow, and aortic blood flow. To evaluate the pulmonary circulation, we measured right ventricular pressure, left ventricular pressure, pulmonary arterial blood flow, and alveolar blood flow. Slow infusion of 9% NaCl solution was effective for increasing arterial pressure compared with slow infusion of 0.9% NaCl solution. However, rapid intravenous infusion of 9% NaCl solution resulted in a decrease in left ventricular developed pressure and arterial pressure and an increase in left ventricular end-diastolic pressure and central venous pressure. The hypotensive effect was larger with rapid intravenous 9% NaCl infusion than with intra-aortic infusion, indicating that change in cardiac performance played a more significant role than change in peripheral resistance. 9% NaCl infusion induced an increase in pulmonary vascular resistance and central venous pressure and a decrease in right ventricular dP/dt max, suggesting acute cor pulmonale. Diastolic ventricular crosstalk-induced left ventricular failure was also observed. In conclusion, a higher infusion rate or osmolality carries a risk of inducing acute cor pulmonale and subsequent left ventricular failure, even if the infusion volume is unchanged.