

Title : NITROPRUSSIDE-INDUCED HYPOTENSION: ROLE OF HEART RATE IN DETERMINING HEMODYNAMIC EFFECTS AND TACHYPHYLAXIS

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INTRODUCTION

The administration of sodium nitroprusside (SNP) may be associated with either no change or an increase in heart rate (HR). The latter tends to counteract the decrease in arterial pressure, necessitating use of further doses of SNP. We studied the hemodynamic and blood gas responses to SNP infusion to elucidate the role of HR in determining (1) the cardiovascular responses and (2) the dose requirements of SNP necessary to maintain hypotension.

METHODS

Studies were conducted on 30 consecutive patients undergoing major orthopedic procedures under N₂O-O₂-halothane anesthesia. NP-induced hypotension was employed to reduce intraoperative blood loss. SNP (0.01%) was administered to decrease and maintain mean arterial pressure (MAP) 40% lower than preoperative values. Measurements were made before anesthetic induction; before and at 30-minute intervals during SNP infusion for 4 hours; and when MAP returned to pre-SNP values. Measured and derived variables included cardiac output (CO), arterial (AP) and right atrial pressures (RAP), HR, stroke volume (SV), systemic vascular resistance (SVR), rate-pressure product (RPP), arterial and mixed venous PO₂, PCO₂, pH, O₂ content, and hematocrit.

RESULTS

Based on the response of HR to SNP administration, two groups of patients emerged. In Group 1 (12 patients), HR did not change, whereas significant tachycardia (from 66 to 104 beats/minute) occurred in Group 2 (18 patients).

Group 1: CO was not altered, implying that hypotension was due to decreased SVR ($P < 0.01$). The rate of SNP infusion (180 μ g/min) was not changed once the desired level of hypotension was achieved. RPP decreased significantly ($P < 0.02$).

Group 2: HR showed a progressive and significant increase with SNP infusion. A five-fold increase (from initial infusion rate) in SNP dose was required to maintain hypotension. CO increased significantly ($P < 0.05$) after 30 minutes and then continued to increase; it was three times the pre-SNP value after 4 hours. RPP was not significantly changed. Arterial PO₂ and O₂ content decreased ($P < 0.05$) in both groups. No metabolic acidosis occurred in either group.

DISCUSSION

This study strongly demonstrates that when SNP-induced hypotension was associated with tachycardia, the hemodynamic response was altered and use of further doses of the drug was required to maintain hypotension. Tachycardia was probably a compensatory (reflex) mechanism for the decrease in AP. It is not clear why HR did not change in Group 1 in response

to SNP-induced hypotension. Interestingly, these patients did not require a further increase in SNP dose.

Some important clinical implications emerged. First, tachycardia heralded the onset of tachyphylaxis. Indeed, examination of reports of toxicity and death associated with SNP administration revealed that tachycardia had been a consistent finding in these patients. However, metabolic acidosis did not develop in our patients. This is probably a late event resulting from inhibition of cytochrome oxidase by cyanide, the major degradation product of SNP.

Second, development of tachyphylaxis is not as rare as is currently believed: 18 of 30 patients exhibited tachyphylaxis.

Finally, cyanide ions (released from SNP) antagonize the action of SNP on vascular smooth muscle. (1) Therefore, when more SNP is used to further decrease the blood pressure, more cyanide is produced, which further diminishes the effectiveness of SNP as a vasodilator. Thus, control of tachycardia by β -adrenergic blockers seems a logical approach in decreasing the dose of SNP (and cyanide production) required to maintain hypotension.

REFERENCES

1. Grayling GW, Miller ED Jr, Peach MJ: Anesthesiology 49: 21-25, 1978.