Title : "VAPORIZER ABERRANCE" AND "SECOND GAS EFFECT" : WHICH IS CLINICALLY SIGNIFICANT ?

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INTRODUCTION : During inhalational anesthesia, the introduction of N_2O induces two effects on the kinetics of volatile agents. 1) In the patient, at a constant inhaled vapor concentration (F_I), it increases the expired vapor concentration (F_E), i.e. the "second gas effect" (1). 2) In the vaporizer, at a constant dial setting, it decreases the delivered vapor concentration (F_V), i.e. the "vaporizer aberrance" : F_V decreases abruptly (2), and later increases to reach a stable level lower than without N_2O (3). Withdrawing N_2O results in reverse effects in the patient and in the vaporizer.

Since both effects are concurrent and opposite, the aim of the study was to measure their combined effect in anesthetized patients.

METHODS : After institutionnal approved informed consent, 18 patients, scheduled for abdominal surgery, ASA I-II, 18 to 70 years old, without any cardiac, vascular, pulmonary, renal or hepatic disease, were randomly assigned into three groups: Halothane (H) (n=6), Enflurane (E) (n=6), and Isoflurane (I) (n=6). They were all ventilated with the same open circuit Dräger® Seneca, with a 12 $ml.kg^{-1}$ tidal volume (V_T), 12 min^{-1}, and with a constant fresh gas flow ($\dot{V}_{fg}$) of 8.5 $l.min^{-1}$. The volume of the circuit was 6 liters. The halogenated agent was administered with a Dräger® Vapor 19 vaporizer. The same vaporizer was used at the same dial setting in each group. Each vaporizer was checked three times during the study.

$\dot{V}_{fg}$ was measured with precision rotameters, V_T with Wright spirometer, and vapor concentrations with an infrared analyzer (Datex Normac®), zero-corrected for N_2O. Anesthesia was induced with flunitrazepam 0.05 $mg.kg^{-1}$, fentanyl 0.006 $mg.kg^{-1}$ and pancuronium 0.1 $mg.kg^{-1}$. After intubation, anesthesia was maintained with fentanyl and pancuronium on demand, and with volatile agent in 100% O_2 at one dial setting for each agent so that F_E was near 0.5 MAC. Once F_E had stabilized for 15 min, then 60 % N_2O was abruptly introduced. Once F_E had again stabilized, N_2O was withdrawn and 100 % O_2 was administered. F_V, F_I, F_E were measured every 10 sec. during 4 min, then each minute during 6 min, and then every 5 min until F_E had stabilized for 15 min. F_V was measured after the surgical procedure. Results are expressed as mean concentrations in percent ± sem.

RESULTS: There were no differences in the patients characteristics between the three groups. Changes in concentrations are shown in the figure .

DISCUSSION : Regarding F_V, the observed vaporizer aberrance in the three groups is the same as previously described (2,3). This was attributed to N_2O solubility in the liquid phase of the anesthetic agent (2) and to difference in viscosity between N_2O and O_2 (3). It must be emphasized that the tested vaporizer is known to present a minimal aberrance with N_2O (3).

F_I decreases exponantially with a short time-constant of 42 sec., related to $\dot{V}_{fg}$ flowing through the volume of this open circuit.

When adding N_2O in the inhaled gases, F_E does not increase for 1-3 minutes : there was no observable "second gas effect". This is related to the decrease in F_V and F_I.

In group E, F_E increased after the third minute, but not in the other two groups : this is probably related to the decrease in cardiac output observed with E (4) and not with H or I at these low concentrations.

Withdrawing N_2O slightly increases F_E in the three groups, in spite of the "reverse second gas effect" (5) : this is related to the increase in F_V and F_I.

CONCLUSION : Despite the "vaporizer aberrance" is low with the tested vaporizer, this effect is more important for the patient than the "second gas effect". The "second gas effect" only minimizes the consequences of the "vaporizer aberrance".

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