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Comparison of cocaine alone or with adrenaline on nasal mucosal blood flow

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Abstract

Cocaine is commonly used in ENT practice for its vasoconstrictor and anaesthetic properties. It is sometimes combined with adrenaline. The laser Doppler Flowmeter was used to compare the effect of 5 per cent cocaine alone or with adrenaline (1 in 1,000) on nasal mucosal blood flow.

The results show an average fall in blood flow of 76.7 per cent for cocaine with adrenaline, compared to 61.2 per cent with cocaine alone. The difference is significant ($P<0.05$). The time taken for the blood flow to fall was an average of 131 s and 160 s respectively. These differences are not significant.

Introduction

Cocaine solution is widely used in ENT outpatients to cause vasoconstriction of the nasal mucosa and facilitate inspection of the nasal cavity. It is also used as a topical anaesthetic for minor surgical procedures in the nose. Even in patients undergoing general anaesthesia prior preparation of the nose with cocaine will reduce intra-operative blood loss (Pearman, 1979).

The preparation of cocaine used varies greatly. Aqueous solutions from 0.5 to 10 per cent are used via an atomizer. Cocaine paste may be up to 25 per cent, whilst some surgeons use a slush made by mixing adrenaline or saline with cocaine crystals (Verlander and Johns, 1981).

The addition of bicarbonate such as in Moffet's solution (Moffet, 1942) increases the absorption by shifting the equilibrium towards the uncharged, lipid soluble form of the molecule.

The mechanism of action of cocaine as a local anaesthetic is to block the sodium channels in nerve membranes and thus to prevent depolarization. Unlike other local anaesthetics, it also has the property of preventing the re-uptake of endogenous noradrenaline, or exogenous adrenaline at the nerve ending. It thus raises the level of circulating catecholamines and sensitizes target organs to the effects of sympathetic stimulation.

The purpose of this study was to see if the addition of adrenaline to cocaine solution effected the rate or degree of nasal mucosal vasoconstriction.

Methods and materials

Thirteen healthy volunteers (aged 27–40, mean 30 years) from the staff of The Royal National Throat, Nose and Ear Hospital were used. All were questioned to exclude a history of nasal surgery, nasal disease, medication or known allergy to cocaine.

The subjects rested supine on a couch for 15 mins before anterior rhinoscopy was performed to exclude any anatomical abnormality and to determine which inferior turbinate was the most congested. Safety goggles were worn by the subject and a plastic aural speculum inserted into the clinically more congested nose and secured in place.

The laser Doppler probe had a 25 SWG 'Butterfly' needle taped to it so that the end of the needle was 2 mm from the end of the probe. Solutions could thus be dropped directly onto the area of mucosa around the probe tip. The Doppler probe and needle were introduced via the aural speculum so as to lie on the anterior end of the inferior turbinate.

The Doppler flux signal was recorded continuously by a Doppler Flowmeter (Moor Instruments, MBF3). The bandwidth was set to 15 kHz and the time constant to 3 s.

Two solutions were used, cocaine 5 per cent and cocaine 5 per cent with adrenaline (1 in 1,000) freshly prepared by the hospital pharmacy. 0.1 ml of one solution was dripped via the Butterfly cannula after the Doppler flowmeter showed a stable baseline. The second solution was applied on another occasion at least 24 h later. The order in which the two solutions were applied was randomized.

After application of the solution the Doppler reading was recorded for five minutes. The recording was then printed out onto a paper chart, which could later be analysed.

From the printout it was possible to obtain a baseline level of flux, a new steady state after the application of the test solution, and the time from beginning of application of the solution until the new steady state was reached. The results were analysed by the student's t-test.

Results

There were no adverse reactions to the solutions although four recordings were rendered unusable by movement artefact.

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The percentage change in flux for each solution is given in Table I. The average fall in flux for cocaine with adrenaline was 77 per cent (S.E. 11.3). The average fall with cocaine alone was 61 per cent (S.E. 18.2). The differences are significant (P<0.05).

The time taken for the maximum fall in flux is given in Table II. The average time for cocaine with adrenaline was 131 s (S.E. 65), while for cocaine alone it was 160 s (S.E. 117). These differences are not significant.

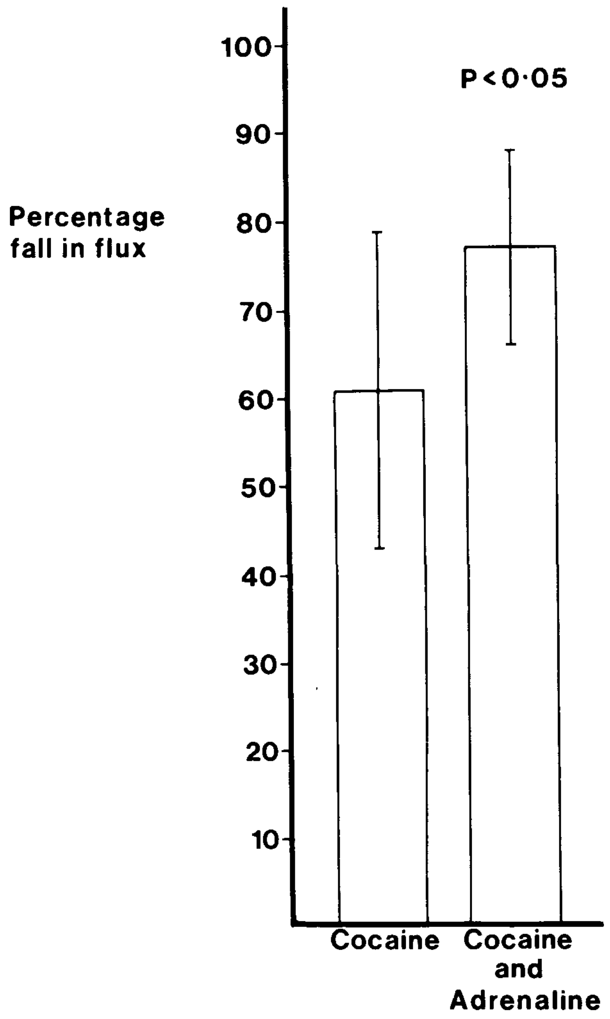
Discussion

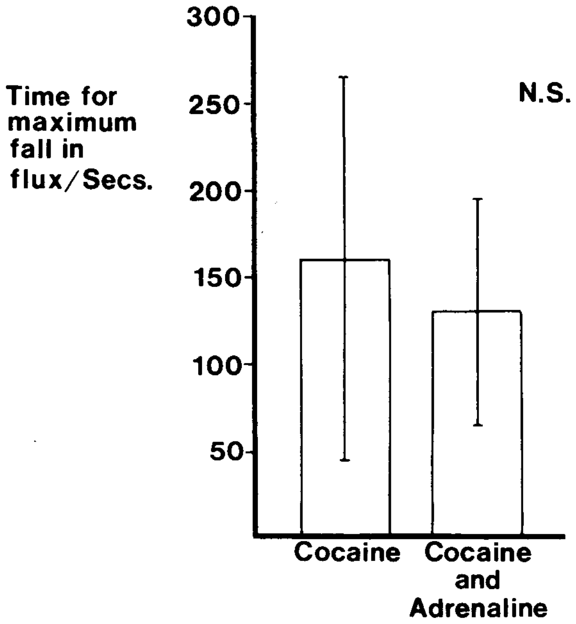
Adrenaline is added to cocaine preparations in the belief that it:

(i) causes a greater and faster degree of vasoconstriction;
(ii) reduces the systemic absorption of cocaine and therefore the risk of cocaine toxicity.

There is, however, a theoretical argument for not adding adrenaline in that it would be potentiated by the cocaine which prvents re-uptake at the nerve ending. This might result in a greater incidence of cardiac arrhythmias, hypertension and tachycardia.

There are several methods of measuring nasal blood flow in humans, each with their advantages and disadvantages. Xenon washout technique (Bende, 1983), laser Doppler (Olsson *et al.*, 1985) and submucosal temperature probe (Porter, 1991) have all been used recently. Comparison between techniques show that





they assess different parts of the vascular supply to the nose. A comparison between Xenon washout and laser Doppler (Olsson, 1986) came to the conclusion that the laser Doppler measured blood flow in the superficial mucosa, whilst the Xenon washout reflected changes in the deeper layers.

Noradrenaline does not effect nasal blood flow as measured by Xenon washout but the laser Doppler shows a fall. The laser Doppler has also been demonstrated to detect falls in nasal blood flow after the application of cocaine (Wright and Cochrane, 1990). For these reasons the laser Doppler was used in this study.

The Doppler probe emits a laser light of approximately 1 mW. A receiver within the probe detects reflected light, and compares the change in frequency with that of the emitted signal. The frequency is changed by light reflected from moving particles *i.e.* red blood corpuscles, and the resultant signal (flux) represents the product of the number of corpuscles moving through the measured volume and their mean velocity. This flux has been shown to correlate with blood flow in a linear fashion (Johnson *et al.*, 1984, Smits *et al.*, 1986).

This study shows that the addition of adrenaline to cocaine does increase the degree of vasoconstriction on the surface mucosa of the inferior turbinate. It is not possible, however, to deduce what the effect is on the deeper tissues where the erectile cavernous venous plexus is found. Some authors have stated that intraoperative blood loss is less with cocaine and adrenaline preparations (Beaumont, 1974; Pearman, 1979), but controlled trials are lacking; most statements are based on clinical impression.

The rate of vasoconstriction in the cocaine with adrenaline group was less than with cocaine alone but the difference failed to reach statistical significance. The time taken to reach maximum vasoconstriction (130 s and 160 s respectively), is similar to the latency of the anaesthetic effect. Adriani and Zapernick (1964) found a latency of 4 mins with a 4 per cent cocaine solution.

Whether the addition of adrenaline to cocaine effects the toxicity of the latter is debatable. Campbell and Adriani (1958) using cocaine in the pyriform fossa of

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dogs could find no difference in the systemic blood levels with or without adrenaline. Their method of analysis, however, was columetric and relatively insensitive. Bromley and Hayward (1988) using liquid gas chromatograph showed a significantly reduced absorption of cocaine by the addition of adrenaline.

It is not clear, however, whether this difference is clinically important. Mayer (1924) advised against the addition of adrenaline after an enquiry into deaths due to local anaesthetics. Verlander and Johns (1981) stated that the adrenaline does not speed the onset of anaesthesia or prolong its duration, yet may risk a higher incidence of cardiac arrhythmias. This risk may, however, be more theoretical than practical.

Only 5 per cent of topically applied cocaine in the nose is absorbed systemically (Quiney, 1986). The majority of toxic reactions are due to overdosage. Bromley and Hayward (1988) noted that there was no difference in the pulse or blood pressure during the intraoperative use of cocaine with or without adrenaline. They noted an unusually high absorption in two patients, who had been given cocaine with adrenaline, and suggest that many toxic reactions are due to idiosyncratic rapid cocaine absorption.

This study supports the use of adrenaline when added to cocaine solutions on the basis that it increases the degree of mucosal vasoconstriction. Whether the adrenaline enhances or prevents cocaine toxicity has yet to be established firmly.

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