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Caffeine, ephedrine and their combination: effects on blood pressure and heart rate

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CAFFEINE, EPHEDRINE AND THEIR COMBINATION: EFFECTS ON BLOOD PRESSURE AND HEART RATE

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EXECUTIVE SUMMARY

The ability to maintain or acutely enhance the performance of military personnel could be crucial to a mission in scenarios such as extended search and rescue and sustained operations. In this regard, DCIEM has been investigating the effects of various pharmacological and nutritional treatments to determine their effect on physical performance. Two such substances ingested in combination, caffeine and ephedrine, have been shown to enhance physical performance. Before these substances can be recommended for use it is imperative that potential health risks are clarified. Therefore, it was the purpose of this study to determine the effects of acute ingestion of caffeine, ephedrine and their combination on heart rate (HR) and blood pressure variables. The results indicated that in non-users of caffeine resting systolic blood pressure (SBP) surpassed hypertensive levels (140 mm Hg) and remained at this level for 3 hours after ingesting the combination treatment. SBP levels gradually returned to placebo levels 8 hours after ingestion of the combined caffeine and ephedrine. Although diastolic blood pressure and HR also increased after the combined treatment ingestion, the magnitude was minimal and dissipated within 24 hours. It appears that in a healthy young individual acute ingestion of a preparation of caffeine, ephedrine or the two in combination would not have long lasting adverse effects on resting blood pressure or heart rate.

Key words: caffeine, ephedrine, heart rate, blood pressure

ABSTRACT

The ingestion of a combination of caffeine and ephedrine has an ergogenic effect on physical performance. Before recommending tactical applications of such a treatment the health risks must be determined. Therefore, it was the purpose of this study to clarify the effects of an acute ingestion of caffeine, ephedrine and their combination on heart rate and blood pressure variables. Twenty male and female subjects had their resting blood pressure and heart rate measured before and throughout 48 hours after ingesting either caffeine (c) (375 mg), ephedrine (E) (75 mg), c+e, or a placebo (p). Treatments were randomized and double blind. Systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) were measured pre ingestion, 1, 3, 5, 8, 24, and 48 hours post ingestion. Venous blood samples were also obtained at these times and analyzed for caffeine and ephedrine level. All measured variables were significantly increased by the treatments. SBP increased the most after the c+e treatment, approached hypertensive values at the 1 hour mark (138 mm Hg), decreased thereafter, and was similar to p levels by 8 hours. DBP increased the most within the first hour in the c and c+e treatment, decreased thereafter, and was similar to p levels by 8 hours. DBP levels remained below the 90 mm Hg level. HR was significantly increased by the c+e and e treatments, reached peak levels at 5 hours (75 b/min) and was similar to placebo levels by 24 hours. Caffeine and ephedrine plasma levels peaked between 2 and 4 hours and by 48 hours they returned to placebo levels. It was concluded that in normo-tensive healthy young individuals acute ingestion of a preparation of caffeine, ephedrine or the two in combination would not have long lasting adverse effects on blood pressure or heart rate.

Key words: ergogenic, diastolic, systolic, heart rate, caffeine, ephedrine

INTRODUCTION

Recent investigations demonstrated that a mixture of caffeine (c) and ephedrine (e) ingested 1.5-2 hours before exercise causes rapid and significant improvements in high intensity aerobic work capacity (Bell and Jacobs, 1999; Bell et al. 1998, 1996). The mechanisms behind the enhanced performances were suggested to be primarily related to the stimulation of receptors in the central nervous system (CNS) although stimulation of metabolic receptors in skeletal muscle undoubtedly also occurs (Dodd et al. 1993; Hoffman and Lefkowitz, 1990; Lefkowitz et al., 1990; Nehlig and Debry, 1994; Rall, 1990). These findings would suggest that c+e may be an effective ergogenic aid, i.e., performance enhancing substance, that could have important tactical applications for Canadian Forces (CF) personnel engaged in operations where a rapid enhancement of high intensity physical work capacity would be beneficial.

Both c and e are considered relatively benign drugs by Health Canada regulatory authorities and are currently uncontrolled. Although the drugs are considered to be benign, adverse effects have been noted (Reynolds, 1989). Further recent reports from the US FDA suggested that ephedrine has caused heart problems and its use should be restricted.

In light of this increased focus on ephedrine, it is important to clarify the potential health risks caused by ingesting c+e. In the previous studies of Bell and Jacobs (1999) and Bell et al. (1998, 1996) although acute increases in heart rate (HR) were noted when either e or c+e were ingested, measurements were not made after exercise, nor was blood pressure (BP) measured. Others (Weller and Nevola, personal communications) who have used the c+e at similar dose levels found that it elevated both HR and BP at rest and during exercise, but the changes were not followed to determine when levels returned to normal values. Thus the effect of ingesting c+e on resting HR and BP has not been systematically investigated.

Therefore, the purpose of this study was to evaluate the effects of c, e and c+e on HR and BP for a period of 48 hours after ingestion.

Additionally, we could find no published information about the elimination of c and e when administered simultaneously other than in our pilot studies which suggested that the elimination from the circulation for both c and e were prolonged when ingested together as compared to when they are ingested alone. Thus a second purpose was to determine elimination rates of c, e and c+e by measuring their plasma concentration at regular intervals.

METHODS

Subjects

Informed consent was obtained from 20 subjects (16 males and 4 females) with age ranging between 19 and 51 and weight between 60 and 90 kilograms. Each subject

et al., 1989) and the Huyn-Feldt-epsilon factors were used to adjust degrees of freedom for multiple comparisons. Statistical significance was accepted at the $P \leq 0.05$ level.

RESULTS

Systolic Blood Pressure

Figure 1 depicts the effect of the treatments on systolic blood pressure (SBP). There was a drug by time interaction. At one hour post treatment ingestion, SBP had peaked in all treatments trials, with c+e>e>c>p. SBP at peak ranged from 117.6 ± 8.3 mm Hg (mean ± SD) for placebo to 138.3 ± 10.6 mm Hg for c+e. At 3 hours SBP had decreased but all treatments were still greater than p (c+e=e>c>p). By five hours SBP for the treatments were further reduced, but still significantly greater than p (c+e=e=c>p). At 8 hours only e was significantly greater than p. By 24 hours all levels were similar and equal to pre ingestion levels.

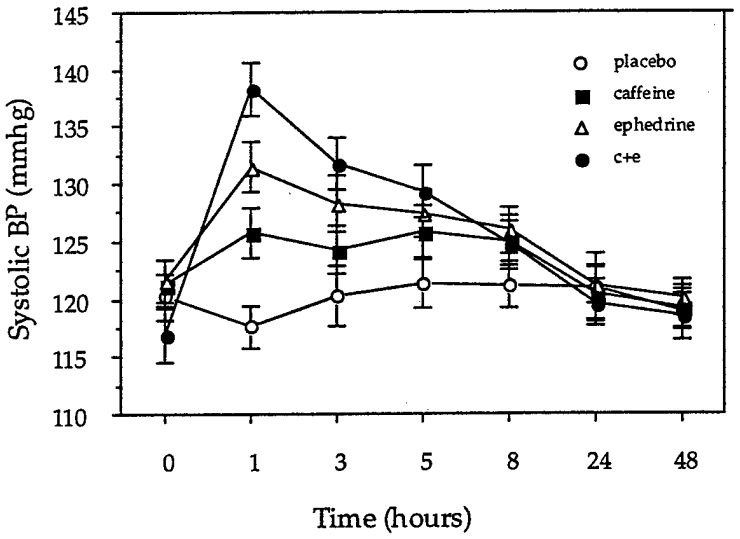

Figure 1: Effect of c, e and c+e ingestion on systolic blood pressure.
Values are mean (SEM).

Diastolic Blood Pressure

Figure 2 depicts the effect of the treatments on diastolic blood pressure (DBP). Again there was a drug by time interaction. At one hour post treatment ingestion, DBP had peaked in all treatments trials, with c+e=e=c>p. DBP at peak ranged from 77.6 ± 6.9 mm Hg for placebo to 83.7 ± 7.0 mm Hg for c+e. At 3 hours DBP had decreased and only C was greater than p. At 8 hours all levels were similar. The magnitudeof the changes in DBP were considerably less than those for SBP.

Caffeine and Ephedrine Concentrations

Figure 4 shows the level of ephedrine in the plasma during the e and c+e treatment trials. There was no difference between the clearance rates. Peak levels occurred between 2 and 4 hours after drug ingestion.

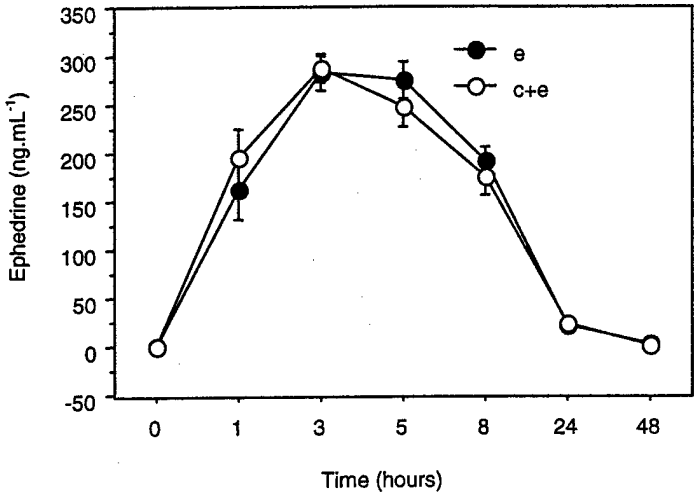

Figure 4: Plasma ephedrine levels post e and c+e ingestion. Values are mean (SEM).

Figure 5 shows the level of caffeine in the plasma during the c and c+e treatment trials. There was no difference between the clearance rates. Peak levels occurred between 2 and 4 hours.

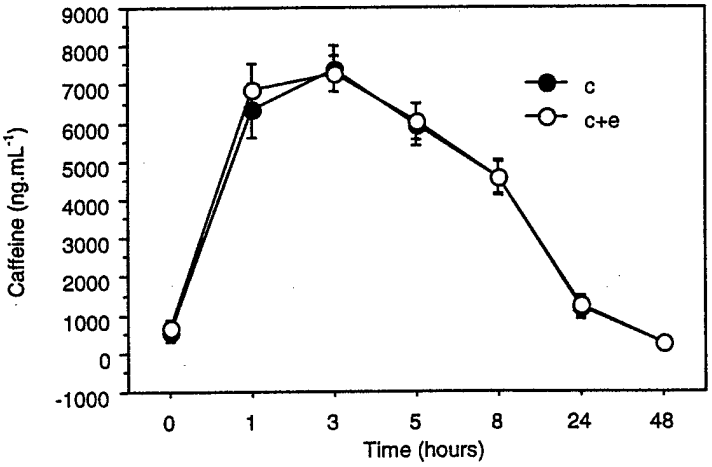

Figure 5: Plasma caffeine levels post c and c+e ingestion. Values are mean (SEM).

with any drug, some individuals may be extraordinarily sensitive. In a subsequent experiment we have measured systolic and diastolic pressure in excess of 214/112 in a young, healthy male, after ingestion of c+e (Pasternak, H. Jacobs, I. and Bell, D. Personal communication). He was a non caffeine user.

Further, it is possible that our data collection points did not capture the highest SBP sustained by each subject. Peaks might have occurred between 1 and 3 hours if SBP pressures correlates with plasma levels of c and e. We can see by Figures 4 and 5 that peak plasma levels of e and c appeared to crest by 3 hour. At this time SBP were lower.

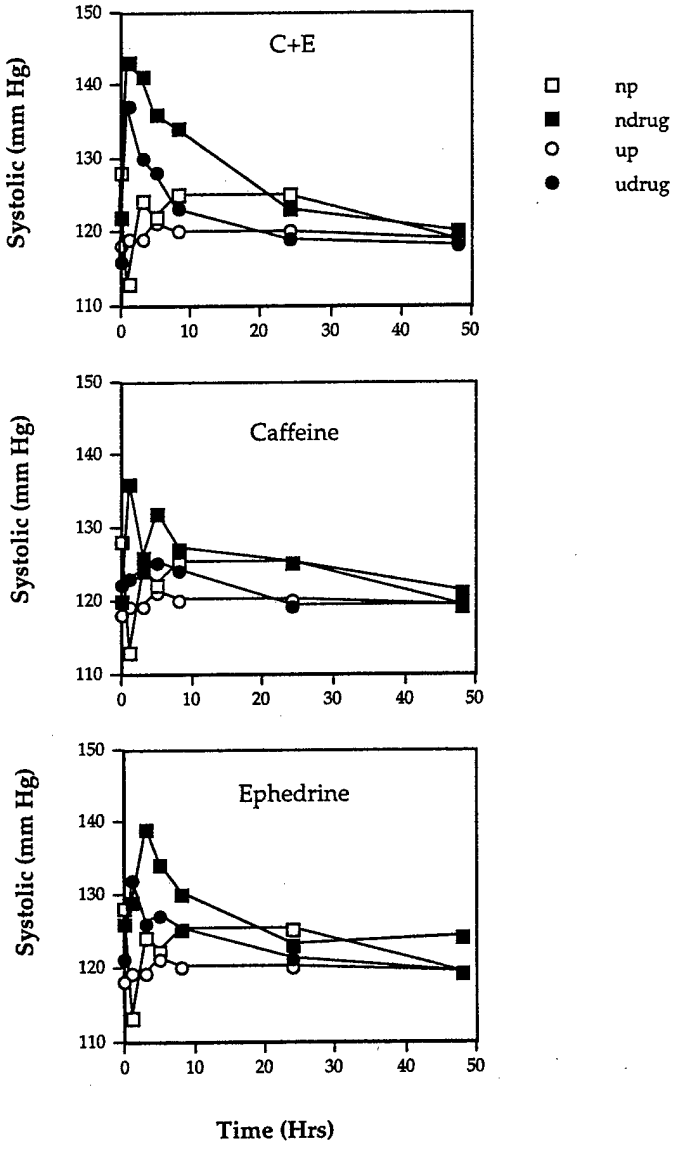

Figure 6. Effect of caffeine, ephedrine and c+e on S BP in caffeine users = u = circles, and non users = n = squares. Open symbols represent placebo trials, closed symbols drug trials.

than at one hour. Thus it is possible that higher SBP may have occurred before 3 hours and after 1 hour. Regardless of the peak, the other results remain the same

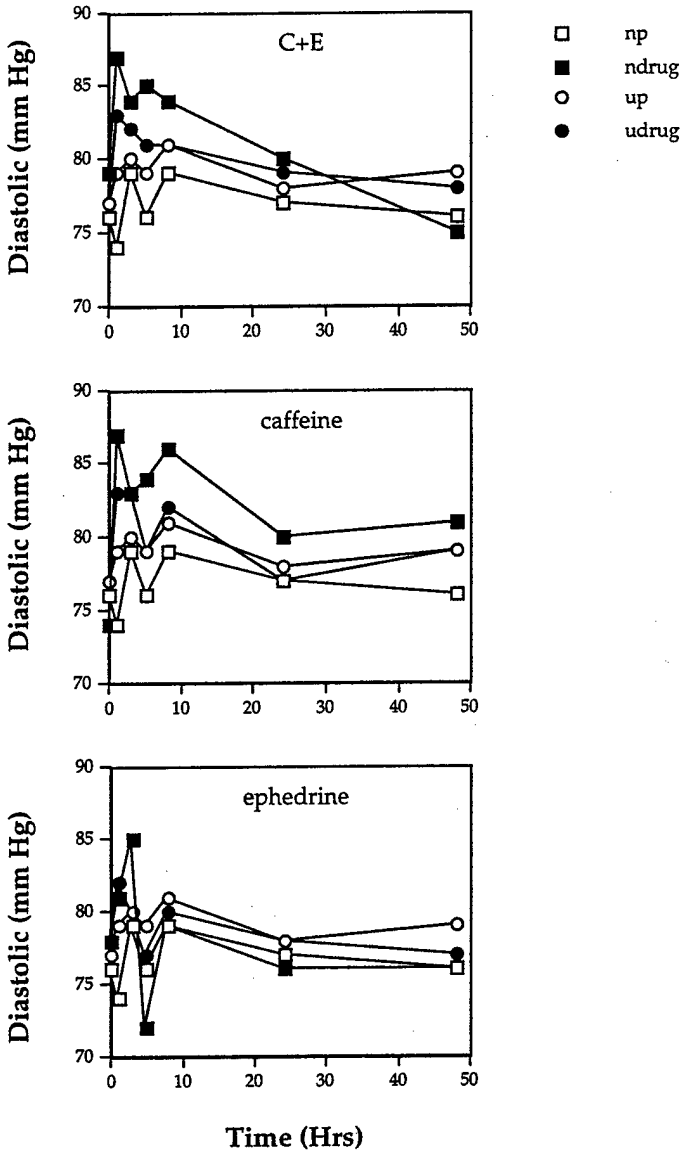

Figure 8. Effect of caffeine, ephedrine and c+e on D BP in caffeine users = u = circles, and non users = n = squares. Open symbols represent placebo trials, closed symbols drug trials.

CONCLUSION

It appears that in a normo-tensive healthy young individuals acute ingestion of a preparation of caffeine, ephedrine or the two in combination would not have long lasting adverse effects on resting blood pressure or heart rate.

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