

**ROCK CLIMBING: OBSERVATIONS ON HEART RATE AND
PLASMA CATECHOLAMINE CONCENTRATIONS AND THE
INFLUENCE OF OXPRENOLOL**

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ABSTRACT

Observations are presented on the electrocardiogram and plasma catecholamine concentrations of 11 healthy men monitored during two rock climbing ascents. A placebo was administered prior to the first climb and an oral dose of the beta blocking agent oxprenolol ("Trasicor") prior to the second. Mean heart rates were 166 (\pm 20.4 SD) and 120 (\pm 10.2) respectively. Median plasma adrenaline concentrations were 0.05 μ g/l and 0.33 μ g/l before and after the climbs following the placebo. No significant difference was observed in the adrenaline concentrations before and after climbing following oxprenolol, or of noradrenaline concentrations on either occasion.

These results are interpreted as suggesting that this popular sport represents more an anxiety-type of psychological stress than a physical stress and as such is likely to increase moral fibre rather than muscle fibre.

INTRODUCTION

Increasing affluence and leisure has swelled the ranks of those who partake in recreation requiring physical fitness greater than that demanded by their work. The modern epidemic of coronary artery disease has also focussed attention upon the desirability of 'keeping fit' (Turner and Ball, 1973). Fitness means different things to different people as has been so succinctly reviewed by Shephard (1969). Although rock climbing is a sport in its own right it originated as one of the means of training to overcome the more difficult sections of the ascent of high mountains. Crags suitable for indulging in the sport are easily accessible from most major British cities, and enjoy increasing popularity both from devoted climbers and those who seek an enjoyable means of keeping fit.

It is therefore appropriate to consider whether this form of exercise is likely to be useful in securing the increasingly sought-after benefits of regular physical exertion which have been reviewed at length by Åstrand and Rodahl (1970). Alternatively, is rock climbing one means, among others, of producing the psychological fitness assuring the climber that he possesses the necessary skill, strength, endurance and experience to complete his chosen climb? (Edwards 1975).

METHODS

Subjects

Eleven men who were either members of the police force undergoing arduous training or professional climbing instructors with apparently normal hearts (the police had been medically examined and the instructors' occupation was assumed to preclude cardiac abnormality) volunteered to participate in the study. Their mean age was 31 (range 24-48) and experience varied from novice to professional.

Procedure

Each subject undertook two climbs, the first in the morning and the second in the afternoon, the whole study being completed in the course of a single day. A single blind technique was used, each subject being given a placebo tablet one hour prior to his climb in the morning and an oral dose of the beta-blocking agent oxprenolol one hour before his second climb in the afternoon.

The climbs which were conducted on the sandstone cliff Bowles Rocks near Tunbridge Wells were so chosen that they were of comparable difficulty for each of the subjects' first and second ascents. Different routes were

selected for each occasion since to have allocated the same climb for both ascents would have resulted in the second ascent being less stressful than the first because of prior knowledge of the positions of ledges and other details of the route. Each climb was of roughly 10-15 minutes duration. Being short, in general the climbers considered that the selected routes required minimal physical effort, but they engendered considerable anxiety owing to the steepness of the rock face and its slippery nature caused by rain which continued all day.

ECG Recordings

The Recard miniaturised tape recording system* was used for these studies. The apparatus consisted of two light weight electrodes taped to the chest to approximate to a V5 configuration and connected to a recorder weighing 350 gm and measuring 12 x 7 x 4 cm which was easily secured in the subjects' clothing. The records were subsequently played back through a demodulator and recorded onto to conventional ECG paper for analysis.

Plasma Catecholamine Estimations

Blood samples were taken about 15 minutes before and within the first minute after each climb, centrifuged and the plasma separated and deep frozen, within 5 minutes of venepuncture. Particular care was taken about the timing of this procedure in view of the documented decay of plasma catecholamines (Carruthers, Taggart, *et al*, 1970). Analysis was by a semi-fluorimetric method previously described (Carruthers, Taggart, *et al*, 1970).

Statistical Analysis

The concentration of catecholamine in the plasma was not normally distributed. Median values rather than means were therefore calculated and the statistical significance of differences was estimated by non-parametric testing. Of the appropriate tests the Wilcoxon is the most powerful and this was used.

RESULTS

All subjects developed a tachycardia during both the climbs following a placebo and following oxprenolol. Maximum heart rates ranged from 130 to 200 per minute during the climb following the placebo and from 115 to 140 on the second occasion after oxprenolol (Table I). The degree of shatter imposed upon the tracings by the necessary continued use of pectoral girdle muscles precluded precise analysis of the electrocardiogram, although it was clear that neither any arrhythmic activity or important ST segment depression

occurred during any of the climbs, nor was there any doubt about the accuracy of the heart rate measurements derived from the tracings.

TABLE I

Mean maximum heart rates (with standard deviations) recorded from 11 subjects during a 10 minute period of rock climbing on two occasions, once following a placebo and a second following 40 mg oxprenolol

	PLACEBO	OXPRENOLOL
Mean Maximum Heart Rate	166 ± 20.4	120 ± 10.2
	P < 0.001	

Plasma Catecholamine Concentrations

Plasma adrenaline concentrations sampled after the climb following the placebo were considerably increased compared to the before climbing samples (Table II), whereas there was no significant difference in plasma noradrenaline concentrations.

This increase in plasma adrenaline concentration was not observed after the climbs following oxprenolol, and again there was no significant difference in plasma noradrenaline concentrations (Table II).

TABLE II

Plasma catecholamine concentrations (median values) in 11 subjects before and after rock climbing on two occasions, once following a placebo and the second following an oral dose of 40 mg Oxprenolol

	PLACEBO		OXPRENOLOL	
	Before	After	Before	After
Total Catecholamines $\mu\text{g/l}$	0.58	0.93	0.60	0.91
	p < 0.05		N.S.	
Noradrenaline $\mu\text{g/l}$	0.55	0.67	0.56	0.61
	N.S.		N.S.	
Adrenaline $\mu\text{g/l}$	0.05	0.33	0.04	0.19
	p < 0.001		N.S.	

*(Vingmed, Oslo)

N.S. = Not significant at the 5% level by the Wilcoxon sign test.

DISCUSSION

Changes in the plasma concentration of catecholamines have been studied before and after an undertaking giving rise to anxiety (Taggart, Carruthers, *et al*, 1973) and the effect of using a beta-adrenoceptor-blocking drug in such circumstances has been investigated (James, Pearson, *et al*, 1977). It is the general consensus of opinion amongst climbers that rock climbing (as contrasted with mountaineering) entails a strong element of anxiety together with a considerable but by no means intense element of physical exertion. Much of the time is spent in stationary contemplation of the route and selecting hand and foot positions. In near-vertical or overhanging crags such stationary periods can involve considerable isometric exertion with the need for periodic changing of the hand or foot holding the climber to the face. The routes chosen for this study although hard were such that uncertainties could be resolved without isometric stress on the arms and difficulties were typically overcome in a series of rapid upward moves. The rock was open, smooth, and dripping with rainwater and did not lend itself to isometric exertion as a mode of remaining on the face.

Despite the relatively low height of the popular outcrop where the experiment was carried out, the climbs ranging between about 30' and 100' above the ground, the element of fear is present since an uncontrolled fall of even 10' is likely to result in injury. Whereas there has been much discussion on the relative proportions of the hormones adrenaline and noradrenaline secreted in response to a particular emotion, it is known that strong physical exertion is associated with a predominant increase in noradrenaline (Taggart, Parkinson, *et al*, 1972). Such an increase was conspicuously absent in the present study, supporting the contention of those who participate in this sport that it is mainly an emotional rather than physical challenge which is presented by the rock face.

Differentiation between emotions of different types and intensities on the basis of relative adrenaline and noradrenaline secretion rates is controversial. Von Euler (1964) who reviewed the available evidence up to 1964 considered that fear and anger or aggression equated with increased circulating adrenaline and noradrenaline respectively. Frankenhaeuser (1971) considered that adrenaline secretion was dictated largely by the presence of a high degree of arousal and noradrenaline in situations where the outcome was inevitable.

Our previous studies are more in agreement with Von Euler. Motor racing, for example, is associated with a predominant increase in plasma noradrenaline concentration (Taggart and Carruthers, 1971) although the outcome could hardly be considered inevitable or there would be few competitors! The experience of dental

procedures is associated with a predominant plasma adrenaline increase (Taggart, Hedworth-Whitty, *et al*, 1976) which even with modern techniques, to the simple minded normal coward, must be associated with fear? We interpret our results in this study therefore as implying that fear was the dominant emotion.

The absence of even a small increase in plasma noradrenaline content in the samples following a climb was unexpected since this is known to occur during physical exercise (Taggart, Parkinson, *et al*, 1972). The absence of such an increase suggests, therefore, that if fear is present, the exertion has to be very forceful for the exercise to result in a demonstrable increase in this hormone.

The lack of increase in plasma adrenaline concentration following beta-blockade could be accounted for by this blockade breaking a feedback loop which probably exists (Breggin, 1964). This feedback mechanism appears to involve a fear of defacing the shelf image or appearing to be nervous, which in turn increases anxiety, so giving rise to a spiral of increasing autonomic activity.

The tachycardia observed during the climb following the placebo was considerable, the maximum heart rate in four of the eleven subjects being in excess of 175 per minute. The moderate effect only of beta-blockade in suppressing tachycardia is in keeping with the findings of others during the performance of physical exercise (Imhoff, Blatter, *et al*, 1969). This finding may be used to support the statement that physical exertion was an integral party of this study. This being so, the more mild forms of physical exertion would seem likely to effect a tachycardia by vagal withdrawal rather than by sympathetic activity.

Oxprenolol while probably increasing the confidence of the climbers by blocking the anxiety spiral referred to above, presumably neither reduced nor increased their skill, effectiveness or safety. A lack of reduction of these factors is obviously important in people who are receiving beta-blockade for one reason or another while participating in potentially dangerous occupations. It is theoretically possible, however, that the confidence born of reduced anxiety following beta-blockade might encourage a person to overreach his abilities.

On the basis of these observations we suggest that the dominant emotion involved in rock climbing is one of fear, namely passive self-preservation during the performance of the task. The climber would appear to be not so much attacking the mountain as trying to stay on it. This contrasts for example with racing car driving which if the views of Von Euler are correct, may be interpreted as engendering a mood of active competitive aggression.

It is concluded that hard rock climbing on small crags is not, of itself, a sport necessarily requiring, or by its practice producing, physical fitness in the everyday sense of the term, or having its cardio-protective implications (Morris, Adam, *et al*, 1973). It is predominantly a psychological stress of the short-term anxiety-producing type but the authors in drawing this conclusion by no means wish to detract from the sport and its participants may well develop thereby a particular type of psychological fitness of considerable value. It is of course obvious that if a rock climber regularly spends many hours on a crag certain muscles will become hypertrophied (e.g. the lumbricals) and to that extent will

achieve a degree of fitness in the conventional sense, but his fitness will be a specialised fitness, particularly of muscles required to enable him to climb. This fitness will not necessarily make him capable of, for example, long distance walking or running or enable him to climb the controversial hill of fitness leading away from heart disease.

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