

After informed consent, each patient was evaluated clinically to rule out other concomitant illnesses. They were hospitalized for 2 days prior to the test and allowed to have normal diet. No medications were given during this period. On the third day morning, they were subjected to treadmill stress test on a computerised treadmill using Bruce's protocol. They were made to exercise till they reach the maximal possible work load.

The patients were then administered garlic oil in the form of capsules. Eight capsules were given in two divided doses on the same day following exercise test and were discharged from hospital. They were followed fortnightly to ensure that they were taking garlic capsules regularly. After 6 weeks of garlic oil therapy, they were again subjected to the treadmill stress test. Throughout the study they were allowed to take 150 mg of aspirin daily and isosorbic dinitrate sublingually whenever needed.

Treadmill stress test:

Three forms of stress testing are commonly performed, tests with standardized external work load, tests which are standardized by heart rate response, and test designed to reach the maximal possible work load. In the present study the maximal exercise test on treadmill was employed in which the exercise was progressively increased until maximal work load was attained. The test was however discontinued at a lower level of work if the patient develops chest discomfort, severe shortness of breath, dizziness, fatigue, ST segment depression >0.2 mV (2 mm), a fall in systolic

blood pressure exceeding 10 mmHg or the development of ventricular tachyarrhythmias (8).

During stress test, heart rate and blood pressure were monitored. Resting and peak exercise levels of heart rate and blood pressure and total duration of exercise were determined. Cardiac work load was assessed in terms of double product which was derived from multiplying maximum heart rate by maximum systolic blood pressure. The results obtained from two treadmill stress tests, before and after garlic administration were compared using student's 't' test for paired sets of data.

Preparation of garlic oil:

Peeled garlic cloves were crushed, extracted in ethyl acetate and the solvent evaporated. The resulting oil was dissolved in Soy oil and this oil extract of garlic was encapsulated. Each capsule contained garlic oil equivalent to one gm of raw garlic and 260 mg Soy oil. Four capsules were administered twice a day with meal.

RESULTS

Garlic oil administration for six weeks resulted in a significant ($P < 0.01$) reduction in the heart rate at peak exercise and also significant ($P < 0.01$) reduction in work load upon the heart as indicated by the double product. This resulted in better exercise tolerance ($P < 0.05$) and improvement in subjective symptoms. The resting heart rate, resting mean blood pressure and the blood pressure at peak exercise were not significantly altered (Table I). The ECG

TABLE I: Effect of garlic on cardiac performance and exercise tolerance in patients with CAD.

	<i>Initial</i> (N=30)	<i>6 weeks after garlic</i> (N=30)
1. Resting heart rate (per min)	80.00±4.38	78.66±3.44 P=NS
2. Resting mean blood pressure (mmHg)	104.33±6.82	100.66±5.80 P=NS
3. Heart rate (per min) at peak exercise	165.66±4.32	146.50±9.40 P<0.01
4. Mean blood pressure (mmHg) at peak exercise	114.00±10.68	113.00±11.80 P=NS
5. Double product	28583.33±2177.50	25154.33±2137.35 P<0.01
6. Exercise tolerance (min)	9.16±0.93	10.40±0.97 P<0.05

Values are means ± SD. P compared with initial. NS, Not significant. Double product, maximum heart rate x maximum systolic blood pressure during stress.

changes also remained same at the end of the study.

DISCUSSION

In the present study, we have observed that administration of garlic oil has prevented, to a certain extent, the increase in work load on the heart during an acute physical stress in patients with ischemic heart disease without affecting the resting parameters and also without altering the basic disease process (as there was no improvement in resting ECG changes). The significant reduction in heart rate at peak exercise and a decrease in double product signifies a reduction in work load on the heart resulting in better exercise tolerance. In a previous study, it was shown that most of the therapeutic benefits of garlic were dose - dependent (9), and therefore we selected eight capsules of garlic oil daily

which are equivalent to eight gram of raw garlic. Even in this dose for 6 weeks no side effects were observed.

The beneficial effects of garlic during physical stress have been observed in experimental animals. Garlic oil administration showed a definite effect on stress affected mice. It prevented decrease in physical strength induced by physical or chemical stress and prompted recovery from the affected condition along with lower cortisone level (6). It has also been demonstrated that 7 days of garlic oil administration enhances physical endurance caused by isoprenaline. The degree of myocardial damage produced by isoprenaline was also reduced significantly (10). The mechanism may be related to suppression of the stress induced activities of the peripheral sympathetic system without affecting adrenal medulla and pituitary adrenocortical system (11). The corticoids thereby spared which are known to enhance adaptability. A study on hospital indoor patients has also shown the value of garlic in psychological stress in human beings (7).

Withania somnifera (Ashwagandha) (12) and *Ocimum sanctum* (Tulsi) (13) are other well known adaptogens of plant origin described in literature. Brekhman described many other substances of plant origin which have adaptogenic properties. Panax ginseng, Elecetherococcus senticoccus, Echinopanax elaum, Acantopanax sesslitorum and Rhodiola rosea are some of them (14). He proposed that these medicines probably act at the cellular level by their antioxidant property and by their influence on the process of biosynthesis of proteins and

nucleic acid. Garlic is also an antioxidant (15). The mechanism of action might be similar.

Garlic is commonly used as food additive and can be recommended as a dietary supplement for long term use without toxic effects. It has the added advantage of having wide range of medicinal properties in

general and therapeutic potential in patients with CAD in particular. The present study demonstrates another property of garlic whereby it enhances adaptability to stress in patient with ischemic heart disease. It therefore can be considered as an adaptogen and included in the expanding list of adaptogens especially beneficial to patients with CAD.

REFERENCES

1. Srivastava KC, Bordia A, Verma SK. Garlic (*Allium sativum*) for disease prevention. *South African J Science* 1995; 91: 68-77.
2. Barness J, Anderson LA, Phillipson JD, eds. Garlic. In: Herbal medicines. 2nd ed. London: Pharmaceutical Press 2002; 226-240.
3. Bordia A. Effect of garlic on blood lipids in patients with coronary heart disease. *Am J Clin Nutr* 1981; 34: 2100-2103.
4. Ali M, Thomson M. Consumption of a garlic clove a day could be beneficial in preventing thrombosis. Prostaglandins. *Leukot Essent Fatty Acids* 1995; 53: 211-212.
5. Bordia A, Verma SK. Effect of garlic feeding on regression of experimental atherosclerosis in rabbits. *Artery* 1980; 7: 428-437.
6. Takasugi N, Kotoo K, Fuwa A, Saito H. Effect of garlic on mice exposed to various stresses. *Oyo Tukurl Pharmacometrics* 1984; 28: 991-1002.
7. Kajiyama J. Clinical studies of Kyoleopin. *Jap J Clin Rep* 1982; 16: 1515-1518.
8. Salwya AP, Braunwald E: Ischemic heart disease; In: Braunwald E, Fauci AS, Kasper DL, Hauser SL, Longo DL, Jameson JL eds. Harrison's Principles of Internal Medicine 15th ed. New York: McGraw Hill 2001; 1399-1410.
9. Bordia A, Verma SK, Srivastava KC. Effect of garlic on platelet aggregation in human: a study in healthy subjects and patients with coronary artery disease. *Prostaglandins Leukot, Essent Fatty Acids* 1996; 55: 201-205.
10. Saxena KK, Gupta B, Kulshreshtha VK, Srivastava RK, Prasad DN. Effect of garlic pretreatment on isoprenaline induced myocardial necrosis in albino rats. *Indian J Physiol Pharmacol* 1980; 24: 233-236.
11. Kvetnansky R, Takasagi N, Oprsalova Z, Jezova D, Jurcovicova J, Fuwa T. Neuroendocrinological effects of aged garlic extract in control and stress rats (Abstr. 25). First World Congress on the Health Significance of Garlic and Garlic constituents. *Washington DC (USA)* 1990.
12. Bhattacharya A. Antistress activity of sitoindesides VII and VIII - New acylsteryglycosides from *Withania somnifera*. *Phytotherapy Res* 1987; 1: 32-37.
13. Bhargava KP, Singh N. Anti-stress activity of *Ocimum santum* Linn. *Indian J Med Res* 1981; 73: 443-451.
14. Brekhman II, Dardymov IV. New substances of plant origin which increase non-specific resistance. *Ann Rev Pharmacol* 1969; 9: 419-430.
15. Grune T. Influence of *Allium sativum* on oxidative stress status - a clinical investigation. *Phytomedicine* 1996; 2: 205-207.