Section X

Blood pressure changes in Surya Namaskar- a longitudinal perspective and its comparison with Yoga Proficient
10. Blood pressure changes in *Surya Namaskar*- a longitudinal perspective and its comparison with Yoga Proficient

10.1 Introduction

Effect of exercise training on cardiovascular system is well documented (24, 31, 34, 44, 45, 67, 74, 77, 83, 95, 97, 103, 107, 108, 118, 123, 129, 153, 178, 185, 195, 200, 202, 223, 231, 234, 269). It is also proved that Yogic Asanas as a part of the training programme solely or along with some other conventional physical training play an important role in the improvement of cardiovascular efficiency. Wiley *et al* in a study had shown that isometric exercise training reduces the resting blood pressure (269). Study by Selvamurthy *et al* had shown that the practice of Yogic Asanas for a few months is beneficial to control essential hypertension (209). Here they suggested that the sluggish baroreflex mechanism in essential hypertension could be reactivated after a few days of Yoga training (209). *Surya Namaskar* (SN), a Yogic Asana, is very dynamic in nature and consists of movements of many of the muscles and joints of the body. In the present study the effect of training on the blood pressure (BP) changes during *Surya Namaskar* is evaluated longitudinally.

10.2 Aim

The present study was undertaken to observe -

10.2.1. Changes in BP in SN in yoga trainees at three different phases of Yoga training.

10.2.2. Comparative aspects of changes in BP of Yoga trainees with that of Yoga Proficient.
10.3 Material and methods

9 normal healthy male volunteers who were free from any clinical disorders were chosen for the present study. Another 20 male yoga instructors who were referred to as Proficient and Semi-Proficient (10 each). Trainees underwent Yoga training alongwith SN daily in the morning. The detailed protocol of practicing SN is described in the earlier Section. Proficient and Semi-Proficient were also requested to maintain the same time duration for practicing SN for the uniformity in the study (For better comparison to observe the physiological effects). 1st, 2nd and 3rd phase of the study was conducted at the beginning of the 4th, 7th and 12th month of Yoga training respectively. While the trainees, Proficient and Semi-Proficient performed SN in the laboratory; BP was measured in 3rd and 11th postures of Surya Namaskar.

These two particular postures were chosen because of the convenience of recording the blood pressure in these postures. BP was recorded by an arm cuff by electro sphygmomanometer of a polygraph (Propaq, USA). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured and mean blood pressure (MBP) was calculated following the standard formula. All the BP values were expressed as mmHg.

Paired t-test was applied for comparing the BP data between Yoga trainees and unpaired t-test was applied for intergroup comparison that is between Yoga trainees and Proficient and Semi-Proficient.

10.4 Result

The SBP, DBP and MBP changes during Surya Namaskar of the Yoga trainees at the 1st, 2nd, 3rd phase of the Yoga training, Yoga Proficient and Semi-Proficient in the 3rd posture and 11th posture were shown from the Figure 56 to Figure 61. Statistical significance amongst the mean values of SBP, DBP and MBP of yoga trainees, Proficient and Semi-Proficient in two postures were given in the same graphs.
10.4.1 Responses in systolic BP

From the Figure 56 and Figure 57 it appeared that in the 3rd posture SBP was decreased significantly (P<0.001) from the 1st Phase to the 3rd phase. SBP was significantly higher in Yoga Proficient as compared to Yoga trainees at the 3rd phase of the training (P<0.05). SBP was significantly higher in Yoga Semi-Proficient as compared to 2nd and 3rd phase of the training (both are significant at P<0.001).

In the 11th posture SBP was reduced significantly (P<0.001) from the 1st to 3rd phase. Values of the SBP of Proficient and Semi-Proficient showed significantly higher value from the 2nd and the 3rd phase at P<0.01 and P<0.001 respectively. There was no difference of SBP value between 1st phase of Yoga training and Proficient and Semi-Proficient.

10.4.2 Responses in DBP

In the 3rd posture DBP was decreased significantly from the 1st phase to 3rd phase (P<0.001) and from the 2nd phase to 3rd phase (P<0.001). Proficient and Semi-Proficient showed significantly higher value of DBP from the 2nd phase (P<0.05) and from the 3rd phase (P<0.001).

In the 11th posture DBP was reduced significantly from the 1st phase to 2nd phase (P<0.05) and from the 2nd phase to the 3rd phase (P<0.05). When 1st phase was compared with the 3rd phase, DBP was reduced significantly (P<0.001). Proficient showed significantly higher value of DBP from the 1st phase and the 2nd phase (P<0.01) and from the 3rd phase of the training (P<0.001). But Semi-Proficient showed significantly higher value only from the 3rd phase (P<0.001). There was no difference of DBP between 1st phase of Yoga training and Yoga Proficient and Semi-Proficient.

10.4.3 Responses in MBP

In the 3rd posture MBP was reduced significantly from the 2nd to 3rd phase (P<0.01) and from the 1st to 3rd phase (P<0.001). Proficient showed significantly higher value of MBP from the 2nd phase (P<0.05) and from the 3rd
phase of the training (P<0.001). Semi-Proficient showed significantly higher value from the 2\textsuperscript{nd} phase (P<0.01) and from the 3\textsuperscript{rd} phase (P<0.001) of the training. In the 11\textsuperscript{th} posture MBP was reduced significantly from the 1\textsuperscript{st} phase to 2\textsuperscript{nd} phase (P<0.01) and from the 1\textsuperscript{st} phase to 3\textsuperscript{rd} phase (P<0.001) of the training. Proficient and Semi-Proficient showed always higher value of MBP from the 2\textsuperscript{nd} phase (P<0.001) and from the 3\textsuperscript{rd} phase of the training (P<0.001). There was no significant difference of MBP value between 1\textsuperscript{st} phase of Yoga training and Yoga Proficient and Semi-Proficient.

10.5 Discussion

The present study showed a decrease in SBP in the two postures due to the effect of training. SBP depends mainly upon the cardiac output that is the product of stroke volume and heart rate (21). Exercise training undoubtedly reduces the heart rate at rest as well as during submaximal exercise due to the improved circulatory capacity (118, 209). Training also increases the stroke volume at rest and during submaximal exercise (118). Generally, this change results from an increase in internal ventricular volume and possibly an enhanced ventricular contractility (224). Since the cardiac output is the product of heart rate and stroke volume, it is evidently clear that a low heart rate at a given oxygen uptake is most likely associated with a larger stroke volume (4). Study by Saltin et al. had shown that training for 50 days following a 20 day period of bed rest did increase the stroke volume and decrease the heart rate at submaximal work rates (185). Thus, the effect of training on heart rate and stroke volume might have caused a reduction in the cardiac output at submaximal work rates. Seals and Hagberg also showed that a modest decrease in blood pressure (less than or equal to 10 mm Hg) occurs at rest and submaximal exercise after training (201). SN is considered as a submaximal exercise. Progressive reduction in SBP during two postures of Surya Namaskar at three different phases of training might have occurred as a result of decrease in cardiac output. DBP depends mainly upon the peripheral resistance (21) and the MBP is the product of cardiac output and the peripheral resistance. The significant fall in DBP and MBP in two different postures of Surya Namaskar may be due to reduction of peripheral resistance occur due to reduced
sympathetic drive and increased capillary growth in training (111). Study by Kelley et al had shown that resting SBP and DBP decreased by 2% following four weeks of training schedule. Training schedule consisted of walking programme only (90). SN practice can be considered as an aerobic exercise training programme utilizing a range of 10-50% of the VO2max. It has been shown by Mughal et al that aerobic exercise training for 12 weeks at 50% of the VO2max significantly reduced SBP and DBP by 5.7 mm Hg and 1.4 mm Hg respectively (132).

It was shown in another study by Willey et al that isometric exercise training that consisted of four contractions of 50% of maximum effort held for duration of 45 sec followed by one minute rest reduced resting SBP and DBP by 9.5 and 8.9 mm Hg respectively. Training schedule consisted of 5 days per week for 5 weeks duration (269). Different postures of the SN are isometric in nature because one has to hold the different postures for a certain duration where the tension in the muscle is gradually built up but the muscle length remained the same. This might be the reason for reduction of SBP and DBP in SN due to training.

Another important factor associated with training is an increase in arterial distensibility on which SBP and DBP depends. A study by Giannattasio et al has revealed that an ordinary level of physical activity plays a major role in modulation of arterial mechanical properties (59). Thus it is evident that the effect of training in the present study might have influenced the arterial distensibility leading to a progressive fall in SBP and DBP.

The comparatively higher value of SBP and DBP in Yoga Proficient and Semi-Proficient with respect to Yoga trainees may be due to irregularity of practice of Yogic exercises by the Yoga Proficient or may be due to ageing. It is reasonable to believe that only a minor difference in the age between trainees and Proficient may not be the sole reason for lower level of cardiovascular conditioning in Proficient. The reason probably lies in the fact since Yoga trainees are infantry soldiers, they used to practice PT exercise along with the yogic exercises.
Summary

The blood pressure (systolic, diastolic and mean) responses were recorded in two postures (3rd and 11th posture) during the performance of SN in Yoga trainees at three different phases of the Yoga training. Trainees' blood pressure values were compared with that of Yoga Proficient and Semi-proficient values. It was found out that the systolic blood pressure (SBP) decreased significantly in 3rd posture from 1st Phase to 2nd phase and from 1st phase to 3rd phase. SBP gradually reduced significantly in the 11th posture from the 1st to 2nd phase and from 1st to 3rd phase. Diastolic blood pressure (DBP) decreased significantly in the 3rd posture from the 1st phase to 2nd phase and from the 2nd phase to 3rd phase. DBP reduced significantly in the 11th posture from the 1st phase to 2nd phase and from the 2nd phase to the 3rd phase. When 1st phase was compared with the 2nd phase, DBP reduced significantly. Mean blood pressure (MBP) reduced significantly in the 3rd posture from the 2nd to 3rd phase and from the 1st to 3rd phase. The trainees' SBP, DBP and MBP value was closer to that of Proficient and Semi-proficient after 3 months of training only.

The improvement in blood pressure responses in the trainees might have resulted from the improved circulatory function as a result of Yogic training. SBP depends mainly on the cardiac output that is the product of the stroke volume and heart rate. The improved cardiac output might have resulted from the lower heart rate and higher stroke volume due to the effect of Yogic training. This might have caused reduction in the SBP at different phase of the training. This happens during any conventional type of physical training programme also. The reduction in DBP in the trainees might have resulted from progressively reduced peripheral resistance as a result of Yogic training. Since MBP is the product of cardiac output and peripheral resistance, the gradual fall in MBP in the trainees is clearly understandable. The comparatively higher value of SBP, DBP and MBP in Yoga Semi-proficient as compared to the other groups was possibly due to detraining effect.
Figure 56. Systolic blood pressure (mm Hg) in trainees at three different phases of the training and in Proficients and Semi-proficients in 3rd posture of the Surya Namaskar. Values are mean±sem.

Figure 57. Systolic blood pressure (mm Hg) in trainees at three different phases of the training and in Proficients and Semi-proficients in 11th posture of the Surya Namaskar. Values are mean±sem.

- 1st Phase
- 2nd Phase
- 3rd Phase

- Proficients
- Semi-proficients

*+/+$ P<0.05       * Comparison to first phase
**+/++/$$ P<0.01  + Comparison to second phase
***+/+++/$$$ P<0.001 $ Comparison to third phase
Figure 58. Diastolic blood pressure (mm Hg) in trainees at three different phases of the training and in Proficients and Semi-proficients in 3rd posture of the Surya Namaskar. Values are mean±SEM.

Figure 59. Diastolic blood pressure (mm Hg) in trainees at three different phases of the training and in Proficients and Semi-proficients in 11th posture of the Surya Namaskar. Values are mean±SEM.
Figure 60. Mean blood pressure (mm Hg) in trainees at three different phases of the training and in Proficients and Semi-proficients in 3rd posture of the Surya Namaskar. Values are mean±sem.

Figure 61. Mean blood pressure (mm Hg) in trainees at three different phases of the training and in Proficients and Semi-proficients in 11th posture of the Surya Namaskar. Values are mean±sem.

- 1st Phase
- 2nd Phase
- 3rd Phase
- Proficients
- Semi-proficients

* /+/$ P<0.05  * Comparison to first phase
**/++/$$ P<0.01  + Comparison to second phase
***/++-$/$$$ P<0.001  $ Comparison to third phase