POSTURAL AND DIURNAL VARIATIONS IN BLOOD PRESSURE AND PULSE RATE

Preliminary Report :

By

G.R. CHANDRASEKHAR, C. K. HIRANYA GOWDA and G. S. RAGHUNATH RAO

Department of Pharmacology, Medical College, Bangalore

There is no general agreement on the relative values of B.P. in the recumbent and erect postures of the body. There is controversy regarding the influence of exercise and ingestion of food on the B.P. Similarly regarding the diurnal pulse frequency changes, there is difference of opinion. To judge the physical fitness of an individual, some authors consider the degree of alteration in pulse rate that occurs due to postural changes. The upper and lower limits of this change in a physically fit individual are not clearly established. The following are a few examples of such controversy :—

BLOOD PRESSURE

Postural Variations : Oliver (12), Meylan (11), Karrenstein (9) and Sewall (16) are all more or less of the same opinion that on changing from the horizontal to the vertical posture, the systolic pressure should rise, although in some it may not change. But Shapiro (13), Stephens (18) and Hill (7) observed a fall in systolic pressure under the same change of posture. Cotton, Rapport and Lewis (2) stated that systolic pressure fell on changing from the sitting to the standing posture.

The literature of studies giving postural changes in B.P. where postures are assumed without muscular effort has been omitted since such experiments give conditions unlike active postural changes.

Influence of exercise on B.P. : Smythe (17) says that systolic pressure decreases on exercise. Alvarez & Stanley (1) say that the systolic pressure may rise or fall in exercise. Erlanger and Hooker (3) say that diastolic pressure may rise or fall in exercise.

Influence of food and times of the day on B.P. : Erlanger & Hooker (3) say that changes in systolic & diastolic pressures are modified by intake of food. Oliver (12) and Jellineck (8) observed variable changes in systolic pressure associated with meals and times of the day. Weysse and Lutz (19) and Alvarez and Stanley (1) feel that change in systolic pressure can be influenced both by the time of the day and ingestion of food but that diastolic pressure is influenced mainly by the time of the day. Hensen (6) feels that even systolic pressure changes are independent of meals.

PULSE CHANGES

Postural Changes : To judge a person physically fit Meylan (11) expects more than 16 beats per min. rise from reclining to standing. Schneider and Truesdell (14) say that the smaller the difference the better it is. Geigel (4) gives only the upper limit of pulse rate change and says that a variation of more than 30 beats indicates a weak heart.

Diurnal variations : Knox (10) and Guy (5) found that the pulse rate was more in the earlier part of the day than in the later part. But Schneider and Truesdell (15) found that the heart rate tended to be higher towards the evening than in the earlier part of the day.

Having come across such controversy, it was thought advisable to make our own observations regarding postural and diurnal variations in B.P. and pulse rate and influence of ingestion of food and exercise on the same.

METHOD

Selection of volunteers : A pilot experiment was conducted selecting six male volunteers aged 40 and above. The selected volunteers consisted of tall and thin (MDR 5'—10" ; 123 lb), tall and stout (SPA 5'—7" ; 182 lb) short and thin (MVL 5'.4" ; 143 lb) short and stout (HCSM 5' 3" ; 176 lb), medium height and thin (SRDG 5' 3" ; 129 lb) and medium height and stout (LNR 5'.5" ; 175 lb) individuals. Three were heavy smokers and 3 were non smokers. One thin individual and one stout individual (SRDG 129 lb and HCSM 175 lb) were below 40 years of age and the others were around 50 years of age. Even among the latter group as can be seen from their heights and weights, there were thin, stout, short and tall individuals. Volunteers below 40 years were medical students while others were professors.

It is realised that the number of volunteers is too small to draw conclusions. But a large number of readings is taken for each individual. The results are interesting and fairly consistent and hence are considered worthy of presentation.

PROCEDURE

It was ascertained that the volunteers had no symptoms of high blood pressure. Readings were taken according to the proforma shown in fig 1.

At each sitting readings of B.P. and pulse rate were recorded at 3 postures, lying, standing and squatting. In the standing posture 3 types of readings were taken, one immediately on standing, one after 2 minutes of standing and one when the volunteer stood immediately after exercise. Four such sitting were taken in one day. In some instnaces all the four sittings could not be completed on the same day. The intervals between sittings happened to be days or even months to suit the convenience of the volunteers. The exercise imposed on the volunteers was walking 25 yards briskly.

B.P. was recorded using a sphygmomanometer and stethoscope over the brachial artery. Simultaneously pulse was counted. Recording was always started with lying posture. To take this reading the volunteer was made to lie down comfortably on a couch till two consecutive pulse rates at 2 min. intervals were constant. When readings were taken in squatting posture, the volunteer was made to squat on his feet whether with heels raised or heels down, whichever was more comfortable for the volunteer. In general pot bellied persons found it comfortable with heels up and the others with heels down.

No restriction was imposed on their food habits except that they should not take breakfast or any beverage before the morning readings and that they should take lunch in the middle of the day and supper at night.

Fig 1.

B.P. and Pulse Record

Name	Date	Postures	Before breakfast		½ hr. after lunch		4 hrs. after lunch		Immediately after supper	
			B.P.	Pulse ½ Min	B.P.	Pulse ½ Min	B.P.	Pulse ½ Min	B.P.	Pulse ½ Min
Age :		1. Lying down								
Height :		2. Immediately on standing								
Weight :		3. 2 Min. after standing								
		4. Standing after walking 25 yards								
		5. Squatting after walking 25 yards								

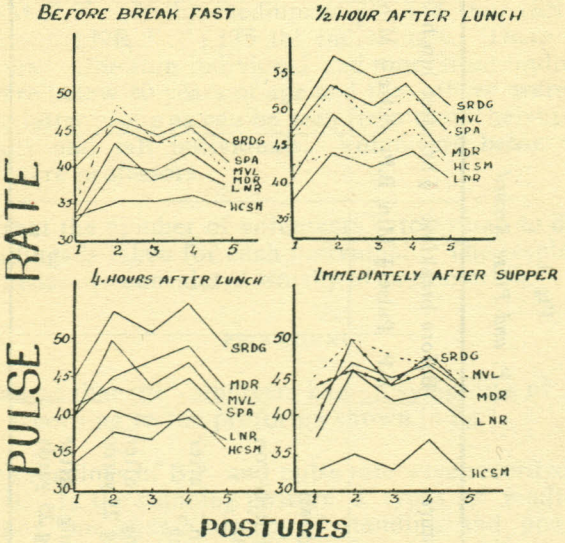
RESULTS

Under the conditions of this experiment, if any observation was made consistently in not less than 5 out of 6 cases it was considered noteworthy.

By reading the graphs in figures 2 to 8 the following salient features were discovered.

FIGURE-2.

POSTURAL CHANGES IN AVERAGE ½ MINUTE PULSE RATE - ANALYSED VALUES.



1. LYING DOWN 2. IMMEDIATELY ON STANDING 3. TWO MINUTES AFTER STANDING. 4. STANDING AFTER WALKING. 5. SQUATTING AFTER WALKING.

Observation on the pulse rate :

1. *Variations in relation to time of the day and feeding* : In any posture in 5 out of 6 cases the pulse was fastest in the mid day, ½ hr. after lunch (fig 4).

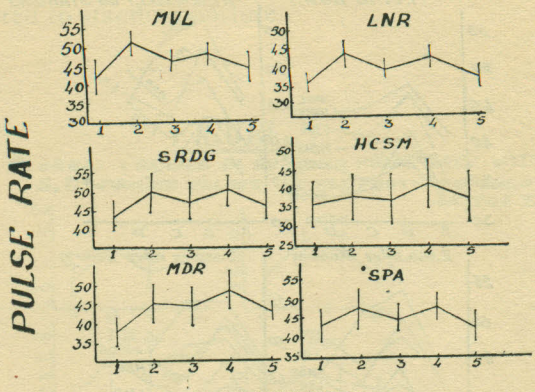
1. (*a*) On pooling the values taken at all postures, it was still highest at the same time in the same 5 cases (fig 5).

2. *Variations due to posture & exercise* : At any time of the day the average pulse rate was slowest either on lying down or on squatting on feet in all the 6 cases.

On standing after exercise the pulse was higher than on standing for 2 minutes before exercise in all cases. But MVL immediately after supper was the only exception (fig 2).

FIGURE.3

POSTURAL CHANGES IN AV ½m. IN PULSE RATE WITH S.D POOLING VALUES AT ALL TIMES OF THE DAY.



1. LYING DOWN. 2. IMMEDIATELY ON STANDING 3. 2 min. AFTER STANDING. 4. STANDING AFTER WALKING. 5. SQUATTING AFTER WALKING

VERTICAL BARS REPRESENT S.D

2. (*a*) On pooling the values taken at all times of the day, the same result was seen without exception (fig 3).

Observations on Blood Pressure :

Variations in relation to time of the day, feeding and exercise : There was no consistent variation in B.P. in relation to times of the day, exercise or food.

3. *Postural Variations* : The only constant feature in 5 out of 6 volunteers was that the systolic pressure was higher on squatting than on standing in any time of the day (fig 6).

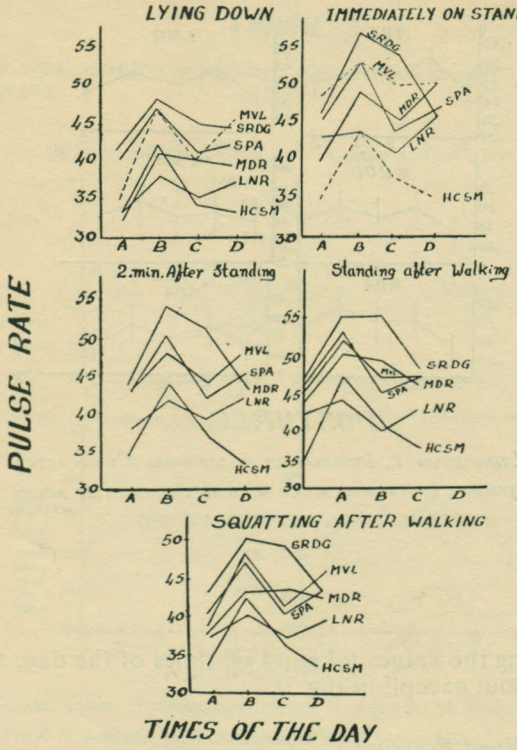
3. (*a*) Even on pooling the values taken at all times of the day systolic pressure showed the same pattern in the same 5 volunteers (fig 7).

4. In 5 out of 6 volunteers the diastolic pressure was higher on squatting than on standing only when readings were taken immediately after supper. It was less consistent at other times of the day (fig 8).

5. In some cases systolic pressure on lying was higher than the systolic pressure on standing (fig 6).

FIGURE 4

DIURNAL CHANGES IN Av. ½ m. PULSE RATE-ANALYSED VALUES.



A: BEFORE BREAK FAST, B: ½ Hr AFTER LUNCH, C: 4 Hrs AFTER LUNCH, D: IMMEDIATELY AFTER SUPPER.

COMMENTS

The findings that the systolic pressure on squatting on feet tends to rise higher than on standing and that the pulse rate on squatting on feet tends to be slower than on standing are interesting.

A tentative explanation for the systolic pressure being higher on squatting than on standing may be attempted as follows :—

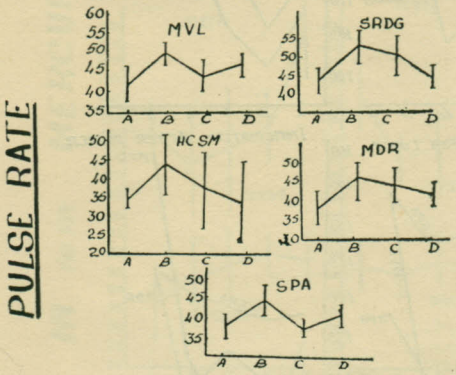
1. Squatting posture favours better venous return than the standing posture by squeezing the muscles of the lower limbs and by pressing on the abdominal vessels.

2. During squatting the thoracic respiration is more prominent than the abdominal respiration which means that the thoracic pump works better on squatting than on standing.

These two factors favour a higher cardiac output and a higher systolic pressure on squatting as compared to standing posture.

FIGURE 5

DIURNAL CHANGES IN Av ½min PULSE RATE WITH S.D – POOLING VALUES AT ALL POSTURES USED IN THE EXPT.



TIMES OF THE DAY

A: Before break fast. B: ½ hour. After lunch. C: 4 hrs. After lunch. D: Immediately after supper.
Vertical bars represent S.D

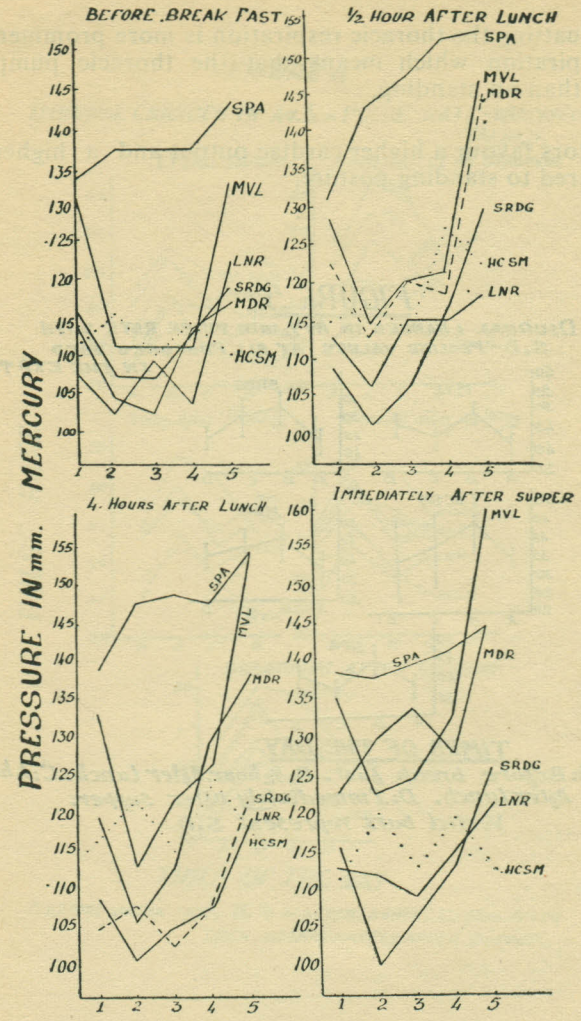
Whether the bradycardia on squatting is primary or secondary to the rise of B.P. is to be investigated.

Pulse rate being highest ½ hr. after lunch may be tentatively explained by the fact that the digestive activity is maximum at that time.

These above explanations however, need experimental verification. Further work is in progress.

FIGURE. 6

POSTURAL CHANGES IN AV. SYST. PR.- ANALYSED VALUES

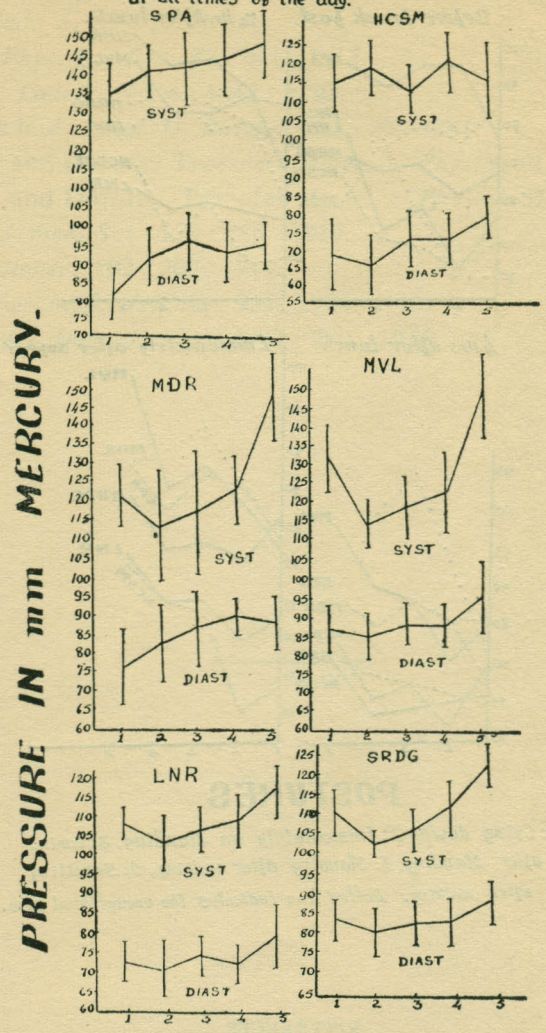


1. LYING DOWN 2. IMMEDIATELY ON STANDING 3. 2 min. AFTER STANDING. 4. STANDING AFTER WALKING. 5. SQUATTING AFTER WALKING

DOTTED LINE INDICATES THE EXCEPTIONAL CASE

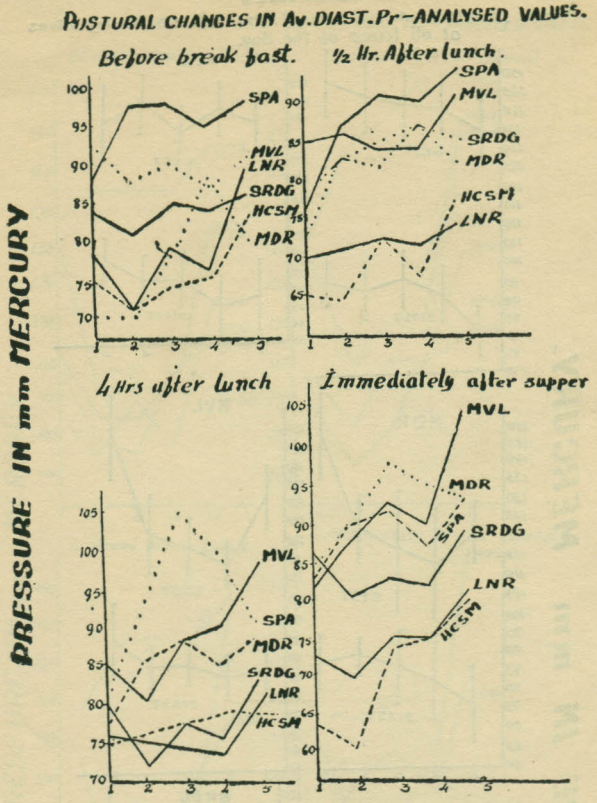
FIGURE 7

Postural changes in Av. Syst. & Diast. Prs with S.D-Pooling values at all times of the day.



1: Lying down, 2: Immediately on standing, 3: 2 min after standing, 4: Standing after walking, 5: Squating after walking, Vertical bars represent S.D.

FIGURE 8



1: Lying down, 2: Immediately on standing, 3: 2 min. after standing, 4: Standing after walking, 5: Squatting after walking. Dotted line indicates the exceptional case.

REFERENCES

1. W.C. Alvarez and L.L. Stanley *Arch. intern. Med.* 46 : 17. 1930.
2. Cotton, Rapport and Lewis *Heart*, 6 : 269. 1917.
3. Erlanger and Hooker *Johns Hopk. Hosp. Rep.* 12 : 145. 1904.
4. Geigel *Deutsch Arch f. Klin Med.* 99 : 31. 1910.
5. Guy *Guy's Hosp. Rep.* 4 : 63. 1839.
6. Hensen *Deutsch Arch f. Klin. Med.* 67 : 436. 1900.

7. A.V. Hill *J. Physiol.* 18 : 15. 1905.
8. Jellinek *Zeitschr, f. Klin. Med.* 39 : 447. 1900.
9. Karrenstein. *Zeitschr, f. Klin. Med.* 1 : 322. 1903.
10. Knox *Edin. Med, J.* 11 : 52, 1815.
11. Meylan *Amer. Phys. Ed. Rev.* 38 : 441. 1913.
12. George Oliver. *Lancet No.* 1 : 1643. 1903.
13. Schapiro Jahres b. d. *Anat. U. Physiol.* 102 : 60, 1881.
14. E.C. Schneider and Dorothy Truesdell *Amer. J. Physiol*, 61 : 429. 1922.
15. E.C. Schneider and Dorothy Truesdell *Amer. J. Physiol.* 67 : 193. 1923.
16. Sewall *Amer. J. med. Sci.* 158 : 786. 1919.
17. Smythe *Practitioner.* 102 : 205. 1919.
18. Stephens *J. Amer. med. Ass.* 43 : 955. 1904.
19. Weysse and Lutz *Amer. J. Physiol.* 37 : 340. 1915.