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Significance of shock index in normotensive & hypertensive individuals

A. N. Badwe* and R. G. Latti

Rural Medical College, Pravara Institute of Medical Sciences, Loni, Tq: Rahata, Dist: Ahmednagar – 413 736 India

QR Code

***Correspondence Info:**
Dr. A. N. Badwe
Associate Professor
Department of Physiology
Rural Medical College Pravara Institute of Medical Sciences, Loni Tq: Rahata, Dist: Ahmednagar – 413 736 India

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Abstract

Objective: To determine SI index in normotensive and hypertensive individual to asses any correlation in hypertensive individuals

Material and Methods: Systolic and diastolic blood pressures were determined in normotensive (n=104) and hypertensive (i.e. treated hypertensive (n=76) and non-treated (n=32)) subjects in supine position. Shock Index (SI) was determined as the ratio of Heart Rate/ Systolic Blood Pressure and normal value was considered in the range of 0.5-0.7.
Recorded data was analyzed between two groups by applying unpaired t- test. The P values less than 0.05 ($P<0.05$) were considered as statistically significant. To find out relationship between blood pressure and shock index in different study groups Pearson correlation coefficient was determined.

Results: Values of shock index were found higher in normotensive as compared to values recorded in treated hypertensive and non-treated hypertensive group. Non treated hypertensive group recorded higher values of shock index than treated hypertensive group.

Conclusions: The accepted value of shock index is generally considered in the range from 0.5 to 0.7.The value in this range indicated hemodynamic stability in the study groups, since SI were not > 0.9 or <0.5 which were considered as an independent predictor in previous studies for the mortality of emergency patients .To consider importance of SI index in hypertensive prospective studies are needed to confirm the result.

Keywords: Shock index, normotensive, treated hypertensive, non treated hypertensive.

1. Introduction

Shock Index (SI) is the ratio of Heart Rate/ Systolic Blood Pressure [1] with normal value considered as 0.5-0.7. Originally it was used to predict shock in medical patients in the Emergency Department, but since then has been evaluated for use in trauma and myocardial infarction. Although it's been around for over 50 years it's doesn't appear to be widely used in guiding clinical care. A value > 0.8-0.9 is associated with worst outcome [2].

SI can be used to predict the severity of hypovolemic shock. Previous studies [3-5] have found that patients with SI more than 0.9 had a greater mortality rate and also found its usefulness as an effective predictor of outcome in postpartum haemorrhage [6].

It is also reported that, SI can be used as prognostic tool for trauma and other emergency cases admitted to emergency department [7].

Severity of trauma patients is determined from considering clinical parameters like heart rate (HR), pulse rate (PR), blood pressure (BP). Similarly the ratio of HR to systolic blood pressure (SBP), the shock index (SI), has been shown to be useful in predicting mortality rates in trauma patients, and may be useful in detecting early acute hypovolemic [8].

From literature survey it is found that, shock index is used mainly to determine severity of hypovolemic shock and mortality in variety of patients as mentioned above.

However it is noted that, patients admitted on emergency basis mostly have higher hear rate & lower blood pressure (HR>90-120 beats/min, systolic BP<90 mmHg, diastolic BP<60 mmHg) [9, 10], and hence have higher values of SI.

There are few studies conducted on utility of shock index in hypertensive patients. Hence in present study, SI index is determined in normotensive any hypertensive individual to asses any correlation in hypertensive individuals.

2. Material and methods

Subjects selected for study were grouped in three categories as normotensive (n=104), treated hypertensive (n=76) and non-treated (n=32) in the age group of 15 – 65 years and above.

2.1. Normotensive

Healthy normotensive subjects without any major signs of cardiac, vascular or neurological involvement, no history of diabetic mellitus, hypertension and no history of drug treatment and systemic illness were included in this group.

Their normal blood pressure status was recorded according to guidelines of, Seventh Report of the Joint National Committee (JNC7) on Prevention, Detection, Evaluation and Treatment of high blood pressure and Indian Hypertension Guidelines II, 2007 with optimal value as <120/<80 mmHg and further variation in systolic blood pressure was considered in the range of 120-139 mmHg. Similarly diastolic blood pressure variation was considered in the range of 80-89 mmHg. These recorded responses will help to understand the variation in these recorded parameters, when compared with treated hypertensive and non-treated hypertensive patients.

2.2. Hypertensive group

Hypertensive patients were divided in to two groups as Treated Hypertensive (THTN) (n=76) and Non Treated Hypertensive (NTHTN) (n=32).

i) Treated Hypertensive (THTN)

These categories of patients were selected on OPD basis, which regularly attended Medicine OPD for their treatment and were considered as treated hypertensive patients. These subjects were under treatment or on blood pressure lowering medication with controlled hypertension (with target blood pressure value 140/90). Their hypertensive status was determined by Medicine department and Family Medicine department. Patients suffering from major illness such as severe diabetic condition, congestive heart failure, coronary artery disease, arrhythmias or other diseases (e.g., renal diabetic neuropathy), or consuming tobacco, alcohol or having BMI >35 Kg/m^2, which may affect autonomic and CVS parameters, were excluded from the study.

Since, the pathophysiology of high blood pressure is unknown in most of the cases (95%) of essential hypertension. In secondary hypertension the exact cause of hypertension can be known.

ii) Non treated hypertensive group (NTHTN)

In this group, hypertension status was newly diagnosed and participants were not aware of their hypertension status. Similarly these subjects were not undergoing any medical treatment at the time of their participation in the study. Their uncontrolled hypertensive status was considered with SBP > 140 to 160 mm Hg and DBP > 90 mmHg. Same exclusion criteria were used to include the hypertensive patients in this group as applied in treated hypertensive group such as patients suffering from diabetes mellitus, congestive cardiac failure, symptomatic coronary artery disease, atrial fibrillation; frequent ectopic beats were excluded from the study.

2.3 Methods

All subjects were called with appointment in the laboratory, 2 hours after light brake fast in the morning (09.00am-12.00pm). Subjects were instructed not to consume caffeinated beverage and to avoid smoking before 12 hours of the test. Subjects were informed in detail about study protocol and written consent was obtained before the study.

Before recording blood pressure, anthropometric characteristics such as height (cm), weight (Kg), body mass index (BMI, Kg/m2), percent fat (%), fat mass (FM, kg), fat free mass (FFM, kg) were recorded in all subjects. Percent fat (%), fat mass (FM, kg), fat free mass (FFM, kg) parameters were determined by method of measurements of girth as described by McArdle *et al* [11].

Subjects were made to lie comfortably on examination table (Reliable Surgicals, Sangamner) for 20 minutes in the supine position. Blood pressure was recorded with digital blood pressure apparatus.

2.4 Statistical Analysis

Recorded data was analyzed for each group by calculating mean and standard deviations (SD). To find any significant change the data was analyzed between two groups by applying unpaired t- test. The P values less than 0.05 (P<0.05) were considered as statistically significant.

To find out relationship between blood pressure and shock index in different study groups Pearson correlation coefficient was determined.

3. Results

Table 1: Anthropometric characteristics in normotensive subjects (n=102)

SN	Age (yrs.)	Height (Cm)	Body weight (kg)	BMI (kg/m^2)	% Fat	Fat mass (kg)	Fat free mass (Kg)
1	15-25	166.81 ± 1.44	53.67 ± 2.01	19.41 ± 0.77	16.00 ± 1.59	9.05 ± 1.07	44.80± 1.45
2	25-35	160.68 ± 2.01	53.54 ± 1.79	20.23 ± 1.79	26.19 ± 0.93	14.36 ± 0.84	39.85 ± 1.18
3	35-45	163.93 ± 1.13	57.15 ± 1.75	21.40 ± 0.55	27.03 ± 0.91	16.46 ± 0.90	41.63± 1.32
4	45-55	162.00 ± 1.71	57.94 ± 2.25	22.39 ± 0.58	29.49 ± 2.14	17.64 ± 2.19	40.49 ± 0.88
4	55-65	155 ± 1.00	56 ± 1.00	24.03 ± 1.43	24.92 ± 0.55	13.70 ± 0.3	41.30 ± 0.30
6	> 65	66.50±0.50	167.50±2.50	62.50±0.50	22.29±0.49	30.92±2.52	19.48±1.59

Values are Mean ± SE.

Table 2: Anthropometric characteristics in treated hypertensive subjects (n=76)

SN	Age (yrs.)	Height (Cm)	Body weight (kg)	BMI (kg/m2)	% Fat	Fat mass (kg)	Fat free mass (Kg)
1	15-25	171±9.00	65.5±15.5	22.03±2.974	22.96±6.78	16.09±8.00	49.41±7.496
2	25-35	169.62±1.77	70.38±1.93	24.50±0.60	33.14±1.69	23.84±1.83	46.57±0.84
3	35-45	169.62±8.1	70.38±8.84	24.50±2.73	33.14±7.77	23.84±8.39	46.57±3.85
4	45-55	165.09±1.66	66.95±2.27	25.27±0.86	33.28±1.07	22.48±1.51	43.4±1.23
4	55-65	162.04±1.12	61.59±2.10	23.43±0.73	30.49±1.30	19.19±1.30	42.26±1.00
6	> 65	158.2±2.267	58.2±7.38	23.32±2.75	29.94±3.37	18.48±4.40	39.8±3.08

Values are Mean ± SE.

Table 3: Anthropometric characteristics in non treated hypertensive subjects (n=32)

SN	Age (yrs.)	Height (Cm)	Body weight (kg)	BMI (kg/m2)	% Fat	Fat mass (kg)	Fat free mass (Kg)
1	15-25	174.5±1.45	84±7.42	27.49±2.01	37.55±2.52	33.47±3.60	52.03±4.10
2	25-35	168±2.65	64.5±2.52	22.88±0.69	29.74±2.79	19.16±2.17	45.33±1.82
3	35-45	62.5±4.70	62.5±4.70	22.42±1.57	30.99±4.04	19.78±3.96	42.71±1.02
4	45-55	161.5±4.33	62.5±1.67	24.03±0.83	28.78±0.76	19.71±1.24	44.30±0.73
4	55-65	161.5±1.00	72.5±5.90	27.60±2.04	39.82±3.93	28.91±4.44	43.59±1.75
6	> 65	162.5±3.93	57±3.33	21.54±0.34	33.22±0.86	18.87±0.62	38.14±2.71

Values are Mean ± SE.

Shock index was calculated as the ratio of heart rate to systolic blood pressure (i.e., HR/SBP) in all study groups. Calculated values of shock index did not vary much from its defined normal range (0.5-0.7) indicating, absence of any kind of risk such as hypovolemic shock, or risk factors involved during emergency (Figure 1, Table 4, 5 and 6).

Table 4: Cardiovascular responses & shock index in various age groups (Normotensive)

SN	Age (yrs.)	SBP (mmHg)	DBP (mmHg)	PP (mmHg)	MAP (mmHg)	HR/MIN	Shock Index (HR/SBP)
1	15-25	121.19±2.30	73.37±1.36	48.33±1.85	89.09±1.72	74.96±2.09	0.623±0.019
2	25-35	115.04 ±4.12	76.79 ± 1.56	41.79 ±1.85	87.39 ±3.12	72.43 ±3.49	0.627±0.021
3	35-45	116.69±4.12	77.31±1.50	43.52±1.52	119.02±27.28	73.10±1.70	0.792±0.183
4	45-55	121.50±3.43	82.25±2.25	39.31±1.82	95.35±2.54	76.19±2.33	0.629±0.015
4	55-65	133.5±1.5	83 ±3	50.5 ±4.5	99.83 ±1.5	78 ±13	0.583±0.091
6	> 65	139.5±0.50	89.5±1.50	50±1.00	106.17±1.17	80±4.00	0.638±0.0541

Values are Mean ± SE

Pressure values are in mmHg. Basal values are before tilt.SBP: systolic blood pressure, DBP: diastolic blood pressure, PP: pulse pressure, MAP: mean arterial blood pressure, HR/MIN: heart rate/min, Shock index (HR/SBP)

Table 5: Cardiovascular responses & shock index in various age groups (treated hypertensive)

SN	Age (yrs.)	SBP (mmHg)	DBP (mmHg)	PP (mmHg)	MAP (mmHg)	HR/MIN	Shock Index (HR/SBP)
1	15-25	127.5±13.5	95±8	32.5±21.5	105.5±0.5	78.5±5.5	0.625±0.023
2	25-35	136.2±4.78	91±5.32	49.6±5.32	106.07±4.90	77.6±6.52	0.515±0.031
3	35-45	141.29±4.04	94.38±3.21	47.5±1.72	107.84±3.93	72.43±3.52	0.464±0.017
4	45-55	139.90±7.70	95.14±3.41	51.19± 3.92	112.63± 3.39	78.52± 3.22	0.441±0.032
4	55-65	146.23±5.13	92.14±2.85	54.18±3.24	110.11±3.43	72.09±3.13	0.415±0.025
6	> 65	150.2±8.36	86.6±2.64	63.6±6.34	107.80±4.36	72±4.72	0.467±0.046

Values are Mean ± SE

Pressure values are in mmHg. Basal values are before tilt.SBP: systolic blood pressure, DBP: diastolic blood pressure, PP: pulse pressure, MAP: mean arterial blood pressure, HR/MIN: heart rate/min, Shock index (HR/SBP)

Table 6: Cardiovascular responses & shock index in various age groups (Non treated hypertensive)

SN	Age (yrs.)	SBP (mmHg)	DBP (mmHg)	PP (mmHg)	MAP (mmHg)	HR/MIN	Shock Index (HR/SBP)
1	15-25	139.33±10.14	91.67±5.70	60.00±5.51	111.00±5.19	86.67±4.26	0.618±0.022
2	25-35	146.25±6.47	86.50±17.65	44.75±6.51	116.42±4.34	75.00±4.02	0.570±0.045
3	35-45	145.80±7.88	97.60±3.56	56.20±8.01	114.33±4.60	67.40±3.50	0.518±0.028
4	45-55	151± 5.85	98± 5.76	53± 3.02	115.67± 5.61	66.67± 5.87	0.420±0.187
4	55-65	162.57±7.32	96.71±4.57	65.86±6.22	118.67±4.81	66.71±3.44	0.505±0.027
6	> 65	165.86±9.12	102.14±4.81	63.71±6.75	123.10±5.77	75.29±4.16	0.479±0.0169

Values are Mean ± SE

Pressure values are in mmHg. Basal values are before tilt.SBP: systolic blood pressure, DBP: diastolic blood pressure, PP: pulse pressure, MAP: mean arterial blood pressure, HR/MIN: heart rate/min, Shock index (HR/SBP)

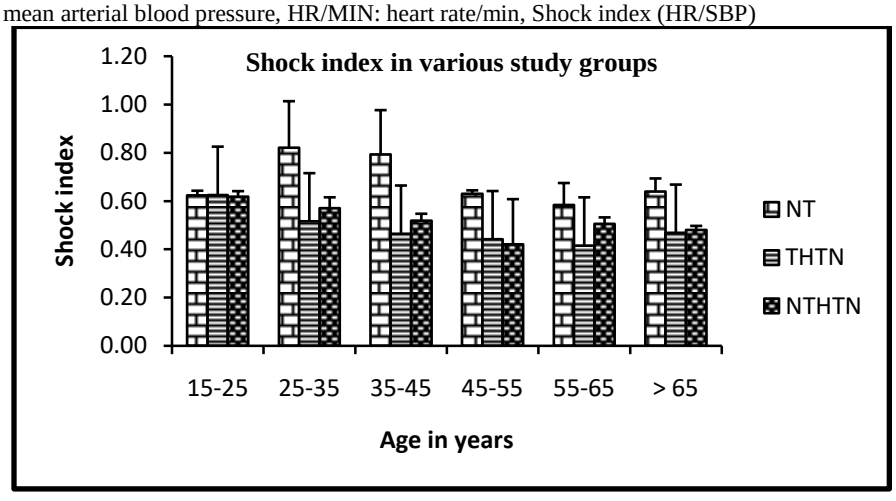

Figure 1: Shock index in various study groups

Values of shock index were found higher in normotensive as compared to values recorded in treated hypertensive and non-treated hypertensive group. Similarly these values were found significantly higher than treated hypertensive age group of 35 45 years (P<0.05) and in same age group of non-treated hypertensive group (P<0.05) (Figure 1, 2, 3 and 4).

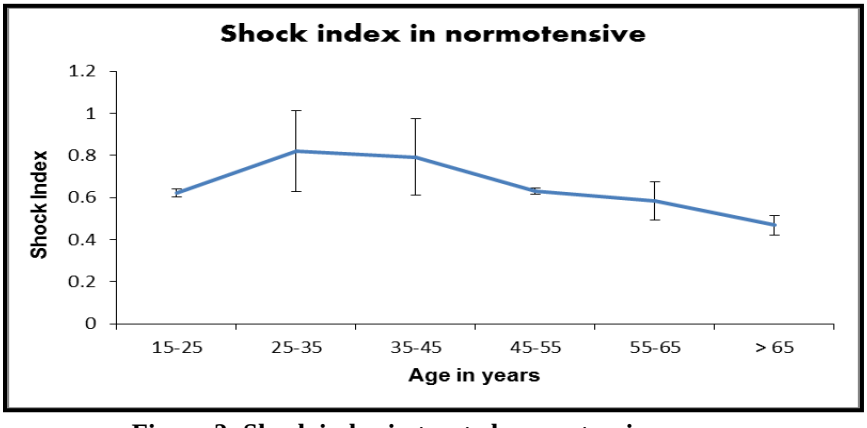

Figure 2: Shock index in treated normotensive group

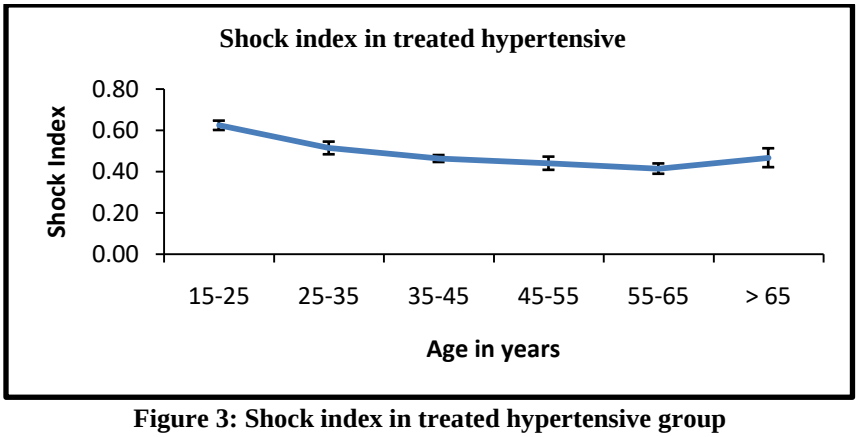

Figure 3: Shock index in treated hypertensive group

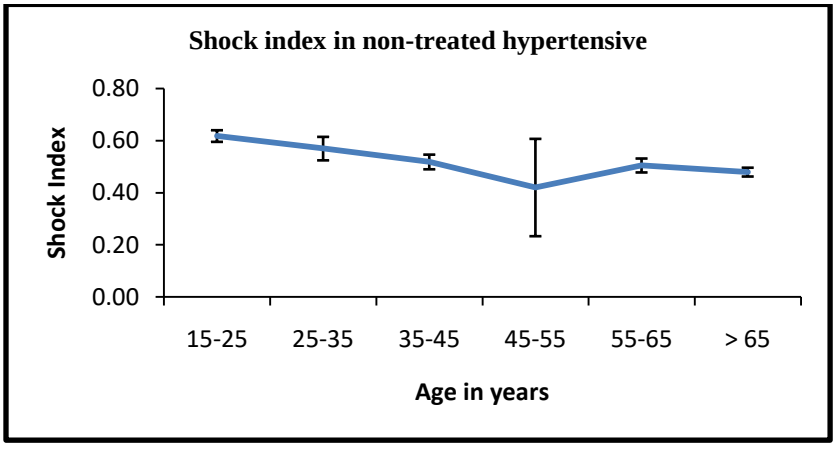

Figure 4: Shock index in non-treated hypertensive group

Non treated hypertensive group recorded higher values of shock index than treated hypertensive group. However these values were found significantly higher in non treated hypertensive age group than treated hypertensive age group of 55-65 years ($P<0.05$).

Correlation coefficient did not indicated any significant relationship between recorded systolic blood pressure and heart rate, since calculated shock index values showed decreasing index values as compared to increase in systolic blood pressure.

4. Discussion

To our knowledge this might be the first study to explore the relationship between shock index, in hypertensive individuals and its clinical outcome.

This study was carried out in hypertensive patients, however vital signs such as SBP<90 mmHg, DBP<60 mmHg, and HR>120 beats/min were not considered to determine shock index, since they are generally used in patients admitted in emergency department.

It is necessary to remember that, low diastolic blood pressure is not indicative of shock or increase in systolic blood pressure does not rule out condition of shock. In most of the studies shock index is determined by considering systolic blood pressure.

The accepted value of shock index is generally considered in the range from 0.5 to 0.7. The value in this range indicated hemodynamic stability in the study group.

Various studies conducted indicated that, shock index is commonly used to assess the amount of blood loss and degree of hypovolemic shock. As reported, shock index in clinical practice is used to assess hypovolemic shock or the severity of non-hypovolemic shock [12,13].

It is reported that, it can be used as clinical predictor in patients suffering from pulmonary embolism rather than in patients who are not in state of shock [14]. This is caused due to hemodynamic instability, which is used as an indicator of clinical severity.

The shock index has been used in some of the emergency departments as clinical severity score for admitted critical patients [15].

From earlier studies conducted, it is noted that, the use of shock index in emergency department cannot be considered as sole parameter to determine clinical severity. The cutoff values determined were found different in studies conducted so far. However the most commonly used shock index value was 0.9 in patients with severe conditions. In our study SI was determined in normotensive and hypertensive subjects, which indicated haemodynamic stability, since SI were not > 0.9 or <0.5 which were considered as an independent predictor in previous studies for the mortality of emergency patients .To consider importance of SI index in hypertensive individuals prospective studies are needed to confirm the result.

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