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RESEARCH ARTICLE

Squatting maneuver - an easy and efficient method to evaluate postural effect on human arterial blood pressure regulation

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ABSTRACT

Background: It is always been never ending process to search for the ideal method for cardiovascular autonomic function tests. However, some considerations of the feasible application of the squatting tests seem justified. Squatting is an active posture test that can be used to assess baroreflex sensitivity. Indeed, the shift from squatting to standing imposes a major orthostatic stress leading to rapid and large changes in arterial blood pressure (BP) and heart rate allowing precise baroreflex assessment.[1] **Aims and Objectives:** The aim of this study is to assess: (1) The frequency of an abnormally large fall in BP on standing from supine and (2) the underlying hemodynamic mechanisms of this fall in BP on standing from supine and from squatting. **Materials and Methods:** Sample size selected was 100 from first year medical students. Basal hemodynamic parameters were recorded in sitting and squatting position, then alteration in these hemodynamic parameters after standing was noted. The mean of three readings of BP obtained, respectively, in each position was considered representative for that position. Statistical analysis is done. **Result:** The change in the position from supine to standing causes a fall in the systolic as well as diastolic BP which was not statistically significant, whereas change in position from squatting to standing, the fall in the systolic and diastolic BP were statistically significant. **Conclusion:** The squatting test is an active posture maneuvers that impose one of the most potent orthostatic stresses. This careful analysis in healthy individuals should help in the understanding of disturbances that may be observed in patients with autonomic dysfunction.

KEY WORDS: Squatting; Posture; Regulation of Blood Pressure

INTRODUCTION

To study the baroreceptor reflex and integrity of autonomic nervous system in man, we have been using number of methods to change the effective filling pressure of heart and the difference in response between the normal and changed filling pressure, especially failing circulation is being noted.[2]

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Filling pressure can be decreased by number of methods such as immediate change in posture from supine to standing, Valsalva maneuver, and venesection. However, to increase the filling pressure is very difficult. Earlier it is found that the children with cyanotic congenital heart disease used to squat when breathless but the reason was less studied. There is sudden and a prompt increase in cardiac output (CO) and arterial blood pressure (BP) due to squatting which is accompanied by an immediate decrease in heart rate (HR) and forearm vascular resistance.[3]

In the general population, about 20% of young subjects frequent complaints of light-headedness or even (near) syncope are reported to occur on standing after squatting[4,5] Thus to prevent syncope, squatting is a potent physical

maneuver, however, a major drawback is that standing up from squatting is a large hemodynamic stressor that often causes new pre-syncopal symptoms.

To perform their morning rituals, people mostly of Indian population are mostly using squatting position. Furthermore, this posture is used for other daily activities such as micturition, bathing, washing, and sitting by most of the people. Complaints of light-headedness and even fainting on active standing are related to a marked transient fall in Arterial BP that also occurs in healthy subjects on active standing.[6-8] Comparable events are observed on arising from sitting[9-12] or squatting[13,14] This initial BP response to the upright position is exclusively associated with active rising.

In most of the previous studies, squatting position has been used to evaluate patients with Tetralogy of Fallot, individuals prone to vasovagal syncope, and heart transplant including diabetic cardiovascular autonomic neuropathy, and also been used as a therapeutic means to counteract the fall in BP in patients suffering from dizziness and orthostatic hypotension or presenting pre-syncope symptoms, such as soon after exercise.[15-19]

However, there have been very few studies using the squatting position as a diagnostic tool to evaluate the effect of this posture on BP regulation. Moreover, almost there are no studies in Indians where this position is used by most of the population frequently.[20-23] Hence, careful analysis of alteration in hemodynamic parameters during the transition from standing to squatting and from squatting to standing helps in the early detection of altered vagal and/or sympathetic function.

The present study has been designed to assess the validity of the observation and to give more stress on including squatting maneuver as one of the important postural methods to investigate the effect of posture on blood posture regulation.

The aims of the present review are to analyze the hemodynamic pattern during a squatting test in various situations and to describe what may be the negative and positive hemodynamic changes associated with this posture. We were, especially, interested in using the squatting test for the assessment of cardiovascular autonomic neuropathy associated with normal subjects.

Lacunae

Orthostatic hemodynamic alterations have been studied in much detail both in normal subjects and in those with autonomic dysfunction with a change in posture from supine to standing. Such a study is expected to clarify or confirm our overall observation regarding IOH onset after squatting as mentioned earlier and may throw some light on a possible triggering factor. Several practice guidelines, including the World Health Organization and the American Heart Association guidelines, recommend that BP should be routinely measured in the sitting or supine followed by the standing position provided that the arm of the patient is placed at the level of the right atrium in each position,[24] in practice, BP is often measured either in a sitting or supine position in a busy clinic or hospital ward.[24,25]

Aims and Objective

The aim of this study is to investigate the clinical value of a new non-invasive method for assessing baroreflex sensitivity using postural change after squatting and to confirm the role of the squatting test in the detection of early sympathetic neuropathy in normal subjects.

MATERIALS AND METHODS

Design

This was a pretest/post-test study.

Sample Selection

The sample size of 100 students between the age group of 18-25 years residing in Kalaburagi district was included in the study. Any subject with a case history of initial orthostatic hypotension or any orthopedic problem or inconvenience for squatting was excluded from the study.

The study was approved by the medical ethical committee of our institution. All the participants were clinically examined to rule out any systemic diseases. After explaining the complete study protocol, the written informed consent was obtained. Investigations took place in the afternoon, at least 1 h after lunch, in a room with a temperature of 37°C. After a 5 min rest on couch in supine position, a basal BP is recorded in the right upper limb in supine position, and subjects were instructed to stand-up immediately and record the BP in standing position immediately and the readings are noted.

Squatting Stress

Then, subjects are asked to squat for 2 min, and at the end of 1 min, BP is recorded in the right upper limb in squatting position and again subjects were asked to stand-up immediately, and BP was recorded in standing position and again difference is noted. To avoid the effect of diurnal variation in BP, readings are recorded at the same time of the day in the same room with same room temperature. To eliminate the effect of age, height and weight of these parameters were considered for statistical analysis.

Statistical Analysis

All variables were checked for normal distribution. When normally distributed changes are expressed as mean and

standard variation, otherwise as median and range. Changes in the hemodynamic variables during the maneuvers were tested by Paired *t*-test. A $P < 0.05$ was consider to indicate a statistically significant difference. For statistical analysis, SPSS software version 17.0 is used. The influence of age, gender, height, and weight on the effects of the maneuvers on hemodynamic variables was analyzed by Pearson's correlation.

RESULT

The findings of the present study are depicted in Tables 1 and 2.

DISCUSSION

The present study has tested the hypothesis that the fall in the hemodynamic parameters, systolic, and diastolic BP is more significant during squatting to standing than supine to standing. As noted in the observation, the change in the position from supine to standing causes a fall in the systolic as well as diastolic BP which was not statistically significant (*P* values for systolic and diastolic BP difference were 0.2033 and 0.9921, respectively), whereas in another postural change that is change in position from squatting to standing, the fall in the systolic and diastolic BP was statistically significant (*P* values for systolic and diastolic BP difference were 0.0213 and 0.002, respectively).

Most of the data published in the literature focused mainly on standing to squatting and have been published. Later on studies done by Sharpey-Schafer and Alimi et al., the possible reason for the large BP fall after standing from a squat may be as follows. The leg and buttock muscles are active and there is a restriction of blood flow due to elevated intramuscular pressure compression of the vasculature during squatting.[26,27] This combination of compression of blood vessels, leading to relative ischemia and active muscle contraction, is likely to result in local vasodilatation of the leg and buttock muscle vasculature. Further by Rossberg and Penaz and Krediet and Wieling added that on standing and loss of compression of the legs, there would be an immediate reduction in leg vascular resistance due to already existing locally mediated vasodilatation.[26-29] Moreover, also supported by studies by Tschakovsky and Sheriff as the muscular effort involved in standing up from a squat position is considerable, it has been demonstrated that rapid vasodilatory mechanisms act in proportion to contraction intensity.[30] This would be expected to cause further vasodilatation. It would therefore be expected that lower limb vasodilatation would be greater in standing up from a squat than from supine or sitting. The combination of the two factors results in a rapid translocation of a large amount of arterial blood from the chest to the distensible venous capacitance system below the diaphragm.

Table 1: Changes in mean values of systolic and diastolic BP from supine to standing

Parameters	Systolic BP	Diastolic BP
Supine	111.9±0.8379	75.98±0.6845
Standing	106.9±0.9521	74.26±0.6852
Difference	5.050±1.268	1.723±0.9685
P value	0.2033	0.9921
Significance	NS	NS

BP: Blood pressure, NS: Non-significant

Table 2: Changes in the mean values of systolic and diastolic BP from squatting to standing

Parameters	Systolic BP	Diastolic BP
Squatting	125.6±1.121	85.35±0.9545
Standing	109.7±0.8893	75.82±0.6986
Difference	15.88±1.431	9.525±1.183
P value	0.0213	0.002
Significance	Significant	Highly significant

BP: Blood pressure

Borst et al., Sprangers et al., Tanaka et al., Wieling et al. suggested that healthy teenagers and young adult subjects using the beat-to-beat measurement of stroke volume with calculation of CO and systemic vascular resistance (SVR) have established that CO actually increases with the onset of standing up, whereas SVR falls markedly.[31-34]

This study confirms the findings suggested by Tschakovsky et al. and Rossberg and Penaz that the fall in BP after arising from squatting is based primarily on a fall in SVR.[35,36] In accordance with the previous studies in healthy young adults, the CO at the moment of the nadir was increased, however, for the large initial fall in BP on standing after supine rest, the hemodynamic mechanism can be either a large fall in CO or in SVR. CO at the moment of the nadir after standing from supine was, in contrast to arising from squatting, tended to be lower. The rapid dilatation in leg muscles on arising from a squatting position can be attributed to the combination of relative ischemia due to compression of blood vessels, active muscle contraction, and elevated lower limb arteriovenous pressure gradient.

Syncopal episodes can be embarrassing, cause injuries, and have a profound impact on the quality of patients' lives. A clear explanation of the underlying mechanism and avoidance of the main trigger (rapid rise) are the principal treatment options. Understanding the pathophysiology provides the rationale for advising patients to rise slowly from supine, especially at night, and possibly sitting at the edge of the bed first. Changing provoking medication regimens that interfere with rapid BP control, such as α-blockers should be considered. Considering the Indian scenario, this research work alerts clinicians and clinician scientists to a common, yet often neglected condition that occurs only on

an active change of posture and discusses its epidemiology, pathophysiology, and management.

CONCLUSIONS

The result of prompt squatting is an increase of the venous return and the arterial resistance. Consequences are increasing of the end-diastolic and systolic chamber pressure, stroke volume, and average arterial BP as well as decreasing of the frequency of the pulse controlled by baroreceptor.

For IOH on standing after supine rest, the hemodynamic mechanism can be either a large fallin CO or in SVR, and for IOH on arising from squatting, a large fall in SVR is a consistent finding.

The BP responses observed after both squatting and standing are thought to be of reflex nature and may be useful to assess the functional integrity of parasympathetic and sympathetic nerves in diabetes.

The intrinsic orthostatic load of the squatting test, which is greater than conventional postural maneuvers, makes the squatting test an easy and useful test to detect early orthostatic dysregulation.

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