Efficacy of isometric exercise full knee extension horizontally (FKEH) - a new and simple maneuver to predict early onset of hypertension

R Pandit, P Roy Chowdhury, T Pramanik, S Singh

Department of Physiology, Nepal Medical College, Jorpati, Kathmandu, Nepal

Corresponding author: Mr. Rajan Pandit, Lecturer, Department of Physiology, Nepal Medical College, Jorpati, Kathmandu, Nepal; e-mail: pandit_rajan@yahoo.com

ABSTRACT
Hypertension is recognized as one of the risk factors for cardiovascular mortality and morbidity. Early identification of persons at increased risk for developing hypertension is a priority, which help them, to live a healthy life by altering lifestyle. Persons having predisposing factors of hypertension (e.g., family history of hypertension) show blood pressure hyper-responsiveness to stress. Elevated blood pressure due to sympathetic stimulation prevailed longer time in susceptible persons. In previous studies some instruments (e.g., hand immersion in cold (4°C) water or isometric exercise by handgrip dynamometer) were required to elicit sympathetic stimulation. In the present study a simple maneuver Full Knee Extension Horizontally (FKEH) has been introduced - a stressor that caused full isometric contraction of quadriceps femoris muscles of both sides. The test was conducted in normotensive, non-smoker males (n=150) of age group 18-25 years. Among them some (n=100) were from families having no history of familial hypertension and others (n=50) were from the families with history of hypertension. The causal blood pressure and heart rate of the participants were recorded. Then the volunteers were requested to perform FKEH maneuver for one minute. Both blood pressure and heart rate were recorded immediately after and 3 minutes following FKEH. The data analyzed using t-test showed that, diastolic blood pressure didn’t return and stabilized to pre-exercise level even after 3 minutes following FKEH in volunteers who were mostly from hypertensive family (P<0.05) i.e., having predisposing factors of hypertension. This indicated those people are prone to early onset of hypertension as their Autonomic Nervous System (ANS) is not competent enough to stabilize their blood pressure to pre-exercise level. Hence, stress in the form of FKEH for one minute may be used as a bedside test to assess the competence of ANS and the proneness of developing early hypertension.

Keywords: Full Knee Extension Horizontally, Isometric exercise, Hypertension

INTRODUCTION
Stress is a condition that disrupts or threatens to disrupt homeostasis. Stress may be physical or mental. Physical stress includes exercise (isometric or isotonic), pain, temperature (too hot or cold) etc. Stress is associated with liberation of glucocorticoids and catecholamines along with other hormones. Cardiovascular reactivity to stress may have a pathological role in neurogenic hypertension. People who are at risk for elevated blood pressure might have exaggerated stress induced cardiovascular responses at a younger age. Hypertension is recognized as one of the risk factor for cardiovascular mortality and morbidity. Hence identification of persons at increased risk for developing hypertension is a priority. Early detection of proneness to hypertension may help an individual to live a healthy life by altering lifestyle (e.g., avoidance of alcoholic drinks, smoking, excessive fatty food intake etc and adoption of the practice of yoga exercise, moderate aerobic exercise, mental relaxation and so on. Once stimulated by stressor, sympathetic system causes rise in heart rate (HR) and blood pressure (BP) but they return and stabilize to normal level within very short period of time after withdrawal of stressor. Elevated BP and HR prevail for longer time in susceptible individual. Naturally, person exhibiting higher cardiovascular reactivity to a stressor and lower rate of recovery after withdrawal of stressor that cause sympathetic stimulation are at high risk for developing early onset of hypertension. Previous studies indicated that sympathetic stimulation caused by stress (e.g., hand immersion in cold (4°C) water, or isometric exercise by handgrip dynamometer) resulted increase in BP which decreased and stabilized to causal BP that prevailed before exercise within few minutes after the completion of exercise. In all those cases some instruments were required to elicit sympathetic stimulation. This inspired us to think whether we can elicit the same without using any instrument. Thus, Full Knee Extension Horizontally (FKEH) a maneuver for isometric exercise was adopted which can evoke sympathetic stimulation for the evaluation of autonomic function and to detect susceptible individual to make them aware so that they can avoid cardiovascular accidents (viz.hypertension) in future by taking proper precautionary measures.
Table-1: Baseline, stress and recovery heart rate and blood pressure in volunteers from hypertensive families

<table>
<thead>
<tr>
<th>Volunteers from hypertensive family</th>
<th>Conditions</th>
<th>HR</th>
<th>SBP</th>
<th>DBP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean±SD</td>
<td>Mean±SD</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>A) n = 35</td>
<td>Baseline</td>
<td>73.17 ± 1.42</td>
<td>115.08 ± 3.15</td>
<td>74.28 ± 2.23</td>
</tr>
<tr>
<td></td>
<td>Immediately after 1 minute</td>
<td>78.14 ± 2.42*</td>
<td>120.80 ± 3.47*</td>
<td>79.60 ± 2.90*</td>
</tr>
<tr>
<td></td>
<td>Recovery</td>
<td>73.40 ± 1.80</td>
<td>115.25 ± 3.53</td>
<td>74.45 ± 2.70</td>
</tr>
<tr>
<td>B) n = 15</td>
<td>Baseline</td>
<td>74.06 ± 1.33</td>
<td>117.46 ± 2.66</td>
<td>75.06 ± 3.45</td>
</tr>
<tr>
<td></td>
<td>Immediately after 1 minute</td>
<td>80.93 ± 2.87*</td>
<td>124.67 ± 3.75*</td>
<td>82.00 ± 3.54*</td>
</tr>
<tr>
<td></td>
<td>Recovery</td>
<td>74.40 ± 1.84</td>
<td>118.0 ± 3.02</td>
<td>80.13 ± 3.06*</td>
</tr>
</tbody>
</table>

*P<0.05, HR= Heart rate, SBP=Systolic blood pressure, DBP=Diastatic blood pressure.

(Fig. 1) Systolic blood pressure was noted at the point where Korotkoff sound became audible and diastatic blood pressure was also noted at the point at which the sound muffled.16,18

Both blood pressure and heart rate were recorded respectively after one minute and three minutes (when the volunteers relaxed their quadriceps as per instruction). During the maneuver, participants were requested to respire normally.

RESULTS

The result has been presented in Table-1 and 2. From the tables it is evident that FKEH maneuver for a minute caused rise of heart rate (HR), systolic blood pressure (SBP) and diastatic blood pressure (DBP). A few volunteers (5%) with no family history of hypertension showed elevated DBP even after 3 minutes following FKEH. On the other hand, more number of volunteers from hypertensive family (30%) showed elevated DBP which did not return to baseline and stabilize following the aforesaid experimental condition, even after 3 minutes (P<0.05).

DISCUSSION

• FKEH (Full Knee Extension Horizontally) was carried out by the young male volunteers (age=22 ±3 yr) only. Age matched females were excluded because during child bearing age, estrogenic effect prevails in them; as well as they have lower autonomic support of arterial BP and lesser effective baroreflex buffering than men.11

• FKEH was done for a minute; BP and HR were measured immediately, then the same parameters were recorded again after 3 minutes FKEH cause withdrawal of vagal tone activation of sympathetic nervous system, release of catecholamines from nerves (norepinephrine) and adrenal gland (norepinephrine, epinephrine). Catecholamines have half life of about 2 minutes in circulation.12

Table-2: Baseline, stress and recovery heart rate and blood pressure in volunteers from normotensive families

<table>
<thead>
<tr>
<th>Volunteers from normotensive family</th>
<th>Conditions</th>
<th>HR</th>
<th>SBP</th>
<th>DBP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean±SD</td>
<td>Mean±SD</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>A) n = 95</td>
<td>Baseline</td>
<td>71.62 ± 2.95</td>
<td>113.81 ± 5.07</td>
<td>72.02 ± 3.08</td>
</tr>
<tr>
<td></td>
<td>Immediately after 1 minute</td>
<td>76.94 ± 3.34*</td>
<td>118.77 ± 4.47*</td>
<td>77.15 ± 2.96*</td>
</tr>
<tr>
<td></td>
<td>Recovery</td>
<td>71.81 ± 3.02</td>
<td>113.87 ± 4.58</td>
<td>72.06 ± 3.06</td>
</tr>
<tr>
<td>B) n = 5</td>
<td>Baseline</td>
<td>74.20 ± 3.03</td>
<td>114.80 ± 2.28</td>
<td>74.00 ± 2.00</td>
</tr>
<tr>
<td></td>
<td>Immediately after 1 minute</td>
<td>80.60 ± 3.58*</td>
<td>120.00 ± 2.80*</td>
<td>80.80 ± 2.28*</td>
</tr>
<tr>
<td></td>
<td>Recovery</td>
<td>74.40 ± 1.81</td>
<td>116.00 ± 3.11</td>
<td>78.40 ± 1.67*</td>
</tr>
</tbody>
</table>

*P<0.05, HR= Heart rate, SBP=Systolic blood pressure, DBP= Diastatic blood pressure.
Thus slight changes in NE beyond its physiological concentration cause rise in BP for 1-3 minutes until it gets destroyed.11 Naturally persons having good autonomic control could bring down and stabilize blood pressure to pre-exercise state quickly (about 3 minutes after the stressor/FKEH for 1 minutes).

- Isometric exercise (FKEH) might cause sympathetic stimulation by two ways -- a pressor reflex originating in contractile muscle.12,13 This reflex originates in sensory receptors which are sensitive to ischemic metabolites generated during muscular contraction. The second mechanism for increased sympathetic outflow is activation of cardiovascular centers by descending central neural pathways involved in the initiation of somatosensory activity.12,13

- Sympathetic activation through baroreflex and the normal sympathetic response may be more rapid and effective than the other mechanisms for increasing HR and force of cardiac contraction.14,15

- A few of the volunteers (5%) with no family history of hypertension showed elevated diastolic blood pressure even after 3 minutes following FKEH. This is in accordance with the observation of Kotchen - "Family studies controlling for a common environment indicate the blood pressure heritability are in the range of 15-35%. In twin studies, heritability estimates of blood pressure are ~ 60% for men and ~ 50% for women."

- Quick stabilization of DBP to the baseline or even below (i.e., within 3 minutes) – indicated competence of ANS at bedside, which in turn can detect slight changes in NE beyond its physiological concentration.

- More number of volunteers from hypertension family (30%) showed elevated diastolic blood pressure even after 3 minutes following FKEH. This is in accordance with the observation of Kotchen - "Family studies controlling for a common environment indicate the blood pressure heritability are in the range of 15-35%. In twin studies, heritability estimates of blood pressure are ~ 60% for men and ~ 50% for women."

- This reflex originates in sensory receptors which are sensitive to ischemic metabolites generated during muscular contraction.

- In the contrary, persistence of diastolic blood pressure at a higher level for discharge to the peripheral blood vessels. On the contrary, persistence of diastolic blood pressure at a higher level for more than 3 minutes might indicate other than the incompetent vascular system resulting in peripheral arteriolar constriction through liberation of more vasoconstrictors from nerves and from adrenal medulla.11 It might also be due to stimulation of muscle chemoreflex which is a potent stimulus for activation of sympathetic nerve activity to increase cardiac output in humans or might be due to less production of nitric oxide from endothelium of blood vessels.11

- A few of the volunteers (5%) with no family history of hypertension showed rise in DBP even after 3 minutes following FKEH, which might be due to gene expression for hypertension. Dysfunctions of Autonomic Nervous System (ANS), less Nitric Oxide release from vascular endothelium or less physical activity in those volunteers. Persons who showed higher cardiovascular reactivity for hypertension, dysfunctions of Autonomic Nervous System (ANS), less Nitric Oxide release from vascular endothelium or less physical activity in those volunteers.

- Results of previous and present study indicated – stress in the form of FKEH for a minute (isometric exercise) might be used as a stressor to stimulate sympathetic nervous system instead of stimulating SNS by using handgrip dynamometer for a minute (isometric exercise) to assess the competence of ANS at bedside, which in turns can detect the young males prone to early onset of hypertension.

REFERENCE


