

Comparison of isometric handgrip test among pregnant offspring of hypertensive parents and pregnant offspring of non-hypertensive parents

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ABSTRACT

Context: A family history of hypertension is one of the important risk factors for the development of pregnancy-induced hypertension (PIH). Offspring of hypertensive parents should be screened for PIH. The isometric handgrip (IHG) test is used to assess autonomic function among them. Autonomic function dysregulation can indicate their predisposition to develop PIH later in the course of pregnancy. **Aim and Objectives:** To compare the IHG among pregnant offspring of hypertensive parents (Group 1) and non-hypertensive parents (Group 2). **Methods and Materials:** This is a cross-sectional study done among 100 pregnant women in the second trimester (50 participants in each group). Blood pressure responses to sustained hand grip for 2 minutes of maximum voluntary contraction (MVC) were recorded, immediately at the end of the IHG test and after 5 minutes of the IHG test. **Statistical Analysis:** Independent *t*-test and Mann–Whitney *U* test were used to compare the responses in two groups. **Results:** There is no statistical difference in basal blood pressure and heart rate between the two groups. Group 1 exhibited a significant increase in systolic blood pressure (SBP) and diastolic blood pressure (DBP) compared to Group 2 immediately after 2 minutes of the IHG test. There is a significant increase in SBP after 5 minutes of the IHG in Group 2. **Conclusions:** Offspring of hypertensive parents have increased sympathetic reactivity and restoration of the blood pressure is significantly less compared to offspring of normotensive parents, which may predispose them for PIH. IHG can be applied as a convenient tool to screen the population who are at risk of PIH in places like primary health centres or field screenings where IHG is one possible option.

Keywords: Family history of hypertension, isometric handgrip test, pregnancy-induced hypertension, screening

Introduction

Pregnancy-induced hypertension (PIH), which includes gestational hypertension, pre-eclampsia, and eclampsia is one of the major

causes of fetal and maternal mortalities. It affects 6–10% of all pregnancies. PIH is defined as, in previously normotensive and non-proteinuric women, blood pressure of $\geq 140/90$ mmHg after a gestational age of 20 weeks with/without proteinuria measured at two different times 6 hours apart. Multiple fetuses, renal disorders, diabetes, pre-existing vascular disorders, and placental abnormalities are some of the causes of PIH.^[1]

A family history of hypertension is a risk factor for developing hypertensive disorders later in life. The prevalence of

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Received: 02-01-2024

Revised: 18-03-2024

Accepted: 25-03-2024

Published: 26-07-2024

Access this article online

Quick Response Code:



Website:
<http://journals.lww.com/JFMPC>

DOI:
10.4103/jfmprc.jfmprc_5_24

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How to cite this article: Shankari CS, Raju A, Vadakaluru U, Niveatha S. Comparison of isometric handgrip test among pregnant offspring of hypertensive parents and pregnant offspring of non-hypertensive parents. *J Family Med Prim Care* 2024;13:3190-4.

hypertension was twice more in the offspring of hypertensive parents compared to normotensive parents. This risk also increases if both parents are hypertensive compared to single-parent hypertension.^[2] The chances of developing PIH are five times higher if the woman has a family history of PIH.^[3] Studies have reported that in normal pregnancy, there is an increase in the sympathetic nervous system activity from 6 weeks of gestation and remains elevated till 6 weeks postpartum compared to non-pregnant women.^[4] It was observed that the offspring of hypertensive parents tend to have a higher sympathetic drive and a compromised vagal tone compared to those of non-hypertensive parents. This may put the pregnant offspring of hypertensive parents at a higher risk of developing PIH. This may be attributed to genetic factors, which also play an essential role in contributing to the physiologic predisposition of PIH.^[2,5]

PIH could cause various complications in pregnancy, as it hinders blood flow to various organs of the mother, it causes damage to various organs, kidney damage is more common, and it also affects the intra-uterine growth of the baby. In PIH, a woman was 1.14 times more likely to have a caesarean delivery.^[6] PIH is usually detected in 20 weeks of pregnancy. The factors currently used for diagnosis are mainly hypertension and proteinuria. This can be detected only after the manifestation of the condition. Early detection of PIH is very crucial for preventing the complications caused by it, for which stress tests that could elicit dysfunctional responses may be used as a screening tool.

The isometric handgrip test (IHG) is a non-invasive test that provides pressor stimuli to the cardiovascular system through efferent sympathetic pathways, with a resultant increase in the heart rate and blood pressure. Performing this test can help in analysing the function of autonomic nervous system impairment, which could cause the risk of developing PIH. The IHG has a sensitivity of 81% and specificity of 96.5% to predict gestational hypertension.^[7]

The study aims to compare blood pressure response to isometric handgrip in pregnant offspring of hypertensive parents and pregnant offspring of non-hypertensive parents.

Subjects and Methods

This study protocol was approved by the Institutional Human Ethics Committee. All the participants were provided with participant information and the procedure of the IHG test was well explained and informed consent was obtained from all the participants for their voluntary participation.

This is a cross-sectional study done among 100 pregnant women in the second trimester, among which 50 participants were the offspring of hypertensive parents and the other 50 participants were offspring of non-hypertensive parents. The sample size was calculated using open Epi software based on the mean differences in the diastolic blood pressure (DBP) between offspring of

hypertensive and non-hypertensive subjects in a previous study^[8] with an allowable error of 10% was taken at 95% confidence interval and power 80%.

Healthy pregnant women in the second trimester (13–24 weeks of gestation) attending Out Patient Department (OPD) for regular consultations were enrolled on the study. Participants with a previous history of hypertension, diabetes, thyroid disorders, multiple pregnancies, and renal diseases were excluded.

The participants were made to rest in a sitting position for 10 minutes to record the baseline blood pressure, using a sphygmomanometer in a sitting position in the non-dominant hand, then they performed an IHG test using the handgrip dynamometer with their dominant hand in which they were instructed to press handgrip dynamometer with maximum effort for three seconds. Two or three trials were given with two minutes of rest in between and the value of maximum voluntary contraction (MVC) was noted. 30% of MVC was calculated and the subject maintained sustained hand grip for 2 minutes at the above-calculated value. The blood pressure was recorded immediately after the IHG test before releasing the hand dynamometer and at the end of 5 minutes after releasing the dynamometer.^[9]

The blood pressure response immediately after the IHG test was calculated by the difference in immediate blood pressure value to the basal blood pressure value which is represented as $\Delta\text{SBP}_{\text{imm}}$ and $\Delta\text{DBP}_{\text{imm}}$.

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) software. The data normality was assessed using the Kolmogorov–Smirnov test. All normally distributed data are represented using mean and standard deviations, and the independent *t*-test was used to compare the two groups. All skewed data are represented as median and interquartile range (IQR) values and the Mann–Whitney *U* test was used to compare the two groups.

Results

Characteristics of the study participants are represented in Table 1. The two study groups did not differ significantly by age and period of gestation. The mean value of MVC performed by the offspring of hypertensive parents is less than the MVC value of the offspring of normotensive parents but this difference is not statistically significant.

The basal blood pressure of the participant is shown in Table 2. There is no statistical difference in the mean values of basal systolic blood pressure (SBP), DBP, and heart rate between the two groups.

The blood pressure response immediately, after the IHG test was calculated by the difference in immediate blood pressure value to the basal blood pressure value, which is represented in Table 3, as $\Delta\text{SBP}_{\text{imm}}$ (mmHg) and $\Delta\text{DBP}_{\text{imm}}$ (mmHg).

Immediately, at the end of 2 minutes of the IHG test, the offspring of hypertensive parents exhibited a statistically significant increase in the SBP and DBP than the offspring of normotensive parents.

Blood pressure response at 5 minutes, after the IHG test was calculated by the difference in 5 minutes blood pressure value to the basal blood pressure value, which is expressed in median (IQR) value and is represented in Table 4. as Δ SBP5 min (mmHg) and Δ DBP5 min (mmHg).

In the offspring of a hypertensive parent the Δ SBP5 min (mmHg) is significantly more than in the offspring of a normotensive parent at 5 minutes after the IHG test. In the offspring of a hypertensive parent the Δ DBP5 min (mmHg) is more than in the offspring of a normotensive parent at 5 minutes after the IHG test but this change is not statistically significant.

Discussion

The normotensive pregnant offspring of hypertensive parents and normotensive pregnant offspring of non-hypertensive parents who are in their second trimester were compared in this study. PIH is associated with autonomic dysfunction, parameters like age, gestational age, obstetrics score and MVC are likely to

alter autonomic function and these parameters are not statistically different in the two groups in this study.

There was no significant difference observed between the two groups in terms of basal SBP, DBP, and heart rate. In a study by Greaney *et al.*,^[2] non-pregnant young women with a family history of hypertension observed no significant difference in the blood pressure at resting condition when compared with young women without a family history of hypertension. A study by Garg *et al.* reported that the non-pregnant offspring of the hypertensive parent have higher basal SBP and DBP compared to the offspring of normotensive parents as there is increased sympathetic activity as well as increased blood vessel responsiveness to the circulating vasoactive agents in the former group.^[4,10] similarly Piccirillo *et al.*^[11] showed increased DBP, such changes were not observed in our study between the pregnant offspring of both hypertensive and normotensive parents. This may be due to the physiological adaptations in blood pressure during pregnancy or other corrective mechanisms like the baroreceptor reflex that regulates the blood pressure response to increased sympathetic activity or pressor substances, which did not show any difference in blood pressure at their basal resting condition.

The IHG test, by providing pressor stimuli elicits a physiological increase in blood pressure, heart rate, and cardiac output.

Table 1: Characteristics of the participants

Parameters	Offspring of hypertensive parents (n=50) Mean±SD	Offspring of normotensive parents (n=50) Mean±SD	P independent t-test
Age (years)	26.00±4.2	26.08±4.1	0.924
Period of gestation (weeks)	20.5±3.3	20.9±3.8	0.597
Maximum voluntary contraction (MVC) in kg	20.10±4.2	22.4±7.7	0.069
Frequency distribution of obstetrics scores			
Primigravida (%)	48	54	-
Multigravida (%)	52	46	-

Table 2: Basal Blood pressure of the participants

Parameter	Offspring of hypertensive parents (n=50) Mean±SD	Offspring of normotensive parents (n=50) Mean±SD	P independent t-test
Basal systolic BP (mmHg)	98.66±12.43	102.88±10.2	0.065
Basal diastolic BP (mmHg)	68.6±8.9	69.7±6.9	0.469
Basal heart rate (beats per minute)	96.46±11.90	95.94±11.84	0.8271

Table 3: Blood pressure response immediately at the end of 2 min of the isometric handgrip test

Change in blood pressure	Offspring of hypertensive parents (n=50) Median (IQR)	Offspring of normotensive parents (n=50) Median (IQR)	P (Mann-Whitney U test)
Δ SBP _{imm} (mmHg)	7.5 (3-10.0)	3 (-0.25-8)	0.001*
Δ DBP _{imm} (mmHg)	6.5 (4-9)	5 (1-8)	0.037*

Table 4: Blood pressure response at 5 minutes, after the isometric handgrip test

Change in blood pressure	Offspring of hypertensive parents (n=50) Median (IQR)	Offspring of normotensive parents (n=50) Median (IQR)	P (Mann-Whitney U test)
Δ SBP _{5 min} (mmHg)	2 (-0.25-5.25)	-2 (-6.0-1.0)	<0.001**
Δ DBP _{5 min} (mmHg)	2 (0-5)	1.5 (-3-5)	0.141

Clinically, it is used as a tool to predict PIH later during gestation.^[7] In this study, we observed a significant increase in the SBP and DBP in the offspring of hypertensive parents when compared to the offspring of normotensive parents immediately at the end of 2 minutes of IHG with 30% of MVC. A study by Degani *et al.*^[7] reported an increase in DBP in response to the IHG test with a PIH predictive sensitivity of 81% and specificity of 96.5%.

In a pilot study, it was observed to have increased DBP after IHG among pregnant women with a positive family history of hypertension.^[8] An increase in DBP in women with a history of PIH was reported by Stickford *et al.*^[12] Contrary to the above discussion Ranadive *et al.* reported no difference in response to IHG in women with a history of PIH and normal pregnancy.^[13] Greaney *et al.*^[2] demonstrated greater increases in mean arterial pressure in young women with a family history of hypertension.

It was postulated that during IHG exercise, physiological changes occur to maintain blood flow to contracting muscles by reflex response like metaboreflex where contracting muscle produces metabolites like lactic acid, H⁺ ions, and adenosine and these products stimulate the afferent nerve which produces reflex increased sympathetic discharge thus producing vasoconstriction and increase in blood pressure. Apart from this, when the muscle contracts, increased muscle tension causes stimulation of mechanoreceptors, which recruit new motor units and thus increase the central Nervous system (CNS) excitatory state, which will also increase the sympathetic outflow. Thus mechanoreflex and metaboreflex increase the perfusion pressure to maintain the blood flow to the exercising muscle. During IHG exercise, along with the increase in peripheral resistance, there is also an increase in cardiac output, which may be attributed to increased heart rate by conscious effort during exercise activating centres in the brain stem.^[4,14] In our study, the offspring of hypertensive parents have a significant increase in blood pressure response to the IHG stress test indicating that they are having increased sympathetic reactivity compared to offspring of normotensive parents which may predispose them to PIH.

BP returns to basal value within 5 minutes after the stoppage of exercise in normal individuals. In our study of offspring of hypertensive parents, restoration of the blood pressure is significantly less compared to that of offspring of normotensive parents. This may be because of a greater sympathetic response to physical stress by various mechanisms like an increase in the sympathetic nerve activity contributing to increased neurotransmitters like norepinephrine, neuropeptide Y, greater reactivity of blood vessels due to increase in alpha 1 receptor sensitivity and an increase in beta 2 adrenergic sensitivity causing increased total peripheral resistance and reduced baroreceptor inhibition. It is also observed that there is a dysfunctional endothelium-dependent vasodilatory capacity where factors like prostacyclin and nitric oxide are not able to sufficiently oppose the vasoconstrictive effects in hypertensive offspring compared to the normotensive offspring all these suggest a possible

mechanism of future hypertension in them when exposed to stress.^[14]

Limitations

This is a cross-sectional study so causality cannot be determined and follow-up of these subjects needs to be done to assess the proportion of subjects who have developed PIH later in the course of pregnancy, which will be the future scope of this current study.

Conclusion

Pregnancy is a state of physiological stress, and the cardiovascular adaptation during pregnancy in the offspring of hypertensive parents decreases, indicating that they may be at risk for developing PIH, thus mandating preventive strategies. Though IHG is considered an outdated method to assess autonomic function, it can be still applied as a convenient tool to screen the population who are at risk of PIH. IHG is one possible option for screening PIH in places like primary health centres or field screening, where sophisticated equipment and other techniques may not be available.

Key message

The IHG test can be used as a tool to screen the population who are at risk of developing PIH.

Acknowledgement

We thank Dr. Ramya Arunprasath for her support and help in recruiting study participants.

Financial support and sponsorship

ICMR-Short-Term Studentship (STS) 2022 funded project.

Conflicts of interest

There are no conflicts of interest.

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