

Does Standing Up Improve the Predictive Value of the Supine Pressor Test for Gestational Hypertension?

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Fifty-six primigravid women at 28–32 weeks' gestation were studied prospectively to compare the roll-over test with the stand-up pressor test in the prediction of gestational hypertension. Blood pressures were measured in the different positions continuously using an automated machine. Twenty patients developed gestational hypertension; two of these were accurately predicted by roll-over test and six by stand-up pressor test ($P < .001$). However, there was no significant difference between the tests in the rates of false negatives, specificity, and negative and positive predictive values. Concomitant measurement of blood pressures in the standing position may increase the sensitivity of the roll-over test for the prediction of gestational hypertension. (*Obstet Gynecol* 76:332, 1990)

The supine pressor or roll-over test is currently considered a useful clinical test for the prediction of gestational hypertension. The test was first described by Gant et al¹ in 1974. They observed that many nulliparous women who were sensitive to angiotensin II and destined to develop gestational hypertension also demonstrated an increase in diastolic blood pressure of 20 mmHg or more when they turned from the lateral to the supine position.

The test has been evaluated in various populations of women and its sensitivity for the prediction of gestational hypertension is reported to range between 14–94%,^{1–7} with a false-negative rate of between 2–3%. One issue that has dominated recent discussion on the subject is how to improve the sensitivity of the test in order to minimize the proportion of false-negative results. It has been suggested that sensitivity can be improved by repeating the test beyond 32 weeks' gesta-

tion in patients with negative test results or by lowering the critical diastolic pressure,⁵ but these methods have not been subjected to empirical experimentation.

The mechanism that produces the hypertensive vascular response in the supine position is largely unknown, but the suggested theories include a baroreceptor-mediated reflex response¹ and activation of the renin-angiotensin system.⁷ Gant et al¹ first demonstrated that a large proportion of women who showed increased vascular reactivity when infused with angiotensin II later developed gestational hypertension, and that this event was related to a positive roll-over test. Because the effect was dose-related, it is possible that any clinical situation that leads to greater endogenous release of vasoactive substances could produce enhanced blood pressure response in marginally susceptible patients. The erect posture is known to trigger the release of various vasoactive substances including noradrenaline, adrenaline, and angiotensin II because of the need to maintain adequate venous return to the heart. In addition, the concomitant presence of the supine hypotension syndrome could compromise the degree of blood pressure elevation that occurs in the supine position. Thus, we hypothesized that in performing the supine pressor test, movement of susceptible patients to the standing position would produce greater blood pressure elevation than movement to the supine position, with a resultant increase in the sensitivity of the test. The aim of this study was to test this hypothesis by comparing the sensitivity of the supine pressor test with that of the stand-up test in the prediction of gestational hypertension.

Materials and Methods

In this prospective study, 56 primigravid women were studied at Obafemi Awolowo University Hospital, Nigeria. The study group consisted of women attend-

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ing the prenatal clinic of the hospital; every consecutive woman who agreed to participate in the fully explained protocol was included. We excluded those with a previous history or evidence of hypertension, diabetes, renal disease, or seizure disorders. The women were seen regularly in the prenatal clinic according to our usual protocol.

Between 28–32 weeks' gestation, all the women underwent supine pressor and stand-up pressor testing in addition to the usual prenatal examinations and urine analysis. All other parameters were within normal limits. Blood pressure was monitored continuously over the brachial artery using Datascope Accutorr I equipment (Datascope Corp., Paramus, NJ). The device provided a simultaneous "on line" printout of the systolic blood pressure, diastolic blood pressure, and heart rate every minute. The Datascope Accutorr system is a versatile instrument designed for research purposes and clinical studies. Because of its popularity around the world, we assumed it to be reliable equipment.

Before performing the tests, we divided the patients into two groups. Those with even hospital numbers were first placed in the left lateral recumbent position and blood pressures were recorded every minute for 15 minutes. When the blood pressure became stable, the patients were rolled into the supine position and blood pressure was recorded every minute for 5 minutes in that position. They were then returned to the left lateral recumbent position and blood pressures were recorded for another 15 minutes to ensure return to baseline levels before the patients stood up. Next, blood pressures were recorded every minute in the standing position for 10 minutes. For the second group of patients with odd hospital numbers, the order of blood pressure measurements was left lateral recumbent, 15 minutes; standing, 10 minutes; left lateral recumbent, 15 minutes; and supine, 5 minutes. The mean diastolic blood pressure was calculated by averaging the 1-minute blood pressure measurements obtained for each of the different positions. The tests were considered positive if there was an increase of 20 mmHg or greater in the mean diastolic blood pressure from the left lateral to either the supine or erect position. If the change in the mean diastolic blood

pressure between the positions was less than 20 mmHg, the tests were recorded as negative.

The women were followed throughout pregnancy, labor, delivery, and the postpartum period. Those developing gestational hypertension were detected according to the criteria of the Committee on Terminology of The American College of Obstetricians and Gynecologists.⁸ This Committee defines hypertension as "a diastolic blood pressure of at least 90 mmHg or systolic pressure of at least 140 mmHg or a rise in the former of at least 15 mmHg or the latter of at least 30 mmHg manifest on at least two occasions 6 hours or more apart."

The sensitivities, predictive values, and false-negative rates for the prediction of gestational hypertension by the two tests were determined and were compared using χ^2 test with Yates correction.

Results

The roll-over test and stand-up pressor test were performed simultaneously in 56 primigravidas between 28–32 weeks' gestation. The women were aged between 17–35 years (mean 21.5; median 21.0). The roll-over test was negative in 54 patients (96.4%) and positive in two (3.6%). In contrast, the stand-up pressor test was negative in 50 patients (89.3%) and positive in six (10.7%). These differences were not significant ($\chi^2 = 3.3$, $df = 1$; $P > .05$). The tests were not concomitantly positive in any of the patients.

Tables 1 and 2 illustrate the range and mean differences of the diastolic blood pressures in the lateral, supine, and standing positions for both the negative and positive tests in the patients. The blood pressure ranges were similar in the supine and standing positions, and the mean blood pressure differentials from left lateral recumbency did not differ remarkably between these positions.

Tables 3 and 4 illustrate the clinical outcomes of the patients. Twenty of the 56 patients (35.7%) developed gestational hypertension. These included the two patients with a positive roll-over test and the six with a positive stand-up pressor test, giving sensitivities of 10.0 and 30.0%, respectively, for the roll-over test and stand-up pressor test in the prediction of gestational

Table 1. Diastolic Blood Pressure in Patients With Negative and Positive Roll-Over Tests

	BP in left lateral position (mmHg)		BP in supine position (mmHg)		Mean difference (mmHg)
	Range	Mean (SEM)	Range	Mean (SEM)	
Negative ROT (54)	41.6–76.7	55.1 (6.5)	48.4–86.4	64.2 (6.4)	9.1
Positive ROT (2)	49.6–60.4	55.0 (5.4)	80.5–83.0	81.8 (1.2)	26.8

BP = blood pressure; ROT = roll-over test.

Table 2. Diastolic Blood Pressure in Patients With Negative and Positive Stand-Up Pressor Tests

d	BP in left lateral position (mmHg)*		BP in stand-up position (mmHg)		Mean difference (mmHg)
	Range	Mean (SEM)	Range	Mean (SEM)	
Negative SPT (50)	42.9–78.0	55.3 (6.2)	55.3–85.1	65.5 (3.8)	10.2
Positive SPT (6)	42.0–62.4	51.9 (5.8)	64.2–84.7	72.7 (3.5)	20.8

BP = blood pressure; SPT = stand-up pressor test.

* After the roll-over tests, the patients were returned to the left lateral position and a second set of blood pressure readings was taken in this position.

hypertension. This difference was significant ($P < .001$). Of the 54 patients with a negative roll-over test, 36 (66.7%) remained normotensive throughout their prenatal course, labor, delivery, and postpartum recovery (predictive value of negative test), whereas 18 patients (33.3%) developed gestational hypertension (false negatives). In contrast, 36 of the 50 patients with a negative stand-up pressor test (72.0%) remained normotensive and 14 of them (28.0%) developed gestational hypertension. There was no difference in the predictive value of negative tests and false negatives between the roll-over and stand-up pressor tests ($P > .5$). Both tests had high specificities (100.0%) for the prediction of gestational hypertension because all the 36 normal women were individually predicted by both the roll-over and stand-up pressor tests.

Discussion

The incidence of a positive roll-over test in this study was 3.6%, not significantly different from the 10.7% positivity recorded for the stand-up pressor test. Western authors have generally reported higher positive roll-over test results, often in the range of 24–45%.^{2,7,9} In contrast, authors from the Indian subcontinent^{6,10} have recorded much lower incidences, and our present data are the lowest so far reported. It is possible that a racial factor may be important because Karbhari et al,¹¹ working with 41% black primigravidas and 20% Hispanics, recorded only 16% positivity for the roll-over test in the United States.

It is of interest that none of the patients had both tests positive at the same time. This suggests that the

tests may be mediated by different mechanisms. Although a reflex increase in blood pressure,⁷ the renin-angiotensin system,¹ and prostaglandins¹² have been used to explain the roll-over test, it is possible that the concomitant presence of the supine hypotension syndrome may modulate results that are obtained in the supine position. All the women with a positive stand-up pressor test and the two with a positive roll-over test developed gestational hypertension, giving a prediction rate of 100% for each of the tests. The reported prediction rates of a positive roll-over test for gestational hypertension have ranged between 7–94%,^{1,3,11} and the rate in this study is the highest so far reported. This may be due to the low rate of positivity of both tests in these women or to our use of automated blood pressure monitoring, whereby observer errors are eliminated.

Similarly, specificity (ie, the ability of the tests to predict the absence of gestational hypertension) was high for both tests because the 36 normal women were accurately identified by both tests. However, the rate of false negativity (33.3%) was particularly high for the roll-over test and was in the range reported by Anderson¹³ and Kuntz⁹ for white women. This rate was not decreased appreciably by changing to the standing position, suggesting that the stand-up pressor test does not decrease the rate of false negatives. This finding indicates that in clinical practice, the stand-up pressor test cannot at present be recom-

Table 3. Correlation of Positive and Negative Tests With Clinical Outcome

	Normal	Gestational hypertension	Total
Positive ROT	0	2	2
Negative ROT	36	18	54
Positive SPT	0	6	6
Negative SPT	36	14	50

ROT = roll-over test; SPT = stand-up pressor test.

Table 4. Comparison of Predictability of Gestational Hypertension Using Roll-Over Test and Stand-Up Pressor Test

	ROT	SPT	P (χ^2 test)
Sensitivity	10.0	30.0	<.001
Specificity	100.0	100.0	NS
Predictive value of positive test	100.0	100.0	NS
Predictive value of negative test	66.7	72	>.5
False negatives	33.3	28	>.5

ROT = roll-over test; SPT = stand-up pressor test; NS = not significant.

Data are presented as percentages.

mended as a replacement for the roll-over test as a screening procedure for gestational hypertension. However, it may imply that there are patients who develop gestational hypertension without the preceding phase of enhanced arteriolar hypersensitivity or who demonstrate hypersensitivity very close to the time of actual development of gestational hypertension. If this were so, a repeat test during the pregnancy should detect more cases with positive test results and thereby decrease the rate of false negatives. This issue is the subject of ongoing research.

The sensitivities of the tests for the prediction of gestational hypertension were low because only 10 and 30% of the women with the condition were predicted by the roll-over test and the stand-up pressor test, respectively. However, it is of interest that the stand-up pressor test achieved significantly higher sensitivity than the roll-over test. This may be due to elimination of the supine hypotensive effect that occurs in the standing position. Indeed, from this study it is obvious that when both tests are used together, one achieves an even higher sensitivity for the prediction of gestational hypertension in primigravid women. In addition, it is possible that sensitivity can be increased by reducing the critical diastolic blood pressure to 15 mmHg, because several patients who had a diastolic blood pressure increase in the range of 15–20 mmHg actually developed gestational hypertension.

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