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 al. 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%, 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' gestation in patients with negative test results or by lowering the critical diastolic pressure, 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 response and activation of the renin-angiotensin system. Gant et al. 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-
ing the prenatal clinic of the hospital; every consecu-
tive 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 test-
ing in addition to the usual prenatal examinations and
urine analysis. All other parameters were within nor-
mal limits. Blood pressure was monitored continu-
ously over the brachial artery using Dataspire Accu-
torr I equipment (Dataspire 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 Dataspire 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 equip-
ment.

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 recum-
bent, 15 minutes; standing, 10 minutes; left lateral
reclined, 15 minutes; and supine, 5 minutes. The mean
diastolic blood pressure was calculated by aver-
aging the 1-minute blood pressure measurements ob-
tained 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 Ter-
minology of The American College of Obstetricians
and Gynecologists. This Committee defines hyperten-
sion as "a diastolic blood pressure of at least 90 mmHg
or systolic blood 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 hyper-
tension by the two tests were determined and were
compared using \( \chi^2 \) test with Yates correction.

**Results**

The roll-over test and stand-up pressor test were
performed simultaneously in 56 primigravidas be-
tween 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 pres-
sor test was negative in 50 patients (89.3%) and posi-
tive in six (10.7%). These differences were not signifi-
cant \( (\chi^2 = 3.3, df = 1; P > .05) \). The tests were not
concomitantly positive in any of the patients.

Tables 1 and 2 illustrate the range and mean differ-
ences 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 posi-
tions, and the mean blood pressure differentials from
left lateral recumbency did not differ remarkably be-
 tween 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 pa-
teins 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>
<thead>
<tr>
<th>Table 1. Diastolic Blood Pressure in Patients With Negative and Positive Roll-Over Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BP in left lateral position (mmHg)</strong></td>
</tr>
<tr>
<td><strong>Range</strong></td>
</tr>
<tr>
<td>Negative ROT (54)</td>
</tr>
<tr>
<td>Positive ROT (2)</td>
</tr>
</tbody>
</table>

\( BP = \) blood pressure; ROT = roll-over test.
Table 2. Diastolic Blood Pressure in Patients With Negative and Positive Stand-Up Pressor Tests

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

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.

hypothesis. 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 30 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 subcontinent6,10 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 Anderson15 and Kuntz16 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

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Gestational hypertension</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive ROT</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Negative ROT</td>
<td>36</td>
<td>18</td>
<td>54</td>
</tr>
<tr>
<td>Positive SPT</td>
<td>0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Negative SPT</td>
<td>36</td>
<td>14</td>
<td>50</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>ROT</th>
<th>SPT</th>
<th>$P$ ($\chi^2$ test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>10.0</td>
<td>30.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Specificity</td>
<td>100.0</td>
<td>100.0</td>
<td>NS</td>
</tr>
<tr>
<td>Predictive value of positive test</td>
<td>100.0</td>
<td>100.0</td>
<td>NS</td>
</tr>
<tr>
<td>Predictive value of negative test</td>
<td>66.7</td>
<td>72</td>
<td>&gt;.5</td>
</tr>
<tr>
<td>False negatives</td>
<td>33.3</td>
<td>28</td>
<td>&gt;.5</td>
</tr>
</tbody>
</table>

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.

References


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