Clinical and Hemodynamic Assessment of the Hepatojugular Reflex

Randall A. Sochowski, MD, James D. Dubbin, MD, and Salim Z. Naqvi, MD

The hepatojugular reflux (HJR) test was studied to assess the ability to clinically predict response during cardiac catheterization and to determine its significance in patients without heart failure and correlate it to their baseline hemodynamic parameters. Sixty-five patients considered to be free of heart failure undergoing routine cardiac catheterization were enrolled. The HJR test, defined as the venous pressure response to sustained abdominal compression, was performed in a standardized manner at the bedside assessing change in internal jugular venous pressure and during right-sided cardiac catheterization measuring change in right atrial pressure. For comparison a sustained increase of 1 cm was considered positive. In 62 of 65 patients the HJR test stabilized by 15 seconds. The results during examination at the bedside agreed with those at catheterization (κ = 0.74, p < 0.001). The HJR test result correlated best with baseline mean right atrial pressure (r = 0.59) and right ventricular end-diastolic pressure (r = 0.51), and in bivariate regression analysis predicted right atrial (F₀.₆₃ = 32.8, R² = 0.34, p < 0.0001) and right ventricular end-diastolic (F₀.₆₃ = 22, R² = 0.26, p < 0.0001) pressures. A positive test had high sensitivity and specificity for predicting right atrial pressure >9 mm Hg (1.0, 0.85) and right ventricular end-diastolic pressure >12 mm Hg (0.90, 0.89). It is concluded that 15 seconds is adequate for interpretation, and bedside observation predicts the response during right-sided cardiac catheterization. A positive test result in patients believed clinically free of heart failure can detect elevated right-sided cardiac pressures and correlated best to baseline mean right atrial and right ventricular end-diastolic pressures. This suggests a central role of right-sided cardiac function in determining the response.

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The hepatojugular reflux (HJR) test was first described by Pasteur in 1885 as a physical sign of tricuspid regurgitation. It has subsequently been believed to be useful in the diagnosis of congestive heart failure. The HJR test involves observation of the jugular veins while applying sustained pressure to the abdomen. The site of abdominal compression does not influence the interpretation of the maneuver. Evidence now suggests that venous pressure must remain elevated only 10 seconds for the test to be considered positive. The increase above baseline of the jugular venous pressure during the HJR test that is considered normal has been stated to be from 15 to 34 cm.

A positive test has previously been thought to indicate decompensated right ventricular function. Fritzzig believed it was one of the earliest signs of cardiac failure. Hemodynamic correlation of this test is available in only 2 studies. It was suggested that a positive test correlated best with a pulmonary capillary wedge pressure of >15 mm Hg. This study was designed to determine if the test performed at the bedside predicts the response recorded during right-sided cardiac catheterization, and to assess the significance of the HJR test in a patient population without overt clinical heart failure and correlate it to their baseline hemodynamic parameters.

METHODS

Patients: Sixty-five patients undergoing routine diagnostic cardiac catheterization for ischemic or valvular heart disease were studied between November 1987 and March 1988. Subjects were examined without knowledge of their history or indication for catheterization, and the results of 1 or the agreement of 2 observers were recorded. Subjects had coronary artery disease alone (n = 40), valvular heart disease alone (n = 6), neither (n = 15), or both (n = 4). Only patients without evidence of overt heart failure, as assessed by clear lung fields, absent S₃ and normal jugular venous pressure were included. The jugular venous pressure was defined as the end-expiratory peak pulsation of the internal jugular vein and a level of ≤4 cm above the sternal angle at 30 degrees was considered normal.

Hepatojugular reflux test: The HJR test was initially performed at the bedside. To compare the results of this examination with that obtained during right-sided cardiac catheterization, a sustained elevation of >1 cm was considered positive. The test was standardized, in a manner similar to that of Ducas et al., by applying continuous pressure to a semiinflated blood pressure cuff.
FIGURE 1. Prediction of hepatojugular reflux (HJR) test result (change in right atrial pressure) at catheterization from HJR test result (change in jugular venous pressure) observed at the bedside. Sensitivity = \( \frac{A}{A+B} = 0.80 \); specificity = \( \frac{D}{C+D} = 0.94 \); \( \kappa = 0.74 \), \( p < 0.001 \). neg = negative; pos = positive.

FIGURE 2. Example A indicates a negative hepatojugular reflux test. Example B represents a positive test.

FIGURE 3. Scatter plot of baseline mean right atrial pressure (RAP) versus hepatojugular reflux (HJR) test result (absolute change in RAP with abdominal compression) with regression line and 95% confidence interval.
TABLE I Correlation of Hepatojugular Reflux (HJR) Result (Absolute Change in Right Atrial Pressure to Abdominal Compression in mm Hg) with Baseline Hemodynamic Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>r</th>
<th>F</th>
<th>R²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right atrial pressure (mm Hg)</td>
<td>0.59</td>
<td>32.8</td>
<td>0.34</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Right ventricular end-diastolic pressure (mm Hg)</td>
<td>0.51</td>
<td>22.0</td>
<td>0.26</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Pulmonary capillary wedge pressure (mm Hg)</td>
<td>0.38</td>
<td>10.5</td>
<td>0.15</td>
<td>0.002</td>
</tr>
<tr>
<td>Pulmonary artery pressure (mm Hg)</td>
<td>0.18</td>
<td>2.2</td>
<td>0.03</td>
<td>0.14</td>
</tr>
<tr>
<td>Left ventricular end-diastolic pressure (mm Hg)</td>
<td>0.15</td>
<td>1.3</td>
<td>0.02</td>
<td>0.06</td>
</tr>
<tr>
<td>Ejection fraction (%)</td>
<td>0.03</td>
<td>0.05</td>
<td>0.001</td>
<td>0.83</td>
</tr>
</tbody>
</table>

TABLE II Sensitivity, Specificity and Predictive Values of a Positive Hepatojugular Reflux Test (Increase >1 mm Hg in Right Atrial Pressure) to Detect Resting Levels of Right Atrial and Right Ventricular End-Diastolic Pressures

<table>
<thead>
<tr>
<th>Parameter (mm Hg)</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Predictive Value</th>
<th>Negative Predictive Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right atrial pressure &gt;8</td>
<td>0.73</td>
<td>0.87</td>
<td>0.53</td>
<td>0.94</td>
</tr>
<tr>
<td>Right atrial pressure &gt;9</td>
<td>1.0</td>
<td>0.85</td>
<td>0.40</td>
<td>1.0</td>
</tr>
<tr>
<td>Right ventricular end-diastolic pressure &gt;8</td>
<td>0.41</td>
<td>0.92</td>
<td>0.80</td>
<td>0.66</td>
</tr>
<tr>
<td>Right ventricular end-diastolic pressure &gt;12</td>
<td>0.90</td>
<td>0.99</td>
<td>0.60</td>
<td>0.98</td>
</tr>
</tbody>
</table>

+ = positive; - = negative.

Taped to the epigastrium sufficient to raise a mercury column 35 mm. Subjects were instructed to maintain quiet breathing through an open mouth during this procedure. The location and degree of pressure exerted is similar to that used in routine clinical practice.

Cardiac catheterization: Right-sided cardiac catheterization was performed through the femoral vein approach using a Courand catheter and a fluid-filled system leveled to midchest. Pulmonary capillary wedge, mean pulmonary artery, right ventricular end-diastolic and right atrial pressures were recorded. To compare the results at bedside examination with those at catheterization, centimeters of water were converted to millimeters of mercury. With the catheter in the midright atrial position a repeat HJR test was performed. The change in right atrial pressure, compressing for a minimum of 45 seconds, was recorded. Left-sided cardiac catheterization followed with measurement of left ventricular end-diastolic pressure and performance of left ventricular angiography in the right anterior oblique projection for calculation of ejection fraction.

Statistical analysis: The HJR test result determined at the bedside was compared with that obtained during right-sided cardiac catheterization using a \( \kappa \) statistic. Baseline hemodynamic parameters were correlated to the absolute change in right atrial pressure during the HJR test using the Pearson correlation coefficient (r). Bivariate regression analysis was performed using the HJR test result as the independent variable and the baseline hemodynamic parameters as the dependent variables generating F (variance ratio) and R² values. Stepwise multiple regression analysis was performed using the baseline hemodynamic parameters in a model to predict a positive HJR test.

RESULTS

In 62 of 65 subjects the right atrial pressure response to abdominal compression stabilized by 15 seconds. In most of the subjects it stabilized earlier and remained constant for 45 to 60 seconds of observation. In 3 sub-

![Figure 4](image)

PCWP >15mmHg

<table>
<thead>
<tr>
<th>HJR test</th>
<th>pos</th>
<th>neg</th>
</tr>
</thead>
<tbody>
<tr>
<td>pos</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>neg</td>
<td>5</td>
<td>45</td>
</tr>
</tbody>
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<td>0.40</td>
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+ = positive; - = negative.

Figures 4. Ability of a positive (pos) hepatojugular reflux (HJR) test (>1 mm Hg increase) to predict pulmonary capillary wedge pressure (PCWP) >15 mm Hg. Sensitivity = A/(A+B) = 0.55; specificity = D/(C+D) = 0.83; positive (pos) predictive value = A/(A+C) = 0.40; negative (neg) predictive value = D/(B+D) = 0.90.
jects there was a delayed return to baseline of border-
line positive tests after 33 to 50 seconds. These 3 tests 
were classified as negative for analysis, although results 
were not influenced if they were considered positive.

Fifteen patients had a positive HJR test at catheter-
zation. Tests in 12 of the 15 had been assessed as cli-
nically positive and 3 as negative. Of the 50 patients with 
negative tests during catheterization, 47 had clinically 
negative and 3 had positive results. These results are 
demonstrated in Figure 1 and show a $k$ value of 0.74 ($p 
<0.001$) for the comparison of bedside examination 
with the results at catheterization. Observation of the 
right atrial pressure revealed that the end-expiratory 
peak transiently increased with the onset of abdominal 
compression in most subjects. It remained elevated (≥1 
mm Hg) in 15 subjects (the positive HJR group), re-
turned to baseline in 32 and decreased (≥1 mm Hg) in 
18. Examples of a negative and positive test are shown 
in Figure 2.

The absolute change in right atrial pressure during 
the HJR test, whether an increase or decrease, was cor-
related with baseline hemodynamic parameters provid-
ing the correlation coefficients ($r$ values) listed in Table 
I. The correlation is strongest with baseline mean right 
atrial ($r = 0.59$) and right ventricular end-diastolic ($r = 
0.51$) pressures and is positive, indicating that the high-
ertest the baseline values of these parameters the more po-
itive is the HJR test result. Figure 3 is a scatter plot of 
the HJR result versus baseline mean right atrial pres-
sure. Bivariate regression analysis was performed using 
the absolute change in right atrial pressure during the 
HJR test as the independent variable and the baseline 
parameters as the dependent variables since it would be 
most useful if the HJR result was predictive of hemody-
namic parameters in a population without clinical heart 
failure. The $F$ and corresponding $R^2$ values from this 
analysis are listed in Table I. These indicate a high de-
gree of significance for prediction of baseline mean 
right atrial and right ventricular end-diastolic pressures 
from the HJR result ($p <0.0001$). A less significant re-
sult is seen for pulmonary capillary wedge pressure. 
Stepwise multiple regression analysis was performed 
with the baseline hemodynamic parameters used in a 
model to predict a positive HJR test. The only hemody-
namic variable that remained in the model was the 
baseline mean right atrial pressure ($p <0.0001$).

The sensitivity, specificity and predictive value of a 
positive HJR test (≥1 mm Hg increase) for determin-
ing different degrees of abnormality in baseline hemo-
dynamic measurements were calculated. Figure 4 dem-
strates a 2 by 2 table where the HJR test is used to 
predict a wedge pressure >15 mm Hg. The sensitivity is 
only 0.55, the specificity 0.83 and the positive predictive 
value 0.40. In a similar manner other tables were con-
structed and the results of 4 of these are shown in Table 
II. Mean right atrial and right ventricular end-diastolic 
pressures 8>5 mm Hg were chosen as they represent 
quoted upper limits of normal.9 Mean right atrial pres-
sure >9 mm Hg and right ventricular end-diastolic 
pressure >12 mm Hg were chosen as they demonstrate 
the highest degree of sensitivity and specificity. All 6 
patients with mean right atrial pressure >9 mm Hg and 
9 of 10 patients with right ventricular end-diastolic 
pressure >12 mm Hg had positive tests. A positive HJR 
test identifies most patients who are clinically consid-
ered to have normal jugular venous pressure but have 
abnormal right-sided cardiac pressures at catheteriza-
tion. The high negative predictive values in Table II in-
dicate that a negative HJR test supports the clinical im-
pression of normal right-sided pressures in these pa-
tients.

DISCUSSION

The stated duration of abdominal compression re-
quired to interpret the HJR test accurately has varied. 
The results of this study support the conclusions of Du-
cas et al4 who believed only 10 seconds was necessary 
for stabilization of the response. An observation period 
of 15 seconds is sufficient to classify patients correctly 
into a positive or negative response. In this patient 
group the interpretation of the HJR test during bedside 
examination predicted the response at right-sided cardi-
ac catheterization in most cases.

We chose a patient population without overt clinical 
evidence of heart failure because a positive test in these 
patients would be most useful if it was found to corre-
late with or predict abnormalities of resting pressures. 
Internal jugular venous pressure estimated at the bed-
side may not accurately represent directly measured 
right atrial pressure in all cases.9 By performing the 
HJR test, the change in venous pressure can be ob-
served regardless of absolute level. In this patient group, 
considered clinically to have normal venous pressures, a 
positive HJR test was associated with elevated right-
sided cardiac pressures at catheterization. A negative 
test confirmed the clinical belief that the resting pres-
sures were in the normal range. False positives and neg-
atives did occur.

One would predict that if the change in right atrial 
pressure with abdominal compression correlated with 
resting pressures it would do so in a continuous manner. 
A more positive HJR test should occur with more ab-
normal resting pressures. We found that the absolute 
change in right atrial pressure that occurred with the 
test correlated positively with the level of baseline mean 
right atrial and right ventricular end-diastolic pressures. 
This was also seen in bivariate regression analysis. In 
stepwise multiple regression analysis only the baseline 
mean right atrial pressure was retained in the model to 
predict the HJR test result. These results would support 
the conclusion that a positive HJR test best correlates 
with the functional status of the right heart. Either ab-
normal right-sided volume or compliance, with an ab-
normal pressure-volume curve, could account for these 
findings.

Other investigators have postulated mechanisms of a 
positive response. Ewy7 suggested that an elevated 
 wedge pressure was the most important factor, although 
a positive response could be seen in right ventricular in-
farction without wedge pressure elevation; he believed
that this supported increased pulmonary vascular volume as an important mechanism. Our study was completed before publication of information that a positive test suggests pulmonary capillary wedge pressure $\geq 15$ mm Hg but does not confirm the usefulness of that observation.

The correlation coefficients obtained in this study, although highly statistically significant, are modest in degree, suggesting that the mechanism of a positive response is multifactorial. Dysfunction of the right heart, either primary or secondary to abnormalities of the left heart, pericardium or other intrathoracic structures may play a central role.

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REFERENCES