Clinical and Hemodynamic Assessment of the Hepatojugular Reflux

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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 ≥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 ($F_{(1,63)}$ = 32.8, R^2 = 0.34, p <0.0001) and right ventricular end-diastolic ($F_{(1,63)}$ = 22, R^2 = 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[1] as a physical sign of tricuspid regurgitation. It has subsequently been believed to be useful in the diagnosis of congestive heart failure.[2] 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.[2,3] Evidence now suggests that venous pressure must remain elevated only 10 seconds[4] 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 1[5] to 3[4] cm.

A positive test has previously been thought to indicate decompensated right ventricular function.[3,6] Hitzig[6] believed it was one of the earliest signs of cardiac failure. Hemodynamic correlation of this test is available in only 2 studies.[4,7] It was suggested that a positive test correlated best with a pulmonary capillary wedge pressure of >15 mm Hg.[7] 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 S_3 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,[4] by applying continuous pressure to a semiinflated blood pressure cuff

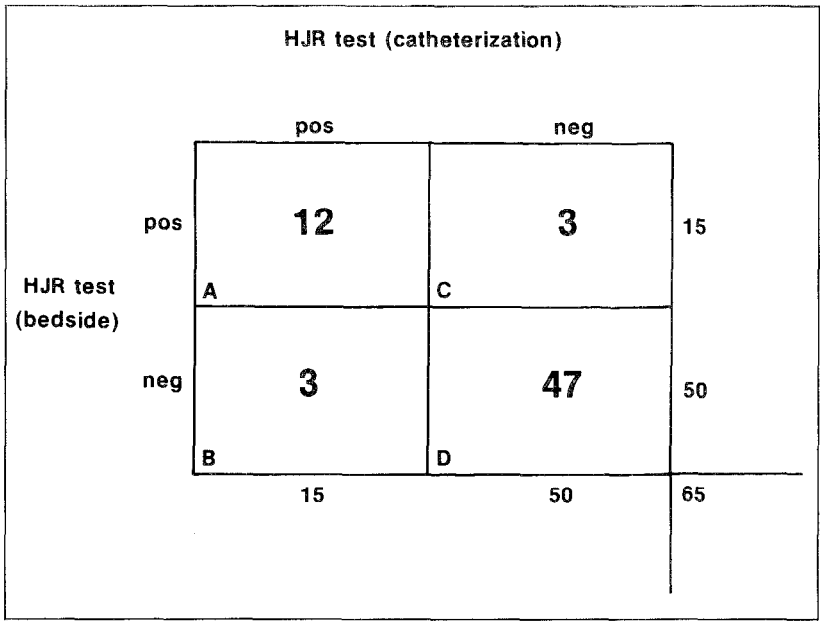

FIGURE 1. Prediction of hepatojugular reflux (HJR) test result (change in right atrial pressure) at catheterization from HJR test result (change in jugular venous pressure) observed at the bedside. Sensitivity = A/A+B, = 0.80; specificity = D/C+D, = 0.94; κ = 0.74, p <0.001. neg = negative; pos = positive.

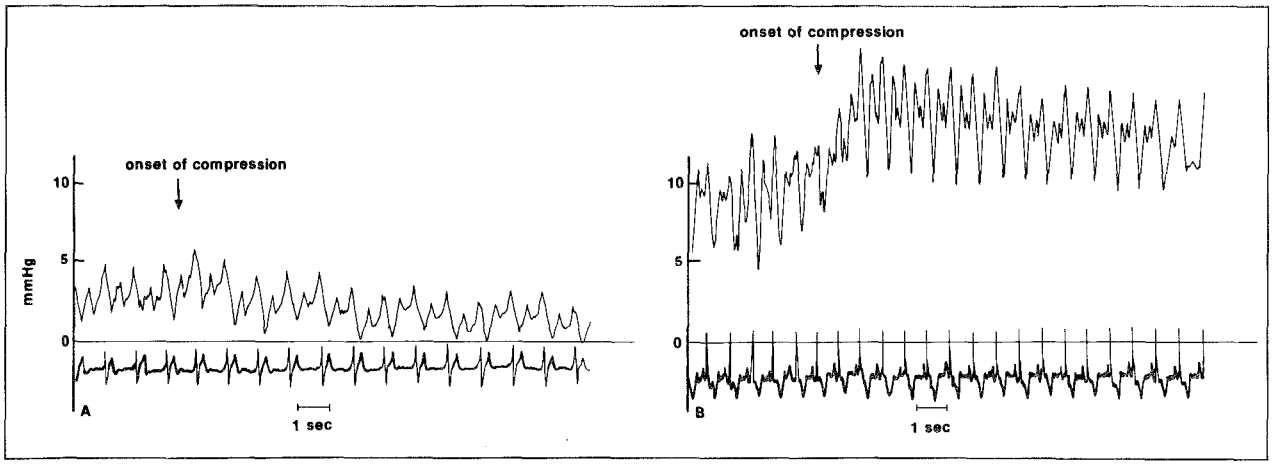

FIGURE 2. Example A indicates a negative hepatojugular reflux test. Example B represents a positive test.

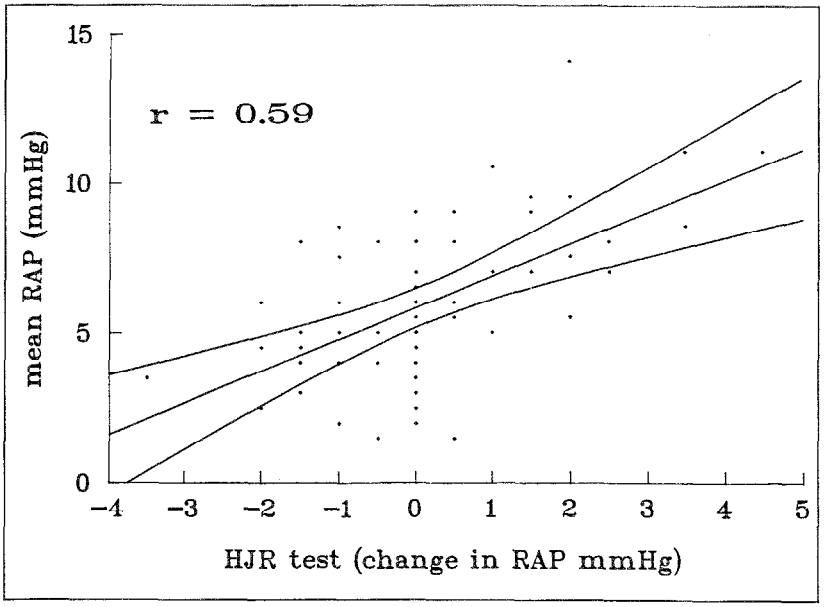

FIGURE 3. Scatter plot of baseline mean right atrial pressure (RAP) versus hepatojugular reflux (HJR) test result (absolute change in RAP with abdominal compression) with regression line and 95% confidence interval.

TABLE I Correlation of Hepatojugular Reflux (HJR) Result (Absolute Change in Right Atrial Pressure to Abdominal Compression in mm Hg) with Baseline Hemodynamic Parameters

	HJR Test Result			
Parameter	r	F	R^2	p
Right atrial pressure (mm Hg)	0.59	32.8	0.34	<0.0001
Right ventricular end-diastolic pressure (mm Hg)	0.51	22.0	0.26	<0.0001
Pulmonary capillary wedge pressure (mm Hg)	0.38	10.5	0.15	0.002
Pulmonary artery pressure (mm Hg)	0.18	2.2	0.03	0.14
Left ventricular end-diastolic pressure (mm Hg)	0.15	1.3	0.02	0.26
Ejection fraction (%)	0.03	0.05	0.001	0.83

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

			Predictive Value	
Parameter (mm Hg)	Sensitivity	Specificity	+	−
Right atrial pressure >8	0.73	0.87	0.53	0.94
Right atrial pressure >9	1.0	0.85	0.40	1.0
Right ventricular end-diastolic pressure >8	0.41	0.92	0.80	0.66
Right ventricular end-diastolic pressure >12	0.90	0.89	0.60	0.98

+ = 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 Cournand 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 κ 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 R^2 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-

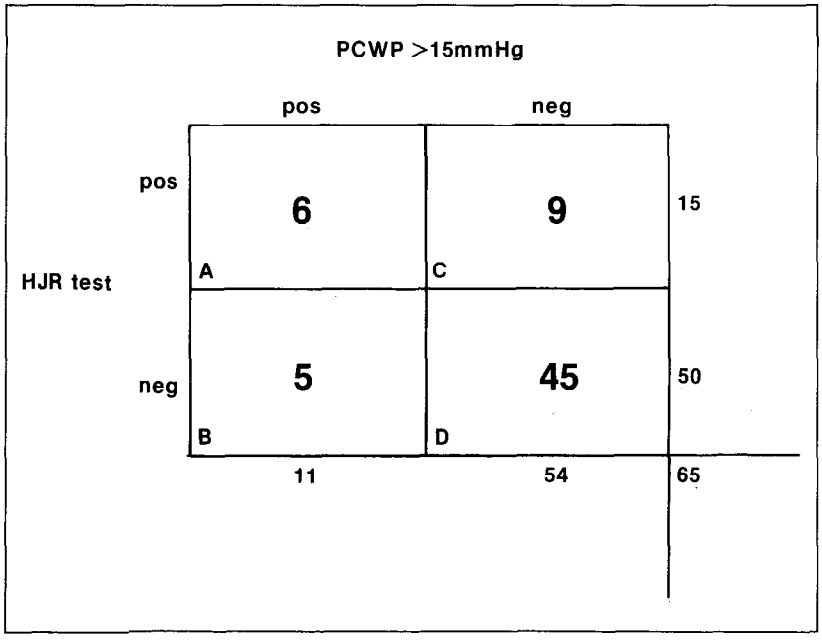

FIGURE 4. Ability of a positive (pos) hepatojugular reflux (HJR) test (>1 mm Hg increase) to predict pulmonary capillary wedge pressure (PCWP) >15 mm Hg. Sensitivity = A/A+B, = 0.55; specificity = D/C+D, = 0.83; positive (pos) predictive value = A/A+C = 0.40; negative (neg) predictive value = D/B+D = 0.90.

jects there was a delayed return to baseline of borderline 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 catheterization. Tests in 12 of the 15 had been assessed as clinically 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 κ 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), returned 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 correlated with baseline hemodynamic parameters providing 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 higher the baseline values of these parameters the more positive is the HJR test result. Figure 3 is a scatter plot of the HJR result versus baseline mean right atrial pressure. 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 hemodynamic 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 degree 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 result 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 hemodynamic 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 determining different degrees of abnormality in baseline hemodynamic measurements were calculated. Figure 4 demonstrates 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 constructed and the results of 4 of these are shown in Table II. Mean right atrial and right ventricular end-diastolic pressures >8 mm Hg were chosen as they represent quoted upper limits of normal.[8] Mean right atrial pressure >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 considered to have normal jugular venous pressure but have abnormal right-sided cardiac pressures at catheterization. The high negative predictive values in Table II indicate that a negative HJR test supports the clinical impression of normal right-sided pressures in these patients.

DISCUSSION

The stated duration of abdominal compression required to interpret the HJR test accurately has varied. The results of this study support the conclusions of Ducas et al[4] 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 cardiac 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 correlate with or predict abnormalities of resting pressures. Internal jugular venous pressure estimated at the bedside 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 observed 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 pressures were in the normal range. False positives and negatives 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 abnormal 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 abnormal right-sided volume or compliance, with an abnormal pressure-volume curve, could account for these findings.

Other investigators have postulated mechanisms of a positive response. Ewy[7] suggested that an elevated wedge pressure was the most important factor, although a positive response could be seen in right ventricular infarction 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 ≥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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