

A Retrospective Review to Evaluate the Safety of Right Heart Catheterization via the Internal Jugular Vein in the Assessment of Pulmonary Hypertension

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ABSTRACT

Background: Right heart catheterization (RHC) is important in the evaluation of pulmonary hypertension, but is not without risk.

Hypothesis: We wished to assess the safety, efficacy, and tolerability of RHC performed via the internal jugular vein (IJV) at our tertiary cardiothoracic center.

Methods: A retrospective review of the medical records for all patients undergoing RHC via the IJV between January 1, 2007 and July 31, 2009 was performed. We do not routinely use ultrasound guidance or stop anticoagulation. Operators with a median experience of 450 procedures performed the RHCs.

Results: Right heart catheterization was performed on 349 patients with a median age of 66 years (range, 17–89), median mean pulmonary artery pressure of 30 mm Hg (range, 8–69), and a median internationalized normal ratio of 2.5. Of 349 patients, we were unable to obtain intravenous access in only 1 patient; 342 (98%) patients tolerated RHC with local anesthetic alone; and 6 patients required additional sedation with benzodiazepines. The median time for the procedure was 15 minutes. Complications occurred in 6 patients (1.7%) and included carotid puncture ($n=3$), sinus bradycardia below 45 beats/min, which responded promptly to atropine and intravenous fluid ($n=2$), and complete heart block without hemodynamic compromise ($n=1$). There were no pneumothoraxes, pulmonary hemorrhage, or deaths related to the procedure.

Conclusion: Right heart catheterization via the IJV is quick, safe, and well tolerated. It is not associated with an increased risk of pneumothorax or other complications when performed by experienced operators.

Introduction

Right heart catheterization (RHC) using a pulmonary artery catheter (PAC) remains the gold standard in the diagnosis of pulmonary arterial hypertension (PAH). In addition to diagnosing PAH and assessing for potential reversibility, it can ascertain whether pulmonary hypertension (PH) is due to cardiac disease and can guide therapeutic intervention. Measurement of pulmonary hemodynamics is also required in patients being considered for cardiothoracic, and occasionally hepatic, transplantation. A percutaneous femoral vein approach is more commonly used in some centers. Less commonly, an internal jugular vein (IJV) approach is used which may reflect concerns regarding risks associated with this site of access. We describe our experience of RHC performed via the IJV at a tertiary center for cardiothoracic medicine.

Methods

We routinely performed RHC via the right internal jugular vein (RIJV) and did not use a femoral approach. We did not stop anticoagulants prior to catheterization and only deferred RHC if the internationalized normal ratio (INR) was above the therapeutic range (INR above 3.5 in anticoagulated patients). We allowed patients to eat and drink prior to RHC. In all patients, a strict aseptic technique was used and all procedures were performed in a dedicated cardiac catheter laboratory. The neck was sterilized with the patient lying flat with 1 pillow under their shoulders and the skin and subcutaneous tissues superficial to the vein infiltrated with local anesthetic (lignocaine). Sedation with intravenous benzodiazepines was only used if patients were unable to tolerate the procedure with local anesthetic and reassurance alone. The RIJV was then located with a 23-gauge needle between the apex of the triangle created by the sternal and clavicular heads of sternocleidomastoid. We specifically chose a lower approach to reduce the risk of carotid puncture. We did not routinely use ultrasound guidance to identify the RIJV. If the RIJV could not be

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located after 2 attempts, a left IJV (LIJV) approach was used. After successful cannulation of the IJV with a Kimmal needle, a size 7 French PAC sheath was inserted over a guide wire using the modified Seldinger technique. Right heart catheterization was then performed using a PAC with measurements of right atrial, right ventricular, and pulmonary arterial pressures, and measurement of cardiac output using the thermodilution method with cold normal saline. Serial saturation measurements were taken for patients suspected of having intracardiac shunts and pulmonary vascular vasodilator studies were performed if clinically indicated in accordance with international recommendations. The PAC was then removed with the patient lying flat. After removal of the sheath, pressure was applied to the site and an occlusive dressing was used to cover the area. The patient was then taken from the catheter suite to recovery and after 30 minutes, discharged to the ward.

A retrospective review of all RHCs performed between January 1, 2007 and July 31, 2009 at our center was performed. Data recorded included patients' age, day case inpatient procedure, complications, and the length of procedure. The data were available through our institution's electronic patient records.

Results

In total, 349 RHC were performed over the above period. The median age was 66 years (range, 17–89 yrs) with 211 female patients. Right heart catheterizations were performed by experienced operators with a median of 450 procedures (range, 100–8000).

Most procedures (58%) were performed as either a day case or patients were electively admitted to our center in view of the extensive distance they had to travel to us which made day attendance impossible. The remaining RHC were performed on inpatients (Table 1). These patients required admission either for further diagnostic evaluation (eg, to identify a cause for PH) and consideration of treatment (eg, PH specific therapy or valvular surgery) or because of a deterioration in their cardiorespiratory function. In these latter cases, RHC was performed after appropriate treatment and as part of an evaluation into their underlying pathology, for example, RHC performed in a patient with ischemic cardiomyopathy admitted with worsening LVF, after diuresis, left heart catheterization, and prior to consideration for transplantation. None of the procedures were performed in patients requiring intensive care support.

Table 1. Number of Procedures Performed as Day Cases, Elective Admissions, and on Inpatients

Day Case	Elective Admission	Inpatient at Time of Procedure
168	35	146

The median mean pulmonary artery pressure was 30 mm Hg (range, 8–69), cardiac output was 4.12 L/min (1.2–13.0), and pulmonary vascular resistance was 3.0 Wood units (0.2–25.4).

A total of 98% of patients (342) tolerated RHC with local anesthetic alone (2.5–7.5 mls 1% lignocaine). Only 6 patients required additional short-acting benzodiazepines (up to 3 mg of intravenous midazolam in 1 mg doses 1 minute apart) to tolerate the procedure. In all cases, RHC was then successfully performed without any complications secondary to sedation. One patient was unable to tolerate the procedure with local anesthetic alone and declined sedation. The procedure was therefore abandoned to prevent the patient becoming distressed.

In total, 330 RHCs were performed via the RIJV. In all cases, the vein was located without ultrasound guidance. A total of 18 procedures were performed via the LIJV. In 12 cases, the LIJV was electively chosen as a result of indwelling lines or previous instrumentation/surgery involving the RIJV. In the remaining cases, LIJV was chosen after unsuccessful cannulation of the RIJV. We were unable to obtain intravenous access in only 1 patient. The median INR in patients undergoing RHC was 2.5. Despite this we had no episodes of bleeding or hematoma formation at the cannulation site.

Complications occurred in 6 patients (1.7%; Table 2). These included carotid puncture with a Kimmal needle. The Kimmal needle was quickly removed and direct pressure immediately applied to the site for 2 minutes. There was no hematoma formation. Right heart catheterization was then successfully performed via RIJV without any subsequent complications.

Two patients developed sinus bradycardia below 45 beats per minute without hemodynamic compromise during PAC deployment. Both patients had resting heart rates prior to the procedure of more than 70 beats per minute and were in normal sinus rhythm with a normal PR interval. In each case, there was a prompt response to 600 mcg of atropine and intravenous fluid without further complications.

Table 2. Complications of Right Heart Catheterization via the Internal Jugular Vein

Complication	No. of Cases
Carotid puncture	3
Sinus bradycardia	2
Complete heart block	1
Total	6
Rate	1.7%

One patient developed complete heart block during RHC and PAC deployment. The patient did not become hemodynamically compromised. The PAC was immediately removed and a temporary pacing wire inserted with good effect. The patient converted to sinus rhythm after 36 hours and the pacing wire was removed.

The median time for RHC was 15 minutes (range, 8–62 min). The longest procedure occurred for the patient who required temporary wire placement and stabilization.

There were no pneumothoraxes, no episodes of pulmonary hemorrhage, no air embolism, and no infections associated with RHC via the IJV. There were no deaths related to the procedure.

Discussion

Pulmonary hypertension is an increasingly recognized disease and despite advances in PH-specific therapy, continues to carry significant morbidity and mortality.¹ Although transthoracic echocardiography is a vital screening tool for PH, RHC is necessary to accurately measure pulmonary artery pressures and diagnose PH.² Measurement of pulmonary capillary wedge pressure and cardiac output to calculate pulmonary vascular resistance, allows distinction between precapillary and post-capillary PH.

The use of PAC in critically ill patients remains controversial and their use is not routinely advised in this setting.³ Previous studies of PAC use in critical care patients have reported complications rates of 5% to 10% although these were high risk patients compared to our group.^{4,5}

A large 5-year evaluation of RHC in patients with PH (performed via IJV in 72.7% of cases) reported 76 serious adverse events with 4 fatalities and 5 pneumothoraxes.⁶ One patient died of a massive pulmonary embolism immediately prior to RHC, 5 days after discontinuation of warfarin therapy for the procedure.⁶

The IJV is widely used to obtain intravenous access and to guide management of fluid balance in critically ill patients. Its routine use for elective cardiac catheterization is less common. We report our experience of 349 RHC using the IJV alone over a 30-month period.

Our experience with RHC via the RIJV supports its use to provide access for measurement of pulmonary hemodynamics. Our complication rate was low and comparable to a previously published larger series which included case fatalities.⁶ We do not routinely stop oral anticoagulation prior to RHC, which we undertake if the INR is below 3.5. We did not encounter increased complications in patients on anticoagulation. Carotid puncture is a well described complication of IJV access and was treated with manual compression alone without formation of a hematoma. Sinus bradycardia can also be seen during IJV access and is associated with increased vagal tone.

The single episode of complete heart block seen in our series may have been due to a combination of increased vagal tone and concomitant verapamil therapy. The patient's baseline electrocardiogram did not show any evidence of an underlying conduction defect. The patient converted to sinus rhythm after 36 hours of pacing via a temporary wire and after discontinuation of verapamil. There were no long-term complications.

Femoral access, particularly in critical care or patients with increased body mass index, may be associated with increased risk of infection or catheter-related bacteremia.⁷ There were no catheter related bloodstream or site infections associated with IJV in our series.

We do not routinely use ultrasound to locate the IJV but use careful identification of anatomical landmarks to identify and cannulate the IJV. In a randomized prospective study comparing the landmark technique for IJV catheterization compared to ultrasound guidance in mechanically ventilated critical care patients, there were significantly higher rates of complications in the landmark group including carotid puncture in 10.6%, pneumothorax in 2.4%, and hemothorax in 1.7%.⁸ Cannulation in both groups was performed by experienced operators. The low complication rate seen in our series is comparable to the ultrasound guidance group in this study. This may be related to the high level of experience in our center coupled with close attention to anatomical landmarks without resorting to ultrasound. Our patient group did not include mechanically ventilated patients whose fluid status may have made cannulation more difficult.

Conclusion

Our series of RHCs performed using an IJV approach alone supports its routine use in RHC. It is a quick, safe, and well-tolerated procedure with a low complication rate when performed in experienced centers. A prospective study may help identify any additional risk factors that may reduce the complication rate further.

References

1. Thenappan T, Shah SJ, Rich S, Gomberg-Maitland M. A USA-based registry for pulmonary arterial hypertension: 1982–2006. *Eur Respir J*. 2007;30:1103–1110.
2. McLaughlin VV, Archer SL, Badesch DB, et al. ACCF/AHA 2009 expert consensus document on pulmonary hypertension a report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents and the American Heart Association developed in collaboration with the American College of Chest Physicians; American Thoracic Society, Inc.; and the Pulmonary Hypertension Association. *J Am Coll Cardiol*. 2009;53:1573–1619.
3. Hadian M, Pinsky MR. Evidence-based review of the use of the pulmonary artery catheter: impact data and complications. *Crit Care*. 2006;10(Suppl. 1suppl 3):S8.

4. Harvey S, Harrison DA, Singer M, et al. Assessment of the clinical effectiveness of pulmonary artery catheters in management of patients in intensive care (PAC-Man): a randomised controlled trial. *Lancet*. 2005;366:472–477.
5. Binanay C, Califf RM, Hasselblad V, et al. Evaluation study of congestive heart failure and pulmonary artery catheterization effectiveness: the ESCAPE trial. *JAMA*. 2005;294:1625–1633.
6. Hoepfer MM, Lee SH, Voswinckel R, et al. Complications of right heart catheterization procedures in patients with pulmonary hypertension in experienced centers. *J Am Coll Cardiol*. 2006;48:2546–2552.
7. Parienti JJ, Thirion M, Megarbane B, et al. Femoral vs jugular venous catheterization and risk of nosocomial events in adults requiring acute renal replacement therapy: a randomized controlled trial. *JAMA*. 2008;299:2413–2422.
8. Karakitsos D, Labropoulos N, De Groot E, et al. Real-time ultrasound-guided catheterization of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients. *Crit Care*. 2006;10:R162.