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Techniques and Procedures

Transvenous Pacemaker Placement: A Review for Emergency Clinicians

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□ **Abstract—Background: Transvenous pacemaker placement is an integral component of therapy for severe dysrhythmias and a core skill in emergency medicine. Objective: This narrative review provides a focused evaluation of transvenous pacemaker placement in the emergency department setting. Discussion: Temporary cardiac pacing can be a life-saving procedure. Indications for pacemaker placement include hemodynamic instability with symptomatic bradycardia secondary to atrioventricular block and sinus node dysfunction; overdrive pacing in unstable tachydysrhythmias, such as torsades de pointes; and failure of transcutaneous pacing. Optimal placement sites include the right internal jugular vein and left subclavian vein. Insertion first includes placement of a central venous catheter. The pacing wire with balloon is then advanced until electromechanical capture is obtained with the pacer in the right ventricle. Ultrasound can be used to guide and confirm lead placement using the subxiphoid or modified subxiphoid approach. The QRS segment will demonstrate ST segment elevation once the pacing wire tip contacts the endocardial wall. If mechanical capture is not achieved with initial placement of the transvenous pacer, the clinician must consider several potential issues and use an approach to evaluating the equipment and correcting any malfunction. Although life-saving in the appropriate patient, complications may occur from central venous access, right heart catheterization, and the pacing wire. Conclusions: An understanding of transvenous pacemaker placement is essential for emergency clinicians. Published by Elsevier Inc.**

□ **Keywords—transvenous; pacemaker; heart block; cardiology; bradyarrhythmia**

Introduction

Temporary cardiac pacing provides electrical cardiac stimulation for treatment of a brady- or tachydysrhythmia, although it is used most commonly for bradydysrhythmia with hemodynamic instability (1–5). In the emergency department (ED), temporary cardiac pacing can be performed via transvenous or transcutaneous means. This review focuses specifically on transvenous pacemaker placement (TVP) in the ED setting.

TVP is a core skill in emergency medicine, and literature suggests high success rates when performed by emergency clinicians (6,7). One retrospective study found that emergency clinicians had a 95% success rate in placing a transvenous pacemaker and obtaining capture; complication rate was 23% (8). Another retrospective study reported a success rate > 95% in ED patients undergoing pacer placement, with no significant complications (9). Understanding the indications, equipment selection, procedure, complications, and pitfalls is integral in successful application of temporary cardiac transvenous pacing in the ED. This review seeks to update prior literature on transvenous pacing with new advances, including ultrasound.

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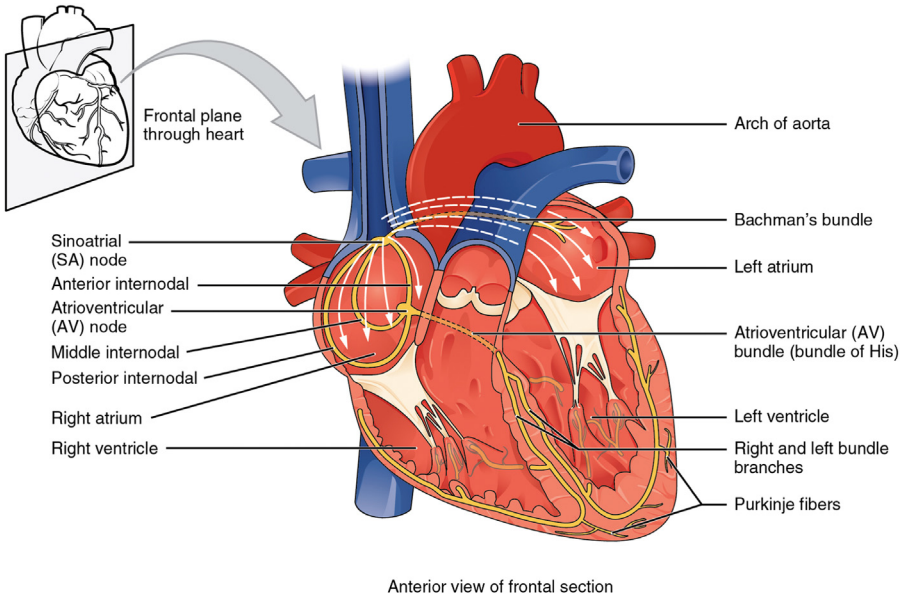

Figure 1. Cardiac conduction. Reprinted from Wikipedia (10).

Discussion

Anatomy and Pathophysiology

The cardiac conduction system includes myocytes and conducting fibers. This system initiates cardiac impulses and conducts them throughout the cardiac tissue (Figure 1), which provides an automatic rhythmic beat and coordinates cardiac chamber contraction. The conduction system includes the sinoatrial (SA) node, intra-atrial conduction pathways, atrioventricular (AV) node, bundle of His, bundle branches, and terminal Purkinje fibers (1–5). Electrical signals arise in the SA node, which is located in the right atrial sulcus at the junction of the superior vena cava and right atrium. Adrenergic and cholinergic fibers innervate the SA node and can affect impulse generation. The impulse generated by the SA node travels to the rest of the atria through the anterior, middle, and posterior intra-atrial conduction pathways, stimulating atrial contraction. The impulse then reaches the AV node, located in the interatrial septum. The AV node modulates impulse conduction, which provides time for ventricular filling (1–5). Following the AV node, the signal is conducted through the bundle of His to the right and left bundle branches. The signal then reaches the Purkinje fibers in the left and right heart, the cardiac apex endocardium, and the ventricular epicardium, resulting in ventricular contraction. Within the myocardial tissue, depolarization propagates between adjacent cells in every direction via gap junctions, allowing for rapid, synchronous myocardial depolarization.

Indications and Contraindications

There are several indications and considerations for TVP. The most common indication for pacing is severe bradycardia resulting in hemodynamic instability. The only major contraindication is asystole. Table 1 provides specifics regarding indications and considerations (1–5,11–18).

Equipment

Pacing generator

There are several pacing generators available, although all possess the same basic features. Modern pacing generators use a four-letter code, with combined pacemaker-cardioverter/defibrillators using a fifth letter as well (Table 2, Figure 2). Emergency transvenous pacing commonly uses "DOO," meaning the atria and ventricles are dual-paced, with no chamber sensed, no sensing response, and no programmability. The amperage control modifies the current delivered to the cardiac system and ranges from 0.1 to 25 mA, but emergent pacing typically starts at 25 mA. Maximizing the current enhances the likelihood of capture and pacing success. If the atrial function is turned to 0, the generator will turn to "VVI," meaning the ventricle is paced and sensed, and the pacemaker is inhibited if the native pulse is sensed. We recommend using DOO. The sensitivity setting typically ranges between 0.5 and 25 mV. The voltage setting is the minimum electrical signal strength the pacer can detect. In asynchronous, fixed-rate mode, the generator does not sense any intrinsic activity

Table 1. Indications and Considerations for Transvenous Pacemaker Placement (1–5,11–18)

Indications	Considerations
Bradycardia resulting in hemodynamic compromise*	Hyperkalemia, hypothermia, decompensated hypothyroidism, β-blocker toxicity, calcium channel blocker toxicity, Lyme carditis, autoimmune diseases, severe acidemia should be managed medically first
Overdrive pacing in unstable tachydysrhythmias	Exogenous pacing of hypothermic bradycardia is not recommended, as these patients require rewarming
Prophylaxis for anticipated clinical course	Caution recommended in digitalis toxicity (pacing may result in ventricular fibrillation)
Consider for prophylaxis for anticipated clinical course (new left bundle branch block or right bundle branch block with new left axis deviation due to AMI)	Caution recommended in those with AMI undergoing anticoagulation
Failure to achieve capture with transcutaneous pacing	Pacing may not be necessary if the patient has an intermittent or infrequent block accompanied by a stable escape rhythm

AMI = acute myocardial infarction.

* Symptomatic sinus node dysfunction; second- and third-degree heart block; atrial fibrillation with slow ventricular response; new left bundle branch block fascicular block, alternating bundle branch block in the setting of AMI; malfunctioning of implant permanent pacemaker. Contraindication: asystole.

Table 2. Pacing Generator Code

First Letter	Second Letter	Third Letter	Fourth Letter
Chamber paced	Chamber sensed	Sensing response	Programmability
A = Atrium	A = Atrium	T = Triggered	P = Simple
V = Ventricle	V = Ventricle	I = Inhibited	M = Multiprogrammable
D = Dual	D = Dual	D = Dual (A triggered and V inhibited)	R = Rate adaptive
O = None	O = None	O = None	C = Communicating
			O = None

and fires regardless of the underlying cardiac rhythm. The generator will also have a sensing indicator meter and rate control knob. The pacing generator is battery operated, and the clinician should ensure the batteries are new prior to floating the pacer.

Pacing catheter/electrodes

There are several brands and sizes for pacing catheters or wires, with most ranging between 3Fr and 5Fr and up to 100 cm in length, marked with lines at 10-cm intervals. TVP kits come in various shapes and sizes, but the necessary equipment for this procedure may require opening several different types of kits (e.g., central line and transvenous pacing). As such, it is paramount that the proper diameter sheath is placed to appropriately accommodate the pacing wire. If a wire is placed through a sheath that is too large in diameter (i.e., 8Fr), the punctured diaphragm of the sheath will continue to bleed, and it becomes a potential source of infection. The most common ED catheter is a flexible, semi-floating bipolar electrode catheter with balloon tip. The balloon can hold approximately 1.5 mL of air. The air injection port contains a locking lever, which secures expansion of the balloon. Inflation of the balloon can assist in wire placement by "floating" the tip into the right ventricle (RV), even if there is a low-flow state. This type of pacing wire typically provides bipolar stimulation, as each wire has a positive (cathode) and negative (anode) electrode. The cathode is the tip of the pacing wire that is inserted. The anode is located 1–2 cm proximal to the tip, with the balloon separating the two components. Both components may be in contact with the myocardium in the RV after placement.

Figure 2. Pacing generator.

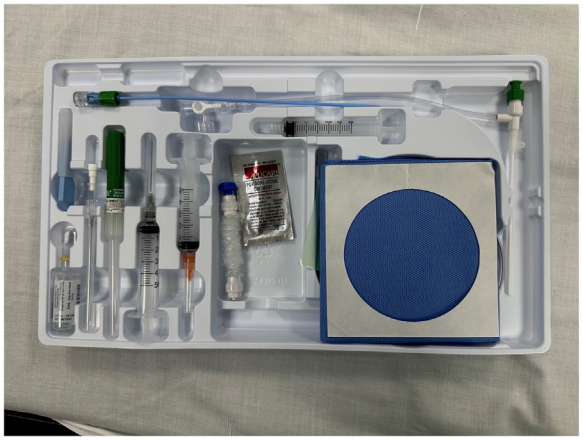

Figure 3. Introducer set.

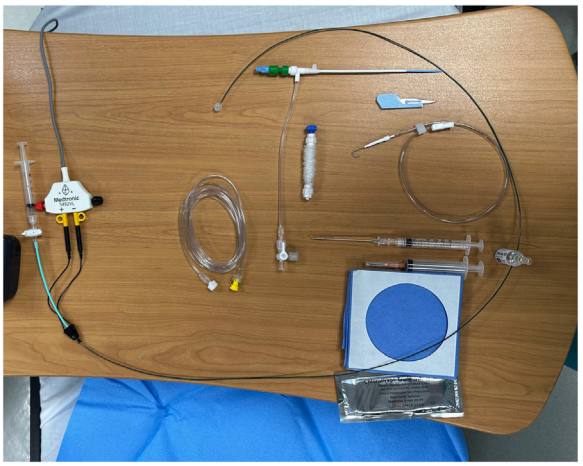

Figure 4. Introducer set pieces with pacing wire.

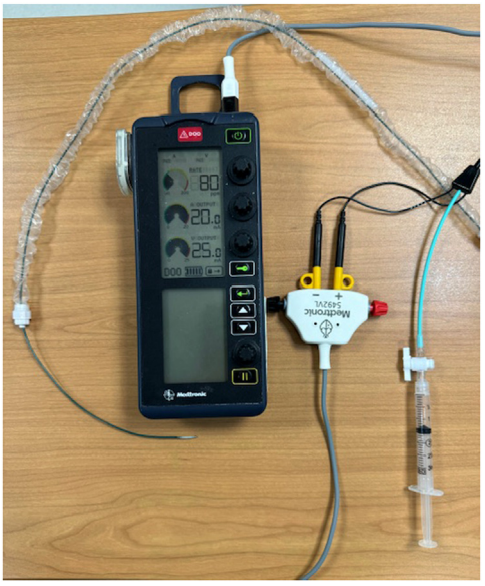

Figure 5. Pacing wire connected to generator.

Monitor

An external cardiac monitor is useful to evaluate the patient's inherent cardiac activity, evaluate the location of the pacing wire, and ensure capture. This often entails an electrocardiography (ECG) machine or patient vital sign monitor, although ultrasound may also be used as an adjunct to guide and confirm placement (19–22). Pulse oximetry is also recommended, which can confirm capture.

Introducer sheath

Prior to placing the pacer, central venous access is necessary and should use an introducer sheath or set (Figures 3–5). This typically includes a dedicated kit or another introducer catheter (e.g., Cordis catheter). The sheath must be larger in diameter than the pacing wire. The size of a pacing wire is based on the diameter of the outside, and the size of the introducer sheath refers to the diameter of the inside. This means a 5Fr pacing wire can fit through a 5Fr introducer sheath. A 5Fr or 6Fr sheath may be used but should be based on the pacing wire size. The introducer sheath typically has a perforated elastic seal covering the external opening that will allow passage of the pacing wire. This seal will not allow air to enter the sheath or blood to escape. There is also a side port on the sheath that can be used for central access. If this type of sheath is not available, a standard IV catheter can be used, but this is not optimal, as it has no seal and will allow leakage of blood. If using a 3Fr or 4Fr pacing wire, a 14-gauge, 1.5- to 2-inch IV catheter may be used. If present, a pulmonary artery catheter pacing port may also be used for floating the TVP.

Table 3. Equipment for Transvenous Pacemaker Placement

Equipment
Pacing generator (using DOO) with batteries and connections with adapters
Mechanical capture monitor: cardiac monitor pulse oximetry, point-of-care ultrasound*
Transvenous pacemaker placement kit†
Introducer sheath with kit (5Fr or 6Fr catheter)
Pacing wire with balloon
Sterile gloves
IV pole (to drape nonsterile wire over sterile field)

* Point of care ultrasound recommended to confirm placement and capture.
† Transvenous pacemaker placement kits vary. The Argon 008566A kit contains no. 11 mini scalpel, 6Fr vessel dilator, 45-cm guide wire, fenestrated drape, towels, 19-gauge arterial needle, povidone/iodine prep swab, 6Fr Tuohy-borst introducer, 10-mL and 5-mL syringes, gauze sponges, 25- and 21-gauge needles, TPE catheter kit, 000 silk suture, povidone/iodine ointment, 5-mL ampule lidocaine hydrochloride 1%, Septishield catheter sleeve (Argon Medical Devices), 18-gauge radiopaque O-T-N catheter.

Site Selection

Potential sites that allow access to the RV include the brachial, femoral, internal jugular, and subclavian veins. The right internal jugular vein allows for the most anatomically straight introduction of the pacing wires successfully into the RV, although the left subclavian is a suitable alternative if the right internal jugular is not available (2–5,19). Both of these sites demonstrate the highest rates of successful placement and capture in the RV, particularly during chest compressions in active cardiopulmonary resuscitation (3–5,23). Subclavian vein access may be achieved via an infraclavicular or supraclavicular approach, although the infraclavicular approach is used more commonly (24,25). The right subclavian and left internal jugular veins can also be used, but are less suitable anatomically based on the required wire trajectory to the RV and may result in incorrect wire placement (3–5,23).

Table 3 provides a summary of the key equipment necessary for TVP, and Table 4 summarizes the procedure.

Setup

Optimal placement requires several key pieces of equipment and two people: one person who remains sterile to obtain central access and float the pacer, and one who is nonsterile to address the pacing generator and leads (3–5). The nonsterile person will set up the pacer generator. The pacing generator has one long nonsterile wire. The pacer has two short sterile wires with two black electrical wire tips; however, these do not fit pacing generators and require special adapters. The pacer kit should include red sterile adapters that slide onto the black wire tips, which can then be connected to the pacing generator. An IV pole should be placed near one of the patient's shoulders so the nonsterile wire can be draped over the sterile field. Leads should be connected to the appropriate outlets in the pacing generator hub prior to floating the wire (3–5). This will be the ventricular outlets for emergent pacing in symptomatic bradycardia. The sterile person will insert the wires into the hub while the nonsterile person holds the hub and generator. The proximal or shorter wire inserts into the positive port, and the distal longer wire inserts into the negative port. The pacing wire connections to the pacing generator should then be tightened. In DOO, current output is maximized to 25 mA and a pacing rate 10–20 beats/min higher than the current rate or 80 beats/min unless using overdrive pacing (3–5,19). If the patient is being transcutaneously paced, the transvenous pacer rate should be set to twice the transcutaneous rate to ensure appropriate capture. This can be convenient, as the transcutaneous pacer provides a backup rate to ensure perfusion is maintained while the transvenous pacer is placed and adequate capture is obtained.

Insertion

The 5Fr or 6Fr catheter should be placed in sterile fashion at the selected site. Prior to inserting the pacing wire into the catheter, the clinician should evaluate the balloon for air leak by immersing it in sterile water or sterile saline and inflating the balloon. Air leak will be demonstrated by bubbles appearing in the water. Once central venous access with the appropriately sized catheter is obtained and the pacing balloon has been tested, the pacing wire can be floated. The sterile sheath should be placed on the catheter prior to floating the pacing wire to protect the wire from contamination after placement. These leads can be floated into the RV with or without a balloon tip (3–5,19). Most kits contain wires that are curved. If using such a pacing wire in the right internal jugular vein, the pacing wire should be inserted so the end of the curve points toward

Table 4. Summary of Transvenous Pacemaker Placement

Steps
1. Obtain central access and place 5Fr or 6Fr introducer sheath.
2. Ensure the patient is positioned so the clinician floating the wire can see the monitor and the patient.
3. Test the balloon with the special syringe (only allows 1.5 mL of air).
4. Place sterile sheath on the pacing wire.
5. Attach the wire extender to the box; connect the wire and generator using adapters (use ventricular outlets for emergent pacing; proximal/short wire inserts into positive port; distal longer wire inserts into the negative port) and tighten wire connections to the generator.
6. Other provider operates the pacer generator: using DOO, set the rate to double the patient's intrinsic rate and maximal output (20–25 mA).
7. Prior to floating, orient the wire to optimize the curve towards the patient's midline, allowing entry into the right atrium.
8. Advance the wire to 15 cm.
9. Inflate the balloon with 1.5 mL of air and lock in the inflated position.
10. Advance wire until electromechanical capture is obtained on cardiac monitor (approximately 35–40 cm).
11. At this point, stop advancing the wire and unlock the balloon port to allow the balloon to deflate.
12. Decrease the current until capture is lost (pacing threshold).
13. Increase the current to 2–2.5 times the pacing threshold (ideally to 2–3 mA).
14. Secure the wire and draw the sterile sheath over the wire.
15. Consider checking the sensitivity settings and changing to VVI (not mandatory).
16. Obtain chest x-ray study and electrocardiogram.

the patient's midline, allowing for the wire to enter the right atrium, and for the left subclavian route, the pacing wire should be inserted with the end of the curve pointing toward the patient's feet.

The pacer wire is pushed through the diaphragm into the 5Fr or 6Fr catheter and advanced to approximately 15 cm (either for the right internal jugular or left subclavian vein sites), followed by balloon inflation with 1.5 mL of air to assist with the floating process into the RV. The syringe and balloon should then be locked in the inflated position. The pacer generator should be turned on in DOO, with settings including a heart rate of 80 beats/min, current of 25 mA, and sensitivity at minimum mV (i.e., the highest setting). The pacing wire is then slowly advanced while the sterile person closely watches the catheter and the patient and the nonsterile person watch the monitor for evidence of electromechanical capture with the pacer in the RV (the optimal position for the pacer wire) (3–5,19). The depth of insertion until capture is reached approximates 35–40 cm for the right internal jugular vein and left subclavian vein. The clinician can estimate the necessary length by placing the wire over the patient's chest prior to wire insertion.

Electromechanical capture occurs when a pacer spike is followed by a left bundle branch complex on the monitor and there is an increase in both heart rate on the monitor and pulse oximetry. At this time, the sterile person should stop advancing the catheter and unlock the balloon port, which will allow the balloon to deflate (3–5,19). The clinician should see the syringe refill with air spontaneously. The clinician should not draw back on the balloon for deflation, as this increases the risk of balloon rupture. If the syringe does not spontaneously refill once the port is unlocked, the balloon may have ruptured, and the pacing wire should be withdrawn. Intermittent evaluation with the balloon deflated may reveal appropriate placement because the balloon can impede contact with the wall. Of note, atrial capture may be sufficient in certain situations, assuming AV conduction is not the primary issue causing bradycardia. Significant tricuspid insufficiency can prevent the pacing wire from entering the RV. If this occurs, the balloon should be deflated prior to reaching the tricuspid valve. The wire should then be twisted counterclockwise when advancing until it passes the tricuspid valve.

Evaluating and Confirming Capture

There are several means of evaluating for capture during TVP. Transesophageal echocardiogram (TEE) is optimal for guidance and confirmation, although this may not be available in all ED settings (19). Transthoracic car-

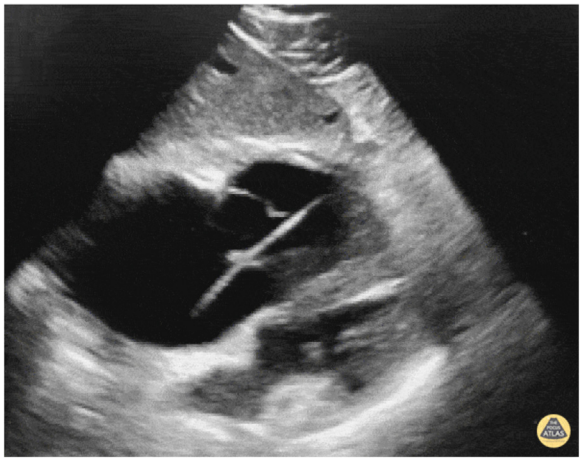

Figure 6. Point-of-care ultrasound showing transvenous pacemaker placement passing through the right atrium to the right ventricle. From The POCUS Atlas, reprinted with permission (26).

diac ultrasound may be used in place of TEE in the ED (20–22). The use of dynamic ultrasound during transvenous lead placement can aid in guiding and confirming lead placement within the RV in real time (20–22). When using transthoracic cardiac ultrasound, the sonographer can best visualize the right atrium and RV in an apical four-chamber view, although a subxiphoid view may also be adequate (20–22). The operator can directly observe movement of the lead in real time through the tricuspid valve into the RV apex (Figure 6) (20–22). Ultrasound can then visualize the pacing wire abutting the RV wall and assess for mechanical capture with organized cardiac activity at the rate set on the pacing generator. It can also visualize the inferior vena cava (IVC) to evaluate for misplacement and evaluate for pericardial effusion after placement (20–22).

ECG machines are used less commonly for monitoring capture in the current era; however, they can remain helpful when there is not a second person to perform the cardiac ultrasound during the procedure. If ECG is used, the machine must be grounded to prevent leakage of any alternating current, which may result in ventricular fibrillation. Monitoring of right-sided ECG leads (V1–3) provides the best evidence of capture (3–5).

On the cardiac monitor, once the pacing wire tip is in contact with the endocardial wall, a pacer spike followed by a QRS segment with ST segment elevation will be seen. The pulse oximetry component of the monitor will demonstrate the rate set on the generator if the pacing wire tip is in contact with the endocardium. This is more reliable than using the rate from the ECG monitor, as the ECG monitor may detect contraction of chest wall muscles and mistake it for capture. Ultimately, there are two forms of capture: electrical and mechanical (2–5). Electrical capture is indicated by a pacer spike followed by a QRS complex on the monitor, and mechanical capture occurs when a pacer spike is followed by myocardial contraction and a palpable pulse. If 25 mA is required for continued capture and cannot be weaned down without loss, this suggests malpositioning of the pacer wire (e.g., coiled within the IVC). Incomplete or intermittent capture also suggests pacer malpositioning. After pacer wire placement in the RV, the current should be decreased until capture is lost. This is referred to as the pacing threshold and is the minimum current necessary to obtain mechanical capture. The current should then be increased to 2–2.5 times the pacing threshold (3–5). The ideal pacing threshold amperage is < 1 mA, meaning the typical amperage used will be 2–3 mA. This can also be tested by having the patient cough. Although less current is required than transcutaneous pacing, this procedure may still require sedation and analgesia.

After Wire Placement and Capture

At the start of the procedure in DOO mode, the pacing generator fires regardless of the underlying rhythm. However, in other modes, such as VVI, if the sensitivity is set to a higher threshold, the generator may not pace because it will not detect a cardiac rhythm. Sensitivity may be adjusted after capture has been obtained if the clinician is comfortable with this step; otherwise, the generator may be left in DOO mode. If the clinician decides to adjust the sensitivity, the mode should be adjusted to VVI. If the sensitivity threshold is appropriately set in VVI, the generator and pacer will sense an underlying bradycardic rhythm and allow an intrinsic beat. It will supplement the rhythm with a paced beat to achieve the set heart rate, which can be adjusted as necessary to achieve perfusion. The default sensitivity is 2 mV. The goal is to be able to see the QRS but not T waves. To adjust sensitivity, the mV should be increased until there is no longer any sensing. The sensitivity is then decreased until sensing is seen, and then reduced again to half that number. This will optimize cardiac sensing (3–5).

A chest x-ray study should be obtained for confirmation after placement; ideal positioning is the pacing wire at the RV apex (3–5,23). Once the pacemaker position has been confirmed, the wire should be secured. The hub of the introducer sheath should be firmly attached to the skin using suture. The sterile sheath connected to the introducer should be drawn back across the wire, and the excess wire should be coiled. An ECG should also be obtained after placement and securement. If the pacing wire is in the RV, a left bundle branch block pattern will be present (3–5).

Table 5. Approach to Troubleshooting Transvenous Pacemaker Placement Failure to Capture

Troubleshooting Steps
Ensure the pacing wire is connected to the generator appropriately
Ensure the pin interfaces are fully connected and pushed completely into the interface for the generator
Evaluate pacemaker depth
Evaluate the pacing generator setting
Consider pushing the wire in further if pacing spikes are present but there is no capture
Consider changing the wire
Place transcutaneous pacer pads and initiate external pacing
Use epinephrine infusion

Troubleshooting

If mechanical capture is not achieved with initial placement of the transvenous pacer, the clinician must address several considerations and use an approach to evaluating the equipment and correcting any malfunction, including failure to capture (Table 5) (2–5,27,28).

Complications

Although transvenous pacing may be the hemodynamically stabilizing procedure, this intervention is not without inherent risk, with a complication rate ranging from 14% to 50% (3–5,19,27,28). These potential complications can be classified on the phase of the procedure: central venous access, right heart catheterization, and the pacing wire (9,28–33). Complications from obtaining venous access are most common, although rates are significantly decreased with use of ultrasound (3–5,9,34,35). Central venous access complications include arterial puncture (< 5%), pneumothorax (1%), infection (< 1.4%), air embolism (< 1%), venous thrombosis or thrombophlebitis (< 1.4%), and catheter or pacing wire looping. Deep venous thrombosis is more common when the femoral site is used (2,28,36–39). Complications of right heart catheterization include dysrhythmias (< 5%), misplacement of the catheter wire (e.g., coronary sinus), perforation of the atrium or ventricle (< 1%), and valvular damage or perforation (5,28–33,40,41). Misplacement of the wire should be suspected if a right bundle branch block (RBBB) occurs on ECG, or if failure to capture, high pacing threshold, or a posteriorly displaced catheter wire on lateral chest x-ray study occurs. Ventricular free wall perforation should be suspected with chest pain, loss of capture, new pericardial friction rub, or if there is pacing of the thoracic wall muscles. Septal perforation may be present with RBBB. Ventricular perforation can be deadly, resulting in pericardial tamponade and death. This complication can be masked by the wire itself and may only become evident once removed (5,28–33). Regardless of when it occurs, worsening hemodynamics peri- or post-transvenous pacer placement warrants immediate ultrasound cardiac ultrasound to evaluate for cardiac tamponade. Complications from the generator and pacing wire include displacement; wire fracture; loose leads; progressive inflammation, fibrosis, or thrombosis; failure of the generator or inadequate output; dysrhythmias; and outside interference (5,28–33). Of note, controls on the pacing generator have a cover or locking feature to prevent inadvertently turning off the generator. Regarding the batteries, there is typically a 24-hour window from when the warning light first appears to device failure. The generator typically has 15 s of stored power in order to change the battery.

Conclusions

Temporary TVP is integral to treatment of severe dysrhythmias and a core skill in emergency medicine. Indications include hemodynamic instability with symptomatic bradycardia secondary to AV block and sinus node dysfunction; overdrive pacing in unstable tachydysrhythmias, such as torsades de pointes; and failure of transcutaneous pacing. Absolute contraindications include the presence of a mechanical tricuspid valve and asystole, although caution is also recommended in patients with severe hypothermia. The right internal jugular vein or left subclavian vein may be used. Insertion includes placement of a central venous catheter or a Cordis catheter. The pacing wire is advanced until electromechanical capture is obtained with the pacer in the RV. Ultrasound is recommended to guide and confirm placement. If mechanical capture is not achieved with initial placement of the transvenous pacer, there are several necessary considerations to correct a malfunction. Complications may arise from central venous access, right heart catheterization, and the pacing wire.

Declaration of competing interest

None.

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Article Summary

1. Why is this topic important?

Transvenous pacemaker insertion is a core skill in emergency medicine and can be life-saving.

2. What does this review attempt to show?

This review provides a focused evaluation of transvenous pacemaker placement for emergency clinicians.

3. What are the key findings?

Transvenous pacemaker placement is needed for those with hemodynamic instability with symptomatic bradycardia secondary to atrioventricular block and sinus node dysfunction, overdrive pacing in unstable, and failure of transcutaneous pacing. Placement sites include the right internal jugular vein and left subclavian vein. Ultrasound can be used to guide and confirm placement. Complications may occur from central venous access, right heart catheterization, and the pacing wire.

4. How is patient care impacted?

Knowledge of transvenous pacemaker placement is essential for emergency clinicians.