Permanent Pacemaker Implantation via the Iliac Vein: An Alternative in 4 Cases with Contraindications to the Pectoral Approach

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We report the outcome of the iliac vein approach for permanent pacemaker implantation in 4 patients in whom the conventional pectoral approach was not possible. The reasons for using the iliac vein approach were: recurrent lead infections at bilateral pectoral positions in 1 patient; superior vena cava obstruction following cardiac surgery in 2 patients; and a postoperative dermal scar due to right radical mastectomy secondary to a persistent left superior vena cava with absence of the innominate vein in 1 patient. This technique was safe and effective during the mean follow-up period of 24.3 months. At the latest follow-up, no patients showed signs of electrophysiological abnormalities. No short- or long-term complications were seen. Conclusions: The iliac vein approach is a less invasive and more feasible alternative without any complications for patients in whom the pectoral approach cannot be used.
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Case Reports

We have performed four pacemaker implantations in four patients using the iliac vein approach between January 2004 and December 2008. All patients were followed up in the outpatient clinic at 6-month intervals.

Implantation procedure
Under local anesthesia, an oblique incision was made cranial and parallel to the inguinal ligament and slightly medial to the femoral artery (Figure 1a, b). Bilateral iliac veins were available for...
lead implantation. The inguinal ligament was dissected, and an external iliac vein was directly exposed. One or two 4-0 monofilament horizontal mattress sutures with pledgets for hemostasis were placed on the exposed external iliac vein, corresponding to the intended number of leads to be implanted. The exposed iliac vein was directly punctured and cannulated with a split sheath using a modified Seldinger technique to introduce the pacing lead. To advance the lead into the endocardial surface of the heart, 25-cm-long split sheaths (Medikit, Inc. Tokyo, Japan) proved useful. The leads used in the present report were 4 active fixation leads (CAPSUREFIXTM NOVUS 5076, Medtronic, Inc. Minneapolis, MN, USA) and 1 passive fixation lead (CAPSURESPTM NOVUS 4092, Medtronic, Inc.). All leads were 85 cm long. When a lead was implanted into the right atrium, a loop was made by the lead in the right atrium to prevent the atrial lead from dislodgement, the tip of the electrode was positioned in an area where the atrial wall had conditions sufficient for sensing and pacing, and then the atrial lead was screwed to the right atrial wall (Figure 2a, b). Ventricular leads were advanced into the right ventricular apex, in the same manner as in the pectoral approach. A subcutaneous pocket for the device was created with another incision, superficial to the deep fascia and cranial to the previous incision. The lead was secured to the fascia and pulled through a tunnel into the subcutaneous pocket and then connected to a pulse generator. Strong generator fixation is necessary to prevent the possibility of subsequent gravity-dependent migration of the device to the inguinal ligament. The patient was maintained on bed-rest for 24 hours and then gently mobilized. Prophylactic anticoagulant (warfarin potassium) was administered to selected patients whom deep vein thrombosis or edema in their lower extremities was anticipated postoperatively. Based on the published literature, the risk of asymptomatic deep vein thrombosis following the iliac vein approach is similar to that of asymptomatic subclavian vein thrombosis associated with transvenous pacing via the pectoral approach.1)  

Case 1  
A 79-year-old woman with complete atrioventricular block (c AVB) was referred for permanent pacemaker implantation. She had a history of cerebral infarction and right radical mastectomy with right axillary lymph node dissection. Permanent pacemaker implantation was attempted with the

Figure 1a  
The anatomy of the venous system of the lower extremity is shown. An incision just above the inguinal ligament is also shown.

Figure 1b  
The run of the transiliac ventricular lead and the position of the generator are shown in the abdominal roentgenogram. The arrow shows the puncture site.
usual left pectoral approach. After insertion of a
guide wire in the left subclavian vein, the guide wire
could not pass the innominate vein, and the passage
of the guide wire suggested the presence of a
persistent left SVC (PLSVC). Left subclavian ve-
nography confirmed the presence of the PLSVC with
absence of an innominate vein. Moreover, there was
stenosis in the mid-portion of the PLSVC (Figure 3).
Therefore the pectoral approach was suspended. Her
age and impaired condition (almost bedridden)
increased the risks associated with using general
anesthesia. We elected to implant a transvenous
pacing system via the iliac vein approach as a less
invasive treatment. A right pectoral approach with
generator implantation at the back of the right
shoulder was not performed because such implantation
has a risk of compression necrosis.

Case 2
A 77-year-old woman had a DDD pacemaker
implantation for c AVB 16 years earlier. Pacemaker
infection necessitated explantation of this system
and implantation of a new VVI pacemaker on the
contralateral side 5 years earlier. Infection and
erosion of her pacemaker on the right side had
developed at the present admission. Because of the
previous pacemaker infection, a total of 3 endocar-
dial electrodes were introduced into the SVC via a
bilateral pectoral approach. Considering her severely
impaired condition (bedridden due to sequelae of
severe cerebral infarction), less invasive treatment
was chosen instead of radical surgery, such as
removal of the implanted electrodes using open-
heart surgery. The removal of the infected pacem-
aker system on the right side was performed, but
the lead remnants remained in the SVC. Further
implantation of an endocardial electrode into the
SVC was not performed. Therefore, a new pace-
maker system was later implanted using the iliac
vein approach after recovery from the infection.

Case 3
A 68-year-old woman with a history of mitral
valve replacement had a pacemaker implantation for
symptomatic (recurrent faintness) atrial fibrillation
with low ventricular response. Although the usual
left pectoral approach was attempted, following the
insertion of a guide wire into the left subclavian
vein, the guide wire could not pass the SVC. Venography suggested the presence of stenosis at
the SVC. Therefore, the pectoral approach was
suspended. Computed tomography (CT) showed that
there was diffuse stenosis at the SVC, which
appeared to be the cause of the thrombus, due to
direct SVC cannulation or repeated insertion of
central venous catheters perioperatively (Figure 4).
Based on these findings, the pectoral approach was abandoned and pacemaker implantation using the iliac vein approach was elected.

Case 4

A 34-year-old woman was treated for c AVB following the Mustard operation for transposition of the great arteries with a VVI pacemaker 29 years earlier. As she was a child at the time of the pacemaker implantation, an epicardial pacing system was implanted with the pulse generator located in the left hypochondrium. The previously implanted epicardial lead showed lead fracture with elevation in the pacing threshold. According to documentation in her medical chart, several attempts were made to implant a permanent pacemaker using a transvenous pacing system via the usual pectoral approach in the past, but the endocardial electrode could not pass the junction between the SVC and the right atrium. The Mustard operation is known to cause intra-atrial stenosis, especially in the SVC, due to the presence of the intra-atrial baffle. Based on these findings, the pectoral approach was abandoned and implantation of a transvenous pacing system via the iliac vein approach was initially scheduled. Since an atrial switch operation had been performed, the tip of the ventricular electrode was located at the apex of the anatomical left ventricle.

Four patients had pacemakers implanted using the iliac vein approach. Three pacemakers were single chamber (VVI), and one was dual chamber (DDD). Five leads (1 atrial and 4 ventricular) were implanted (Table 1), and the majority of the leads were active fixation [1/1 (100%) atrial, 3/4 (75%) ventricular].

Performance of the implanted leads at implantation

During implantation, the mean ventricular R wave amplitude was 8.8 mV, the mean ventricular pacing threshold expressed as calculated energy consumption was 2.00 μJ, and the mean ventricular lead impedance was 684.3 Ω (Table 2). According to the manufacturer’s information, the estimated standard lead impedances that were used in the present report were between 500 and 1000 Ω.

Performance of the implanted leads during follow-up

The mean follow-up period was 24.3 months after implantation. The mean ventricular sensing threshold was 7.5 mV, the mean ventricular pacing thresh-
old expressed as calculated energy consumption was 2.89 mJ, and the mean ventricular lead impedance was 629.0 \( \Omega \) (Table 2). The implanted atrial lead also showed good performance without dislodgement. No short- or long-term complications, including dislodgement or fracture of the leads, infection, threshold elevation, or development of deep vein thrombosis or edema in the lower extremities, were observed.

### Table 1  Patient characteristics

<table>
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<th>3</th>
<th>4</th>
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<td>77</td>
<td>68</td>
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<td>Diagnosis</td>
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<td>cAVB</td>
<td>brady Af</td>
<td>cAVB</td>
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<td>Indications for employing IVA</td>
<td>PLSVC and rt Mastectomy</td>
<td>Previous infection in SVC leads</td>
<td>postoperative SVC stenosis (Mitral valve replacement)</td>
<td>postoperative SVC stenosis (TGA: Mustard operation)</td>
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<td>Atrial lead model</td>
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<td>(−)</td>
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<td>(−)</td>
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<td>MD NOVUS 5076</td>
<td>MD NOVUS 5076</td>
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<td>12</td>
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<td>(−)</td>
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### Table 2  Outcomes of the lead data

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<tr>
<td>(Voltage/pulse width)</td>
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<tr>
<td>atrium</td>
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<td>(−)</td>
<td>(−)</td>
<td>(−)</td>
<td>1.0 V/0.5 mS</td>
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<td>ventricle</td>
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<td>0.75 V/0.4 mS</td>
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<td>0.75 V/0.5 mS</td>
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<td>(Voltage/pulse width)</td>
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<tr>
<td>atrium</td>
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<td>(−)</td>
<td>(−)</td>
<td>(−)</td>
<td>1.3 V/0.4 mS</td>
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<tr>
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<td>0.75 V/0.4 mS</td>
<td>0.6 V/0.4 mS</td>
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<td>0.65 V/0.43 mS</td>
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<td>8</td>
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<td>7.5</td>
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<td>673</td>
<td>571</td>
<td>631</td>
<td>639</td>
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</table>

Discussion

The group of patients presented here accounts for 1.4% of the 284 permanent pacemakers implanted
at Saiseikai Utsunomiya Hospital during the same period. In the present report, the indication for the iliac vein approach was venous or intra-atrial obstructions in 2 patients that were considered to have occurred as a result of cardiac surgery. One patient underwent repeated attempts at SVC lead implantation due to recurrent pacemaker infection. Since the patient already had 3 leads in the SVC, further lead insertion was inappropriate. Another patient had thin right anterior chest skin due to a right radical mastectomy secondary to congenital PLSVC with absence of communication between the right SVC and the PLSVC. Clinically, 1–6% of patients who require permanent pacemaker implantation have features that make the conventional pectoral approach not possible or contraindicated due to various reasons, including anatomical anomalies, acquired subclavian or SVC occlusion, repeated attempts at SVC lead implantation, and inability to place a subdermal pouch on the anterior chest wall due to thin skin.2–9) The insertion of a permanent pacemaker in patients with these complications poses the practical problem of how to gain access to the heart. Though implantation of transvenous pacing leads via the iliac vein is considered an effective alternative procedure in such patients, the iliac vein approach is currently performed in a limited number of institutions.2–9) The underutilization of the iliac vein approach may be due to the fear of possible complications associated with this approach, including lead dislodgement, lead fracture, infection, and retroperitoneal hematoma.2–9) Lead dislodgement, especially the atrial lead has been considered the major complication associated with this procedure. The incidence of atrial lead dislodgement using this approach has been reported to range from 7 to 21%.2–5) When an atrial lead is implanted using the iliac vein approach, due to anatomical morphology where the atrial lead runs from the external iliac vein to the right atrium via the inferior vena cava, the tip of the implanted atrial lead has to continuously bear its own weight. This gravity-dependent force continuously acts on the tip of the implanted atrial lead to withdraw it from the site where it is fixed to the right atrial wall. Therefore, the most important factor for avoiding dislodgement of the implanted atrial lead using the iliac vein approach is to prevent the tip of the atrial lead from bearing its own weight. We believe that making a loop in the right atrium prior to tightening the screw of the atrial lead may serve this purpose. Septal pacing has emerged as an effective therapy for patients with moderate to severe congestive heart failure with prolonged QRS complexes. On the other hand, there may be difficulty in the selection of the pacing site via the iliac vein approach, especially for right ventricular outflow tract (RVOT) pacing, due to anatomical reasons. However, in one report the ventricular lead was positioned at the right ventricular septum using a 58-cm-long endocardial electrode via the iliac vein approach.7) Septal pacing via the iliac vein approach may not always be difficult; in particular, moderator band pacing may be possible. In the future, septal pacing via the iliac vein approach may be necessary in order to obtain narrow QRS complexes in selected patients with moderate-to-severe congestive heart failure with prolonged QRS complexes. To the best of our knowledge, no literature has examined whether crossing the hip joint may have a deleterious impact on lead longevity due to hip joint flexion. However, many authors who have described the iliac vein approach expressed concerns about the relation between lead fracture and hip joint movement.2,4,8,9) It is uncertain whether this complication rate is higher than that for the pectoral approach. Further research is needed to evaluate this complication via the iliac vein approach. However, in order to allay concerns about late lead fracture due to hip joint flexion or lower abdominal wall movement, we believe that direct external iliac vein exposure from the cranial side to the inguinal ligament is preferred. Blind puncture may cause retroperitoneal bleeding or intestinal injury. In our series, under local anesthesia, direct access was obtained into the external iliac vein for insertion of the leads without any complications.

Conclusions

We presented our experience using the iliac vein approach for permanent pacemaker implantation in patients in whom the conventional pectoral approach was not possible. This approach appears not only satisfactory for ventricular lead placement, but it is also satisfactory for atrial lead placement with our modification. This approach appears to be a less invasive and feasible alternative to epicardial lead implantation.

References


5) Barakat K, Hill J, Kelly P: Permanent transfemoral pacemaker implantation is the technique of choice for patients in whom the superior vena cava is inaccessible. Pacing Clin Electrophysiol 2000; 23: 446–449