Original article

Subpectoral Technique of Pacemaker Implantation
—Reduction of Cost and Length of Hospital Stay—

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Abstract

Objective: To reduce the length of hospital stay for patients undergoing pacemaker surgery.

Patient and Methods: We prevented the leads from dislodging by anchoring a screw-in type pacing lead in the right atrium/ventricle through a cephalic vein that was cut down. We retrospectively compared the cost and duration of the hospital stay for the subpectoral technique (35 cases; January 2005–March 2006) and conventional technique (subcutaneous pocket and subclavian vein puncture) (18 cases; October 2003–December 2004) groups.

Results: The mean (± SD) duration of hospital stay was 5.1 ± 2.1 days for the subpectoral technique group and 22.2 ± 15.2 days for the conventional technique group (P < 0.001), and the cost was 2,167,883 ± 147,549 yen in the subpectoral technique group and 2,528,053 ± 217,810 yen in the conventional technique group (P < 0.001). We noted no major complications such as bleeding, lead dislodgement, or wound infection.

Conclusion: Our novel subpectoral technique helped reduce the length and cost of the hospital stay associated with pacemaker surgery.

Key words: pacemaker, subpectoral, cutdown, hospital cost

(Introduction)

In western countries, a pacemaker operation requires usually just one night’s admission¹. Why do Japanese patients need much longer admission²? One of the reasons may be that Japanese have thinner subcutaneous tissue than Caucasians, and Japanese physicians may be afraid of wound healing due to thin tissue covering the generator.

Wound infection is a serious complication of pacemaker surgery³, but we have had no cases of wound infection since we began inserting the generator under the major pectoral muscle (subpectoral technique). We initially used this technique only for contralateral re-implantation of pacemakers that had become infected, but since the re-implantations were followed by good, rapid healing, we decided to try it in routine pacemaker surgery⁴.

Application of a screw-in type lead with a small diameter (7 Fr), which is essential for small Japanese patients, eliminated dislocation of the anchored leads and permitted discharge the day after the surgery. Pneumothorax and hemothorax, which can occur if the subclavian vein is punctured, were avoided by using a cephalic vein cut-down for lead insertion.

By applying the above technique, we reduced the postoperative hospital stay from 22 days to 5, dramatically reducing hospital costs from 2,528,053 yen to 2,167,883 yen.

Methods

Patients

We retrospectively compared the cost and duration of the hospital stay for the subpectoral technique (35 cases; January 2005–March 2006) and conventional technique (subcutaneous pocket and subclavian vein puncture) (18 cases; October 2003–December 2004) groups, excluding patients who required other surgery or intervention during hospital stay. The study period was chosen, because remuneration decided by the Japanese Ministry of Health, Labour and Welfare was the same over the study period (note: there is no private medical budget system in Japan and remuneration is revised annually). The mean ages (± SD) (77.8 ± 9.8 vs. 75.6 ± 7.1 years old, P = 0.40) and sex distributions (males, 17/35 vs. 8/18) were similar in both groups.

Surgical technique

All cases of conventional and subpectoral implantation were performed by the same surgical team including an experienced surgeon (holder of Fellowship of the Japanese Association for Thoracic Surgery). Prior to January 2005, we implanted pacemakers by making parallel subclavian incisions and puncturing the subclavian vein to form a subcutaneous generator pocket. We then kept the patient
bedridden in a supine position for 3 days to avoid dislocation of the anchored leads. Now, however, we make a skin incision on the deltopectoral groove and expose the cephalic vein. We use small caliber bipolar pacing leads and, because the costal-clavicular space in Japanese is narrow, a small (<8 Fr.) introducer. The technique also permits safe maneuverability and prevents lead laceration. For DDD pacemaker implantation, we insert the pacing lead and guide-wire together for the second lead insertion. After anchoring the first lead at the right ventricular apex or septum, we insert the second lead for the right appendage through the 7-Fr introducer. Then, to prevent the lead from dislodging in an ambulatory patient, we screw leads at each position (St. Jude Medical; Tendril SDX model 1488). We secure the sleeve at the edge of the deltoideus muscle with 3-0 silk (Figure 1). The upper margin of the major pectoral muscle faces the deltoideus muscle edge across the deltopectoral groove and the entrance to the generator pocket that is created between the major and minor pectoral muscles (Figure 1). We insert a large generator with an AutoCapture or Ventricular Capture Manager (VCM), and atrial-ventricular interval adjustment (St. Jude Medical; Identity ADx XL DR or Medtronic; Kappa DR 730 or 930), anticipating a battery life of more than a decade. For VVI pacemaker implantation, we use VERITY ADx XL DR (St. Jude Medical) or close the atrial connector of Kappa 730 with silicon glue. After careful hemostasis of the vessels, we close the deltopectoral groove (entrance of generator pocket) with 3-0 Vicryl, and we close the skin and subcutaneous tissue with 3-0 Vicryl and 5-0 Vicryl continuous running sutures in three layers. We do not stop anticoagulant treatments for the subpectoral technique. The heart rate is monitored overnight with an electrocardiogram (ECG). Patients are not confined to bed and are usually allowed to shower 24 hours after the surgery. We check the wound and chest X-ray 1 day after the surgery and discharge the patients when criteria of hospital discharge are satisfactory (Table 1).

### Table 1 Criteria of hospital discharge

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<td>Free of wound pain on elevation of upper limb</td>
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<td>Gauze off (unnecessary for the wound)</td>
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<tr>
<td>No dislodgement of pacing leads on chest X ray</td>
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<tr>
<td>No pacing and sensing failure (VCM, or AutoCapture on)</td>
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<tr>
<td>Good control of anticoagulation when prescribed before the surgery</td>
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<td>No symptom when walking as fast as before the surgery</td>
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**Hospital stay and cost**

Prior to admission, we examine pacemaker indicators (such as a Holter ECG), and we order a chest X-ray, blood test, and ECG one day before and one day after the surgery. In the conventional technique group, oral anticoagulant was stopped and heparin infusion was started. In the subpectoral technique group, oral anticoagulant was continued so the patient could be admitted one day before the surgery. Patients in the conventional technique group received intravenous antibiotics during bed rest. Those in the subpectoral technique group received intravenous antibiotics once before surgery and oral antibiotics for 5 days after it. We used Student’s t-test for statistical comparison of the groups.

### Results

Neither group had major peri-operative complications such as bleeding, hemo/pneumothorax, or wound infection. We gave up lead insertion in the 2 cases of the conventional...
group, but succeeded in all case of the subpectoral group. The mean duration of hospital admission (± SD) was 22.2 ± 5.1 days for the conventional group and 5.1 ± 2.2 days for the subpectoral technique group \((P < 0.001)\). In the latter group, 5 patients were discharged on day 1 after the surgery and 12 were discharged on day 2. The mean cost of the hospital stay (± SD) was 2,528,053 ± 217,810 for the conventional group and 2,167,883 ± 147,549 yen for the subpectoral technique group \((P < 0.001)\). This included savings of 190,000 yen for bed charge fees, 36,000 yen for blood tests, and 18,000 yen for intravenous administration of an antibiotic. As bed charge fees are over 50,000 yen per day, early discharge is essential for cost reduction. In addition, the wound in the subpectoral technique group was cosmetically quite acceptable (Figure 2). The bleeding points during subpectoral technique surgery were the cephalic vein torn on sheath insertion, and the perforator vessels between the major and minor pectoral muscle. As long as a hemostasis was carefully applied to those points, we could operate even on patients on warfarin or aspirin.

Discussion and Conclusions

Our patients who received pacemakers by the subpectoral technique healed well and sooner than those who received them by the conventional technique. Moreover, the subpectoral technique permitted patients to be discharged on their own discretion and depending on wound pain, starting on day 1 after surgery. It should be noted that the success rate of lead insertion was 100% with our subpectoral technique, better than the recent axillary vein puncture technique (known to reduce hemo/pneumothorax) which gives a success rate of 95%\(^6\).

In a larger study using a similar technique, Kistler and his colleagues reported no neurovascular or muscle damage and no postoperative chronic pain among more than 1,000 consecutive cases, and they also noted the cosmetic benefit of the technique\(^7\). They inserted the generator along the upper margin of the muscle band arising from sternoclavicular joint and the sternum\(^7\), while we inserted it along the upper margin of the major pectoral muscle band arising from the clavicle (Figure 1). Therefore, they had to fix the leads on the major pectoral muscle, which resulted in the leads being positioned over the generator, creating the possibility of lead injury in generator changes. When changing the generator because of an exhausted battery, some physicians may hesitate to use our subpectoral technique because of the depth of the wound. However, Kistler reported no trouble with generator change after subpectoral implantation\(^7\). We also performed 2 cases of generator change with the subpectoral technique and implanted the new generator into the subpectoral pocket without any trouble. Those two patients were discharged 1 day after the surgery.

Mond reported that the average hospital stay for pacemaker surgery in Japan is over 16 days\(^1\). His report is the only official and reliable survey of pacemaker surgery in Japan. We could not find any reliable data, except the report by Mond\(^1\), which can be used for international comparison. Indeed, Mond mentioned that Japan was particularly hard to survey and the precise data were still unknown in spite of the largest number of pacemaker operations in the region\(^1\). A hospital stay more than 3 weeks might be too long in our conventional technique, but when data of generator change were included in the calculation, it did not differ significantly from the average in Japan (16 days). We used the same criteria of hospital discharge both in the conventional and in the subpectoral techniques and they are shown in Table 1. Three factors mainly contributed to the too long hospital stay. First, we were concerned about wound healing, especially in thin patients. Second, we had to spend a week before and after the surgery to adjust anticoagulation. Third, in the conventional technique, we confirmed the safety of pacing and sensing before discharge in a pacemaker clinic which was held only twice a month. In the subpectoral technique, we were not concerned about pacing/sensing failure because of novel auto-adjustment systems, such as VCM and AutoCapture, and secure fixation with screw-in leads.

Who should implant a pacemaker, a surgeon or physician? Mond described the precise percentages of surgeons participating in each country except Japan\(^1\). While it appears that pacemakers are implanted by cardiologists in the majority of cases, even in Japan, the cooperation of a surgeon is necessary for the subpectoral technique. At the moment, we are expanding the subpectoral technique to anchor a generator change. AutoCapture or VCM and atrioventricular interval adjustment provide a generator life of more than a decade. Considering the average 83-year life...
span of the Japanese, most pacemaker patients may not require replacement surgery. We believe that our novel subpectoral technique will significantly free up some of the limited medical resources in Japan.

In conclusion, our subpectoral technique for pacemaker implantation significantly reduced the length and cost of the hospital stay.

References