Optimal Placement of Cardiac Catheter Tip in Ventriculoatriostomy
Technical Note

KAZUKI SAKATA, M.D., SHIGEO UEDA, M.D., YOSHITOMO KASHIKI, M.D., AND TAKAO TAKETOMO, M.D.
Second Surgical Division, Gifu University School of Medicine, Gifu City, Japan

In performing ventriculoatriostomy in hydrocephalic cases, it is supposed to be essential to place the cardiac catheter tip within the right atrium, especially at the right mid-atrium, to prevent such postoperative complications as cardiac catheter obstruction and septicemia, and to encourage long-term patency of the shunting system.1-4 For this purpose we routinely are using our modification5,6 of the intracardiac electrocardiography method of Robertson, et al.;4 the Pudenz type of cardiac catheter is filled (not flushed) with 20% saline solution to reduce electrical resistance and prevent commercial current interference.

Case Report

We recently treated a 6-month-old infant with communicating hydrocephalus; ventriculoatriostomy was performed and the cardiac catheter was fixed to the right facial vein so that its tip might be placed at the biphasic P point. Two weeks postoperatively symptoms of septiciemia appeared, and the baby died on the 35th postoperative day. At autopsy the tip of the cardiac catheter was found at the right mid-atrium; there was no clot around the catheter nor any distinct inflammation in the wall of the right atrium. However, there was inflammatory thickening in the region of the tricuspid valve and, histologically, marked inflammation and many bacterial colonies were found.

The cause of this selective infectious endocarditis of the tricuspid valve we assumed to be as follows. The cardiac catheter tip, which had been placed in the right mid-atrium while the patient’s neck was extended during operation, may have reached the tricuspid valve postoperatively, facilitated by normal flexion of the neck in daily life. There it produced a locus minoris resistentiae.

The following experimental and clinical investigations were carried out to substantiate this hypothesis.

Experimental Investigation

In an adult mongrel dog weighing 10.5 kg, the right atrium and the superior vena cava were exposed by thoracotomy. A polyethylene catheter, filled with 20% saline solution, was inserted through the right external jugular vein toward the heart until the intracardiac electrocardiogram showed biphasic P waves with equal positive and negative components, while the animal’s neck was extended (Fig. 1 A). After temporarily fixing the catheter to the jugular vein, the neck was flexed, and the P waves became monophasic positive. Maximal neck flexion was maintained while the catheter was pulled out 15 mm before the original biphasic P waves were once more obtained (Fig. 1 C). On extending the neck at this point, monophasic negative P waves were obtained (Fig. 1 B). The confirmed range of catheter tip movement, 15 mm during flexion and extension of the neck with the catheter inserted to this depth, is indicated by two silver clips in Fig. 2. Thus, it was confirmed that the catheter tip had advanced markedly in a caudal direction during neck flexion and that the amount of the advance could be estimated by changes in intracardiac P waves.

Investigation in Clinical Cases

Based on the conclusion of the foregoing experiment in dog, the following investigations were carried out in clinical cases. Figure 3 shows the intracardiac electrocardiogram during operation on a 9-month-old
Placement of Catheter in Ventriculoatriostomy

Fig. 1. Intracardiac electrocardiograms in dog. A. During neck extension. B. During neck extension, the depth of catheter insertion being 15 mm less than that in A. C. During neck flexion, the depth of catheter insertion being the same as that in B.

infant with communicating hydrocephalus. The patient was placed on the operating table in the routine position with the neck extended. The Pudenz cardiac catheter, filled with 20% saline solution, was inserted into the right facial vein until the intracardiac electrocardiogram lead from its tip showed bi-phasic P waves with equal positive and negative components (Fig. 3 A). The catheter was then pulled out until the original bi-phasic P wave pattern reappeared (Fig. 3 C) while the neck was kept flexed maximally and rotated slightly to the left (so that the jugular vein might be shortened). The catheter had to be pulled out 7 mm, thus indicating that the tip had moved that far caudal during flexion. When the neck was then extended, P waves were mainly negative (Fig. 3 B).

Figure 4 shows the results of a similar investigation on a 47-year-old man with hydrocephalus; this time the catheter tip was found to have advanced 13 mm caudad during flexion of the neck.

Fig. 2. Photograph taken during thoracotomy in dog. Single arrow indicates location of the cardiac catheter tip when the record shown in Fig. 1 B was obtained. Double arrow indicates location of the tip when the neck was flexed. Level of double arrow, where bi-phasic P waves were recorded, was confirmed on autopsy to be the midatrium.

Fig. 3. Intracardiac electrocardiograms in a 9-month-old infant. A. During neck extension. B. During neck extension, the depth of catheter insertion being 7 mm less than in A. C. During neck anteflexion, the depth of catheter insertion being the same as in B.