QRS Morphology in Patients with Right Ventricular Pacing

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The morphology of QRS in patients with right ventricular pacing usually displays left bundle branch block pattern. In some instances, however, different patterns of QRS are observed. It is the purpose of this investigation to examine the relationship between the morphology of QRS and the position of the tip of electrode catheter in patients with right ventricular pacing.

MATERIALS AND METHODS

The twelve-lead electrocardiogram of 16 patients were reviewed in whom transvenous right ventricular pacing was attempted. Nine patients were male and seven patients were female.

Either insertion or repostioning of the electrode catheter were carried out on 30 occasions in 16 patients, including 11 temporary and 19 permanent pacings. The position of the catheter tip was determined by postero-anterior and lateral X-ray films.

RESULTS

Typical X-ray films and electrocardiogram of right ventricular pacing are shown in Figure 1. The QRS displays a left bundle branch block (LBBB) type and the mean frontal axis of QRS is −75 degree. In some cases with right ventricular pacing all the precordial leads from V1 through V6 display QR or rS pattern, as shown in Figure 2. This pattern of QRS was classified as 'S' type.

The tip of the catheter unexpectedly entered the coronary vein in some instances. In such cases the tip of the catheter was directed posteriorly in the lateral X-ray film. In a case shown in Figure 3, the tip of the catheter was placed within the coronary vein and the precordial leads showed a right bundle branch block (RBBB) type of QRS. In another case with the tip

<table>
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<tr>
<th>Cath. Tip</th>
<th>LBBB-type</th>
<th>RBBB-type</th>
<th>S-type</th>
<th>Bilateral-type</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>RV Apex</td>
<td>11</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>19</td>
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<tr>
<td>RV Mid</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>RV Out</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Cor. Vein</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16</strong></td>
<td><strong>4</strong></td>
<td><strong>8</strong></td>
<td><strong>2</strong></td>
<td><strong>30</strong></td>
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Key Words:
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RBBB

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of the catheter placed within the coronary vein all the precordial leads from V1 through V6 showed a dominant R pattern of QRS, as shown in Figure 4. This type of QRS was classified as 'bilateral type'.

Table 1 showed the relationship between the QRS morphology and the position of the tip of the catheter. In 26 cases with the catheter tip placed properly at the apex (19 cases) or at the mid-portion (7 cases) of the right ventricle, 15 showed LBBB type, 2 RBBB type, 8 'S' type, and 1 'bilateral' type of QRS. On the other hand, in three cases in which pacing was carried out from within the coronary vein, two exhibited RBBB type and the other 'bilateral' type of QRS.

In a case shown in Figure 5 temporary pacing was performed with the tip of the catheter placed in the outflow tract of the right ventricle. The QRS displayed and LBBB pattern with a mean frontal axis of +45 degree which is an
Fig. 2. Electrocardiogram in a case with right ventricular pacing, showing an ‘S’ type of QRS with left axis deviation.

Fig. 3. a) Postero-anterior and lateral roentgenograms, demonstrating that the catheter tip was inserted into the coronary venous system.

extremely unusual axis in right ventricular pacing. Three days later, intermittent pacing failure occurred due to intermittent sliding out of the catheter tip into the pulmonary artery from the outflow tract of the right ventricle.

Figure 6 demonstrated the mean frontal axis of the paced QRS in 30 pacings. The mean frontal axis of 27 cases ranged between −45 to −75 degree. The case with the mean QRS axis of +45 degree was the above-mentioned case in which temporary pacing was performed in the outflow tract of the right ventricle. Two cases showing the mean QRS axis of +120 and −135 degree, respectively, exhibited QRS of RBBB type and the catheter tip was unexpectedly placed within the coronary venous system in both cases.

Although the mean frontal axis of QRS was stable and unchanged after pacing was started with the catheter tip placed properly within the right ventricle, QRS morphology of the precordial leads sometimes changed during early pacing period without any pacing trouble. Minor changes of QRS pattern of the left precordial leads were observed in 12 out of 30 pacings and about half of them occurred within 10 days after the
b) Electrocardiogram of the same case, showing an RBBB type of QRS with an unusual axis deviation.

Fig. 4. Electrocardiogram in a case with pacing from within the coronary venous system, showing a ‘bilateral’ type of QRS with left axis deviation.

beginning of the pacings.

**DISCUSSION**

The QRS morphology provides an useful information as to the position of the electrode catheter in transvenous pacing. In the majority of the cases with right ventricular endocardial pacing the QRS complex exhibited a left bundle branch block (LBBB) pattern. Among 26 pacings presented in this report in which the catheter tip was placed properly within the right ventricle LBBB pattern was found in 15 pacings.

In the other 8 pacings from within the right ventricle an ‘S’ type of QRS was found in the precordial leads. This type of QRS is not very unusual in right ventricular endocardial pacing.

and is attributed to the fact that the activation of the ventricles is initiated at the apex and the level of the precordial leads is low enough to produce a predominant negative deflection even in the left precordial leads. It would be suggested from the results of the present series that the 'S' type of QRS in patients with right ventricular endocardial pacing could be regarded as a variation of LBBB type.

Right bundle branch block type of QRS is an unusual finding in transvenous pacing. It has been reported that a right bundle branch block type of QRS is produced when the electrode catheter is unexpectedly inserted into the coronary venous system. Among three our cases with pacing carried out from within the coronary venous system an RBBB type of QRS was observed in two cases and a 'bilateral' type in the third case. The latter pattern of QRS was reported in cases with pacing from the coronary vein and was described to be comparable with QRS pattern of type A WPW syndrome.

There were three instances in the present series showing RBBB type or 'bilateral' type of
QRS in which the tip of the electrode catheter was judged to be paced properly at the apex of the right ventricle. There was no evidence suggesting perforation of the free wall of the right ventricle or interventricular septum by the pacing catheter in these three cases. It has been reported that in some instances an RBBB pattern developed in spite of that pacing was performed with the electrode catheter placed properly at the right ventricular apex. No single explanation seems to be established for this type of electrocardiogram, although some possible hypotheses were proposed that the electrical activation would be initiated at some part of the left ventricle by right ventricular pacing.

In right ventricular endocardial pacing with the catheter tip placed at the apex or its vicinity an extreme left axis deviation is observed in the limb leads because the excitation propagates in an apex-to-base direction. In the majority of our cases of transvenous pacing the mean frontal QRS axis showed extreme left axis deviation as shown in Figure 6. There were three exceptional cases in which the mean frontal QRS axis were +45, +120, and -135 degree, respectively. It was revealed that pacing was carried out from the outflow tract of the right ventricle in the first case and from within the coronary vein in the latter two cases.

**SUMMARY**

In the majority of cases with transvenous right ventricular pacing the QRS complex exhibited LBBB or 'S' patterns and the mean frontal QRS axis ranged between -45 and -75 degrees. When RBBB or 'bilateral' patterns of QRS are encountered in attempted right ventricular pacing or when the mean frontal QRS axis is found to be located between 0 and +270 degree, the position of the catheter tip should be reexamined to avoid a malpositioning of the catheter electrode.

**REFERENCES**


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