Catheterization of the Left Ventricle in Man
Study of Right Bundle Branch Block by Simultaneous Intracardiac Electrocardiography of Both Ventricles

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Simultaneous catheterization of the left and right ventricles was performed in a case of right bundle branch block. It was thought that in right bundle branch block the polarity of the initial deflection of the potentials obtained in the left ventricular cavity could be studied without interference of those contributed by the right ventricular cavity. A description of the technic employed is given. The results confirm those obtained in dogs. There is initial negativity of the potentials obtained within the left ventricular cavity.

Catheterization of the right cardiac chambers and pulmonary artery has been widely applied to the study of cardiac dynamics as well as to the analysis of cavity potentials. Since retrograde catheterization of the aorta had been successfully accomplished for direct aortography, it was felt that modification of such technics might permit catheterization of the left heart for the purpose of recording its cavity potentials. Such studies would be of particular interest in determining the spread of the excitation wave through the interventricular septum and might be accomplished best in subjects with right bundle branch block.

Method

The common carotid artery was exposed surgically under local anesthesia as for cerebral arteriography. A 13 gage needle was inserted through the vessel wall into which a purse string suture had been placed. With the needle directed toward the heart, a tightly fitting No. 5 French radiopaque metallic tipped catheter was slowly threaded into the artery. (A 16 gage needle fitted with a No. 3.5 French catheter was also found suitable.) The catheter was then positioned under fluoroscopic control. Passage through the aortic valve proved difficult and seemed to be accomplished best by allowing the catheter to form a coil, the blunt end of which entered the left ventricular cavity.

The right cardiac chambers were catheterized in the usual manner by introducing a similar catheter into one of the antecubital veins. Spot roentgenograms were taken as permanent and accurate records of the location of both catheter tips whenever electrocardiograms were recorded. The Sanborn Tri-beam Stethocardiette was employed throughout. All intracardiac tracings were taken at three times the conventional speed (75 mm. per second).

Material

A 76 year old white man was admitted to the hospital on Oct. 12, 1948 with the diagnosis of advanced metastatic carcinoma of the liver. The primary site was most probably in the gastrointestinal tract. The possible dangers of the procedure were explained and consent obtained. A routine electrocardiogram (fig. 1) showed right bundle branch block. The QRS complex was widened and measured 0.12 second. The RS-T segments were slightly depressed in leads V2 to V6. The T waves were low.

Catheterization of the left ventricle was performed from the left common carotid artery as described above. Simultaneously catheterization of the right ventricle was performed from the right antecubital vein. Following these procedures and the recording of the electrocardiograms illustrated, the patient developed a right hemiparesis and aphasia. These had improved by the time he was transferred to a chronic institution 10 days later.

Findings

1. With the tip of the left catheter situated above the aortic valve and the tip of the right catheter in the outflow tract of the right ventricle (figs. 2A and 3A), the following findings were noted: (a) Left Side. The peak of R of the atrial complex is reached at 0.06 second. The
ventricular complex shows a very small R wave, with an initially slow then rapid down-stroke. The deflections of higher amplitude are ended at 0.07 second and are followed by a low voltage biphasic deflection. The RS-T segment shows considerable positive displacement with upright T waves. Small U waves are also noted.

and the right catheter still in the right ventricular cavity as in 1 (figs. 2B and 3B), these findings were observed: Left Side. The ventricular complex has no R wave. The onset of the Q wave is synchronous with the Q wave of V4. The initial phase is somewhat slower than the remainder of the complex. The S wave shows distinct notching which is synchronous with the upstroke of the R' in V1. A second QS-like complex of low amplitude follows the first and is almost synchronous with the R'S' of the tracing simultaneously taken from the right ventricular cavity.

2. With the tip of the left catheter situated within the outflow tract of the left ventricle and the right catheter still in the right ventricular cavity as in 1 (figs. 2B and 3B), these findings were observed: Left Side. The ventricular complex has no R wave. The onset of the Q wave is synchronous with the Q wave of V4. The initial phase is somewhat slower than the remainder of the complex. The S wave shows distinct notching which is synchronous with the upstroke of the R' in V1. A second QS-like complex of low amplitude follows the first and is almost synchronous with the R'S' of the tracing simultaneously taken from the right ventricular cavity.

(b) Right Side. The ventricular complex consists of an initial high RS wave which reaches its peak 0.02 second after the beginning of the complex and is followed by an R'S' at 0.085 second after the beginning of the complex. The RS-T segment shows a slight negative displacement followed by an inverted T wave.

2. With the tip of the left catheter situated within the outflow tract of the left ventricle and the right catheter still in the right ventricular cavity as in 1 (figs. 2B and 3B), these findings were observed: Left Side. The ventricular complex has no R wave. The onset of the Q wave is synchronous with the Q wave of V4. The initial phase is somewhat slower than the remainder of the complex. The S wave shows distinct notching which is synchronous with the upstroke of the R' in V1. A second QS-like complex of low amplitude follows the first and is almost synchronous with the R'S' of the tracing simultaneously taken from the right ventricular cavity.

3. With the tip of the left catheter in the ascending aorta at approximately the level of the sinoatrial node and the right catheter

![Fig. 1. Conventional electrocardiogram. Right bundle branch block is present.](image)

![Fig. 2A. Left sided exploring electrode above aortic valve (white arrow). Tip of right sided electrode: outflow tract of right ventricle (black arrow). B. Tip of left sided electrode within the outflow tract of left ventricle (white arrow). Tip of right sided electrode as in 2A. C. Tip of left sided catheter in ascending aorta at approximate level of S-A node. Right sided catheter near the S-A node.](image)
CATHETERIZATION OF LEFT VENTRICLE IN MAN

Fig. 3A. The catheter in the left side is above aortic valve (see fig. 2A). The ventricular complexes show a small R-wave. Right ventricular complexes show an RR' pattern \(1\text{MV} = \frac{10}{10}\).

B. Left ventricular cavity lead (see fig. 2B) shows an initially slow but entirely negative deflection. The configuration of the right ventricular complexes although somewhat different due to slight change of the electrode's position are basically similar to those shown in A \(1\text{MV} = \frac{10}{11}\).

C. The catheter in the left ventricle is at the level of the S-A node. The catheter in the right ventricle is near S-A node. Note the striking similarity of atrial and ventricular complexes \(1\text{MV} = \frac{20}{11}\).

near the sinoatrial node (figs. 2C and 3C), the following findings were noted:

Tracings from both ventricles show essentially the same features. The atrial complex consists of a deep QS wave, the total duration of which is somewhat more than 0.12 second. The ventricular complex reveals an RR' pattern with a negative T wave, similar to the complex from the right ventricular cavity.

Discussion

Wilson and his co-workers\(^1\) produced right bundle branch block experimentally in dogs and recorded intracavity potentials. They reported the presence of an initial R followed by an S wave in the right ventricle while in the left ventricle complete negativity in the form of a QS wave was present. These findings have been corroborated by Sodi-Pollares and co-workers.\(^2\) Hecht\(^3\) studied 2 patients with right bundle branch block by catheterization of the right atrium but did not explore the right ventricle. Tracings taken at low atrial levels showed a small R and a deep S followed by a large R' and small S' in one case. In the other case, a similar pattern was found at upper atrial levels. The small R' seen in the first case was absent but there was a short, deep Q followed by a notched R'. Sodi-Pollares and his co-workers\(^4\) have reported their findings of the right intracavity potentials in human subjects with right bundle branch block and these corresponded to the findings in animal experiments: The ventricular complex consisted of an rsRS pattern followed by a negative T.

The first small positive deflection (r) coincided with the initial R of \(V_1\) while the late positive deflection (R) coincided with the ascending limb of R' in \(V_1\). These were interpreted as representing two separate phases of septal activation. The first represented the normal activation of the upper portion of the septum from the left to the right. The second represented abnormal activation of a lower portion of the septum below the point of block. These same authors also reported their findings in a patient with coarctation of the aorta and patent interatrial septal defect with congenital right bundle branch block. They were able to pass the catheter through the septal defect
and thus record left cavity potentials. The tracing showed a purely negative QS complex with a slurred initial deflection. The RS-T segment and T wave were positive.

Our study of the cavity potentials in a patient with right bundle branch block demonstrates that there is a completely negative initial deflection (QS) in the left ventricular cavity. The absence of positivity seems to support the contention that activation of the septum occurs initially on the left side. Our findings are in accord with those found in experimental right bundle branch block in dogs by Wilson and Sodi-Pollares and their co-workers,1-4 as well as those found in man by Sodi-Pollares.4

Because of the difficulties encountered in the technic of catheterization of the left ventricle, and because of the danger of cerebral complications, we feel that this procedure cannot be recommended. It is of interest to note that since our experience, Zimmerman, Scott and Becker5 reported that they had catheterized the left ventricular cavity from the ulnar artery in 10 cases of aortic insufficiency. Their experience seems to confirm our opinion concerning the general hazards of this procedure. We feel that the left ventricular cavity may best be catheterized during lobectomy or pneumonectomy. Catheters could then be passed through a pulmonary vein into the left atrium and left ventricle.

SUMMARY
1. The left ventricle in a human subject with an intact interventricular septum was catheterized via the common carotid artery.
2. Passage of the catheter beyond the aortic valve is difficult and may be impossible.
3. The occurrence of cerebral complications makes this procedure hazardous.
4. Simultaneously obtained intracavity potentials from both ventricles in human right bundle branch block are described.
5. The findings are in accord with those in canine experimental right bundle branch block. They are similar to the findings in another case of human right bundle branch block in whom the exploring catheter passed coincidentally from the right to the left side of the heart through an interatrial defect.

REFERENCES
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