THE LOCATION AND COURSE OF THE ATRIOVENTRICULAR
CONDUCTION SYSTEM IN COMMON ATRIOVENTRICULAR
ORIFICE AND IN ITS RELATED ANOMALIES WITH
TRANSPOSITION OF THE GREAT ARTERIES
— A Histopathological Study of Six Cases —

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The location and course of the atrioventricular (AV) conduction system were studied histopathologically in 6 hearts by sectioning serially, 4 having common AV orifice (CAVO) with complete or partial transposition of the great arteries (TGA) and 2 having ventricular septal defect of the persistent common AV canal type (VSD-C) with complete TGA.

Two cases of CAVO with TGA and asplenia syndrome (Cases 1 and 2) had 2 discrete AV conduction systems, being posterior and anterior to the site of the defect, respectively. In these 2 cases posterior AV conduction system well developed, whereas the anterior one was hypoplastic. In another case of CAVO with TGA and asplenia syndrome (Case 3), only the anterior AV conduction system existed near the base of the great arteries. In the other case of CAVO with TGA and polysplenia syndrome (Case 4), the posterior AV conduction system was found to have a congenital interruption of the AV bundle of His. Two cases of VSD-C with TGA but with no splenic anomaly (Cases 5 and 6) showed the posterior AV conduction system with communication-free accessory bundles. The posterior AV node, bundle of His and left bundle branch inevitably shifted postero-inferiorly, except in Case 3. The bundle branches were always distributed appropriately to their morphologically matched ventricles.

The superiorly oriented vector in the mean frontal QRS axis in Cases 1, 5 and 6 seemed to be related to the postero-inferior displacement of the posterior AV conduction system, whereas those of the left-inferior oriented vector in Cases 2 and 3 were thought to be responsible for the excessively unbalanced size of ventricles. The complete AV block in Case 4 was correlated with the interruption of the bundle of His. The morphogenesis of the anterior AV conduction system was discussed in relation to the asplenia syndrome.

Key Words:

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THE anomalies of complete or partial transposition of the great arteries (TGA) associated with common atrioventricular orifice (CAVO) are more common than is generally believed. The combined occurrence of these two anomalies may change the clinical course and prognosis of the patients as well as the surgical approach for them.¹ Recent advances in surgical treatment have indicated that almost all forms of CAVO and TGA may now be candidates for surgical correction. This fact means that there is a need for a thorough understanding of the disposition of the conduction system in these anomalies. Therefore, we studied histopathologically hearts with CAVO or its related anomalies associated with TGA in order to clarify the location and course of the

atrioventricular (AV) conduction system.

TERMINOLOGY

Complete Type of CAVO: The mitral and tricuspid orifices are not separated, but consist of a single orifice. This orifice is guarded by bridging anterior, posterior and 2 lateral leaflets. There is no valvular tissue between the bridging leaflets on the naked summit of the ventricular septum.²

Balanced Form of CAVO: Both ventricles have hypertrophy and enlargement.³

Right Dominant Form of CAVO: There is hypertrophy and enlargement of the right ventricle, and the left ventricle is smaller and thinner than normal.³

TABLE I CLINICAL AND PATHOLOGICAL FINDINGS

Case No.	Cardiac anomalies	Associated anomalies	Splenic anomaly	Age Sex	Electrocardiogram			Heart weight	AV-node Post.	Ant.	Accessory bundle
					PR	QRS axis	Others				
1	CAVO + TGA [A,D,D]	ASD-II P. Atresia PAPVD PDA PLSVC	Asplenia	6m, M	0.16 sec	-155°	Rs in V ₁ & rS in V ₆	53g	+	+	-
2	CAVO + DORV [A,L,L]	Dextrocardia ASD-II P. Atresia TAPVD PDA Right Ao.	Asplenia	1m, F	0.14 sec	+60°	q in I,II, III,aV _L ,AV _F , V ₂₋₆	21g	+	+	-
3	CAVO + DORV [S,D,L]	ASD-II P. Atresia PDA	Asplenia	5y, M	0.16 sec	+10°	rS in V ₁₋₅	115g	-	+	-
4	CAVO + DORV [S,D,D]	ASD-II PAPVD PLSVC Co. A	Polysplenia	2m, F	3° AV block	+70°	Junctional rhythm	-	+	-	-
5	VSD-C + TGA [S,D,D]	PDA	-	2.5y, F	0.24 sec	-80°	iRBBB	90g	+	-	+
6	VSD-C + TGA [S,D,D]	PS Surgery*	-	3y, M	0.18 sec	-140°	R in V ₁ & rS in V ₆	85g	+	-	+

Abbreviations: Ao.= Aortic Arch; ASD-II = Atrial Septal Defect of Ostium Secundum Type; CAVO= Common Atrioventricular Orifice; Co. A = Coarctation of the Aorta; DORV = Double Outlet Right Ventricle (Partial Transposition of the Great Arteries); F = Female; M = Male; m = month (s); PAPVD = Partial Anomalous Pulmonary Venous Drainage; P. Atresia = Pulmonary Atresia; PDA = Patent Ductus Arteriosus; PLSVC = Persistent Left Superior Vena Cava; PS = Pulmonary Stenosis; TGA = Complete Transposition of the Great Arteries; Surgery* = modified Mustard's operation; [A,D,D] = Situs Ambiguus; D-loop; D-transposition; [A,L,L] = Situs Ambiguus; L-loop; L-transposition; [S,D,L] = Situs solitus; D-loop; L-transposition; [S,D,D] = Situs solitus; D-loop; D-transposition

Fig.1. A case of common atrioventricular orifice of the complete type and balanced form with complete transposition of the great arteries (Case 1). A and B: Diagrams showing morphology of the heart and conduction system (A: viewed from left side, B: viewed from above). C–F: Microscopic pictures of sections. Weigert van Gieson's stain, $\times 40$. (C: posterior atrioventricular node viewed from posterior, D: posterior atrioventricular bundle viewed from posterior, E: anterior atrioventricular node viewed from right side, F: anterior atrioventricular node and bundle ($\dagger$) viewed from right side) ECG shows sinus rhythm, superior oriented vector in mean frontal QRS axis, and right ventricular hypertrophy.

A–AVN = anterior atrioventricular node, Ao = aorta, ASD = atrial septal defect of the ostium secundum type, CAVO = common atrioventricular orifice, CS = left sided ostium of the coronary sinus, LA = left atrium, LBB = left bundle branch, LV = left ventricle, PA = pulmonary artery, P–His = posterior bundle of His, P–AVN = posterior atrioventricular node, RBB = right bundle branch

Ventricular Septal Defect of the Persistent Common AV Canal Type (VSD-C): This VSD differs from the ordinary VSD in its location and usually occupies the position of the ventricular component of the defect in persistent common AV canal without atrial septal defect of the ostium primum type.⁴

In representing the position relative to the AV node, the terms “anterior” and “posterior” are used synonymously with “ventral” and “dorsal”, respectively in this study.

MATERIALS AND METHODS

The location and course of the AV conduction system in 6 hearts, 4 with complete-type CAVO associated with complete TGA or partial TGA

(synonymous with double outlet right ventricle, DORV) and 2 with VSD-C with complete TGA, were studied. The clinical and pathologic data are summarized in Table I.

Preparations of the materials were done according to Lev's method.⁵ The lower half of the atrial septum and the upper half of the ventricular septum were entirely taken as 2 to 4 blocks from each specimen. These blocks were serially sectioned on the frontal plane at a 7 micra thickness. In addition, the base of the great arteries was removed from each specimen and serially sectioned on the sagittal plane. Every fifth to 10th section was retained, and alternate sections were stained with hematoxylin-eosin and Weigert van Gieson's method. Following the examination of these sections, supplementary

Fig. 2. A case of common atrioventricular orifice of the complete type and right dominant form with inverted partial transposition of the great arteries (inverted double outlet right ventricle), ventricular inversion and dextrocardia (Case 2). A–C: Diagrams showing morphology of the heart and conduction system (A: viewed from left side, B: viewed from above, C: viewed from posterior). D–F: Microscopic pictures of sections viewed from posterior. Weigert van Gieson's stain. (D: posterior atrioventricular node and bundle of His, $\times 40$, E: anterior atrioventricular node and bundle of His $\times 40$, F: posterior atrioventricular node and atrioventricular bundle 3 mm distal to D, $\times 20$) Note the left ventricle, which obviously had the atrioventricular valve apparatus. ECG shows sinus rhythm, normal frontal QRS axis, and q wave in I, II, III, aVL, aVF and V_2-6 .

A–AVN = anterior atrioventricular node, Ao = aorta, ASD = atrial septal defect of the ostium secundum type, CAVO = common atrioventricular orifice, CS = left sided ostium of the coronary sinus, LBB = left bundle branch, LV = left ventricle, PA = pulmonary artery, P–AVN = posterior atrioventricular node, P–His = posterior bundle of His, RBB = right bundle branch, RV = right ventricle

blocks were resected from both ventricular walls and processed similarly, if necessary.

RESULTS

Case 1

This was a 6-month-old male who had situs ambiguus with asplenia syndrome. His electrocardiogram (ECG) showed sinus rhythm (PR: 0.16 sec), a mean frontal QRS axis of -115° and

an Rs pattern in the right precordial leads and an rS pattern in the left precordial leads. The anatomical diagnosis was as follows: 1) situs ambiguus, d-bulboventricular loop, d-TGA with pulmonary atresia, 2) complete type, balanced form CAVO, 3) atrial septal defect of the ostium secundum type, 4) partial anomalous pulmonary venous drainage to the right-sided artium, 5) bilateral superior vena cava and 6) patent ductus arteriosus.

Fig.3. A case of common atrioventricular orifice of the complete type and right dominant form with inverted partial transposition of the great arteries (inverted double outlet right ventricle) (Case 3). A and D: Microscopic pictures of sections viewed from right side. Weigert van Gieson's stain. (A: anterior atrioventricular node, bundle of His and right bundle branch, $\times 25$. D: left bundle branch, $\times 40$). B and C: Diagrams showing morphology of the heart and conduction system (B: viewed from right side, C: Viewed from above). ECG shows sinus rhythm, normal frontal QRS axis and rS pattern in $V_1 - 5$.

A-AVN = anterior atrioventricular node, A-His = anterior bundle of His, Ao = aorta, CAVO = common atrioventricular orifice, LBB = left bundle branch, PA = pulmonary artery, RBB = right bundle branch

Location and Course of the AV Conduction System (Fig. 1): A regular posterior AV node and its approaches were situated beneath the ostium of the left-sided coronary sinus. In addition, an accessory anterior AV node and its approaches were present on the right-anterior side of the common AV annulus adjacent to the aorta. The posterior AV node pierced the central fibrous body to form the posterior bundle of His. This ran along the left lower margin of the CAVO and branched off the radiation of the left bundle branch (LBB) to the left-sided morphologic left ventricle. The right bundle branch (RBB) branched from the bifurcation of the posterior bundle of His. It then ran along the right side of the summit of the ventricular septum to anterior margin of the CAVO and turned toward the apex. The course of the posterior AV conduction system was almost similar to that in isolated CAVO, i.e., it was shifted more postero-inferiorly than the normal course. The anterior AV bundle was hypoplastic. It penetrated into the common AV annulus and divided into 2 vestigial bundle-like tissues. There was no connection between the 2 AV conduction systems by specialized cardiac tissue.

Case 2

This was a one-month-old female who had dextrocardia and situs ambiguus with asplenia syndrome. Her ECG showed sinus rhythm (PR: 0.14 sec), a mean frontal QRS axis of $+60^\circ$ and q waves in I, II, III, aVF and V_{2-6} . The anatomical diagnosis was as follows: 1) situs ambiguus, 1-bulboventricular loop, 1-partial TGA (inverted DORV) with pulmonary atresia, 2) complete type, right dominant form CAVO, 3) atrial septal defect of the ostium secundum type, 4) total anomalous pulmonary venous drainage to the right superior vena cava and 5) patent ductus arteriosus.

Location and Course of the AV Conduction System (Fig. 2): There were 2 AV nodes, i.e., a posterior node beneath the coronary sinus ostium and an anterior node on the left-anterior side of the common AV annulus. The posterior bundle of His diverged from the proximal portion of the posterior AV node. It descended the summit of the ventricular septum to its right side. The bundle branch in the right-sided morphologic left ventricle had the characteristics of LBB, being a thin sheet of cells. In contrast, a chord-like bundle, suggestive of RBB, was identified in the left-sided morphologic right ventricle. It passed intramyocardially to the left side of the ventricu-

Fig. 4. A case of common atrioventricular orifice of the complete type and balanced form with partial transposition of the greater arteries (double outlet right ventricle) (Case 4). A and B: Diagrams showing morphology of the heart and conduction system (A: viewed from right side, B: viewed from posterior). ECG shows complete atrioventricular block with junctional escape beats.

Ao = aorta, ASD = atrial septal defect of the ostium secundum type, AVN = atrioventricular node, CAVO = common atrioventricular orifice, LBB = left bundle branch, LV = left ventricle, PA = pulmonary artery, RBB = right bundle branch, RV = right ventricle, * interruption of the bundle of His

lar septum. The anterior bundle of His penetrated the common AV annulus, which was located just behind the aortic annulus. Then, it branched out into the anterior wall of the morphologic right ventricle as 2 vestigial bundle-like tissues. Therefore, 2 discrete specialized AV conduction systems were present.

Case 3

This was a 5-year-old male who had situs solitus with asplenia syndrome. His ECG showed

Fig.5. A case of ventricular septal defect of the persistent common AV canal type with complete transposition of the great arteries (Case 5). A–C: Microscopic pictures of sections viewed from posterior. Weigert van Gieson's stain. (A: atrio-ventricular node, $\times 40$, B: bundle of His, $\times 100$, C: accessory bundle, $\times 40$), D and E: Diagrams showing morphology of the heart and conduction system (D: viewed from right side, E: viewed from above). ECG shows sinus rhythm with PR prolongation, left axis deviation and incomplete right bundle branch block.

AcB = accessory bundle, Ao = aorta, His = bundle of His, AVN = atrioventricular node, CS = ostium of the coronary sinus, LBB = left bundle branch, PA = pulmonary artery, RA = right atrium, RBB = right bundle branch, RV = right ventricle, VSD-C = ventricular septal defect of the persistent common AV canal type

sinus rhythm (PR: 0.16 sec) a mean frontal QRS axis of $+10^\circ$ and an rS pattern in V_{1-5} . The anatomical diagnosis was as follows: 1) situs solitus, d-bulboventricular loop, 1-partial TGA (inverted DORV) with pulmonary atresia, 2) complete type, right dominant form CAVO, 3) atrial septal defect of the ostium secundum type and 4) patent ductus arteriosus.

Location and Course of the AV Conduction

System (Fig. 3): There was no cardiac specialized tissue in the ordinary posterior position of the AV conduction system. The anterior AV node and its approaches were located at the anterior aspect of the CAVO, just behind the atretic pulmonary artery. The AV node gave origin to the bundle of His. It ran through the anterior wall of the right-sided large right ventricle separating into 2 components: one, presenting a chord-like

Fig.6. A case of ventricular septal defect of the persistent common AV canal type with complete transposition of the great arteries (Case 6). A–C: Microscopic pictures of sections. Weigert van Gieson's stain. (A: atrioventricular node viewed from posterior, $\times 40$, B: bundle of His viewed from posterior, $\times 25$, C: accessory bundle viewed from right side, $\times 40$) D and E: Diagrams showing morphology and conduction system (D: viewed from right side, E: viewed from above). ECG shows sinus rhythm, superior oriented vector in mean frontal QRS axis and right ventricular hypertrophy.

AcB = accessory bundle, Ao = aorta, AVN = atrioventricular node, CS = ostium of coronary sinus, LBB = left bundle branch, RA = right atrium, RBB = right bundle branch, RV = right ventricle, VSD-C = ventricular septal defect of the persistent common AV canal type, PA = pulmonary artery

structure, traversed down to the anterior wall of the right ventricle; the other, having a fan-like structure, was distributed to the left ventricular side of the vestigial septum.

Case 4

This was a 2-month-old female who had situs solitus with polysplenia syndrome. Her ECG showed a complete AV block with junctional escape beats. The anatomical diagnosis was as follows: 1) situs solitus, d-bulbo ventricular loop,

d-partial TGA (DORV) with coarctation of the aorta, 2) complete type, balanced form CAVO, 3) atrial septal defect of the ostium secundum type, 4) partial anomalous pulmonary venous drainage and 5) persistent left superior vena cava.

Location and Course of the AV Conduction System (Fig. 4): An AV node existed posterior and slightly right of the central fibrous body. The node gave origin to the penetrating AV bundle which, however, was completely interrupted by fibrous tissue. About one mm distal to this interrupting site, 2 penetrating bundles of His emerged and gradually came together to form one branching portion of the bundle of His. The branching bundle coursed along the left lower margin of the defect and gave off the LBB, then bifurcated. The RBB ran along the anterior margin of the defect to the trabecula septomarginalis and turned downward to the apex at the root of the papillary muscle of Lancisi. There was no evidence of the anterior AV conduction system.

Case 5

This was a 2-and-a-half-year-old male who had situs solitus with a normal spleen. His ECG showed sinus rhythm with a prolonged PR time of 0.24 sec, a mean frontal QRS axis of -80° and incomplete RBB block. The anatomical diagnosis was as follows: 1) situs solitus, d-bulboventricular loop, d-complete TGA, 2) ventricular septal defect of the persistent common AV canal type and 3) patent ductus arteriosus.

Location and Course of the AV Conduction System (Fig. 5): The course of the AV conduction system was basically the same as in isolated VSD-C, that is, postero-inferior displacement of the AV node, the bundle of His and the LBB. In addition, an accessory bundle was found at the right antero-lateral margin of the AV annulus. This structure was composed of multiple, tightly packed cells and quite distinct from the surrounding myocardium. There was no contiguity between the accessory bundle and the ventricular myocardium.

Case 6

This was a 3-year-old male who had situs solitus with a normal spleen. His ECG showed sinus rhythm (PR: 0.18 sec), a mean frontal QRS axis of -140° , an R wave in V_1 and rS in V_{2-6} . The anatomical diagnosis was as follows: 1) situs solitus, d-bulboventricular loop, d-complete TGA with subpulmonary stenosis, 2) ventricular septal defect of the persistent common AV canal type and 3) surgical procedure (modified Mustard's operation).

Location and Course of the AV Conduction System (Fig. 6): These were almost similar to Case 5, except that the accessory bundle was located in the right postero-lateral margin of the AV annulus.

DISCUSSION

The results of our present investigation on the AV conduction system in CAVO (Cases 1–4) and VSD-C (Cases 5 and 6) associated with TGA can be summarized as follows:

1) In Cases 1 and 2, 2 discrete AV nodes were found, one posterior and beneath the ostium of the coronary sinus and the other on the anterior side of the common AV annulus. The bundle of His and bundle branches, derived from the posterior AV node, were well developed, whereas those from the anterior AV node were hypoplastic.

2) In Case 3, the anterior AV node alone existed at the anterior aspect of the CAVO. It gave origin to the bundle of His and bundle branches.

3) In Case 4, the posterior AV conduction system was found to have a congenital interruption of the penetrating portion of the bundle of His.

4) In Cases 5 and 6, the accessory bundle was found in the AV annulus of the right ventricle in addition to the regular posterior AV conduction system.

5) The posterior AV node, AV bundle and LBB were inevitably displaced postero-inferiorly, except for Case 3.

6) The bundle branches were always distributed appropriately to their morphologically matched ventricles.

In isolated CAVO or VSD-C, the postero-inferior displacement of the AV node, AV bundle and LBB has been found to be the established feature⁶⁻⁹. The posterior AV conduction system of CAVO with TGA or VSD-C with TGA also had this feature. However, they often had an additional AV conduction system in the anterior aspect of the defect.

Mode of the Development of the Anterior Conduction System

Cardiac anomalies, which have been found to have histological evidence for an anterior AV conduction system, are the single ventricle,¹⁰⁻¹⁴ corrected transposition of the great arteries,¹⁵⁻²¹ mixed dextrocardia²² and right juxtaposition of the atrial appendages.²³ Atrio-ventricular and/or ventriculo-arterial discordance, and/or hypoplasia

of the ventricular septum are the common features in these anomalies. Three cases of CAVO with the anterior AV conduction system in our study and those of 4 cases in the previous reports were also complicated TGA. Thus, at least a part of the cases with anterior AV conduction tissue may be explained by the existence of atrio-ventricular and/or ventriculo-arterial discordance. According to Wenink,²⁴ the embryonal myocardium of the sinoatrial, atrioventricular, ventriculobulbar and bulbotruncal rings have morphologically specialized characteristics. The AV node develops from both the sinoatrial and atrioventricular rings. The fusion of the atrioventricular and ventriculobulbar rings becomes the common bundle. In this position, another contact can be made between 2 different rings, leading to the possibility of forming a second node-like structure.²⁴ One can therefore conceive that, if there is discordance of atria and ventricles and/or ventricles and arteries, other parts of these various rings may be remained as well as the normal components to form anterior AV node.

As for the relationships between the location of the AV conduction system and bulboventricular loop, Dick²⁵ has discussed cases of corrected transposition of the great arteries: a d-loop would be associated with a normal posterior AV conduction system, whereas an l-loop would be associated with an anterior AV conduction system with or without a posterior hypoplastic AV node. In the case of the single ventricle, usually having an anterior AV conduction system even though in the d-loop, Anderson¹⁰ has argued that the abnormally situated AV conduction tissue was an overgrowth of the specialized tissue always present in the normal heart. This overgrowth was caused by the failure of the posterior portion of the ventricular septum to develop.¹⁰ We observed, however, a developing posterior AV conduction system in the case of CAVO with TGA in the l-bulboventricular loop (Case 2). This case was not applicable to Dick's²⁵ or Anderson's¹⁰ theory. Wenink²⁴ has mentioned that the bulboventricular ring in the embryo could not be in its normal location in congenital cardiac anomalies. Therefore, it is not possible to predict the exact location of the AV conduction system in anomalies of atrioventricular or ventriculoarterial discordance unless the accurate position of the bulboventricular rings of the embryo can be prognosticated.

In this study, hearts showing the anterior AV conduction system were also complicated with asplenia. It is well recognized that there is a

Fig. 7. Schemes showing the relationship between morphology and mean QRS axis. A: frontal plane, representing Case 1, 5, and 6. B: frontal plane, representing Case 2. C: frontal plane, representing Case 3. D: horizontal plane, representing Case 3.

strong tendency toward symmetric development of a number of normally asymmetric organs or organ systems in congenital asplenia.²⁶ In our opinion, the symmetric development may not be confined to the relationship between right and left, but it seemed to be applicable to that of anterior and posterior (ventral and dorsal) in the heart. If we supposed that an abnormal rotation along the long axis of the bulboventricular tube occurred at early phase, simultaneous TGA and anterior position of the AV conduction system may be explained more easily. Clinicians and pathologists should be aware of the cases of congenital asplenia associated with CAVO and TGA in terms of the prediction of the anterior AV conduction tissue. The mode of development of

the anterior AV conduction system was not likely to relate the morphogenesis of CAVO, because there was no histological or electrophysiological evidence of the anterior AV conduction system associated with the isolated CAVO.

Correlation between AV Conduction Anomalies and ECG Findings with Special Reference to the Mean Frontal QRS Axis

The mean QRS vector represents the mean magnitude, direction and polarity of the electromotive forces for that period.²⁷ The net amount of the myocardium in each portion and the location and course of the conduction system are, therefore, considered to be the 2 main factors in determining the mean QRS axis.²⁸ The established ECG findings of CAVO and VSD-C, i.e., left axis deviation or superior oriented vector in the mean frontal QRS axis, have been proved to be related to the postero-inferior displacement of the AV conduction tissues.^{4, 7, 9} In this study, 3 cases showed a superior oriented axis (-115° , -80° and -140° in Cases 1, 5 and 6, respectively). In Case 1, although we have no evidence which AV conduction system, the anterior or the posterior, had been functioning, the posterior was more well developed than the anterior from the morphological point of view. If the posterior AV conduction system had worked, the superiorly oriented axis could be accounted for in the same way as in isolated CAVO (Fig. 7-A). The left axis deviation in Cases 5 and 6 were also interpreted in the same way as in isolated VSD-C, because their location and course of the AV conduction system were similar to those of isolated VSD-C, and their accessory bundles had no communication to the ventricular myocardium. The mean frontal QRS axis in Cases 2 and 3 was directed to the left-inferior ($+60^\circ$ and $+10^\circ$, respectively), probably because the large right ventricle was situated left-inferiorly to the tiny left ventricle (Fig. 7-B, C). In Case 2, small q waves in leads I, II, III, aVL, aVF and V_{2-6} may be the reflection of the early excitation of the right-sided left ventricle. In Case 3, deep S waves in V_{1-6} may be due to the anterior AV conduction system since the greater portion of the electromotive forces were considered to be directed posteriorly on the horizontal plane (Fig. 7-D). Kupersmith²⁹ has reported similar ECG findings in the corrected transposition of the great arteries with the anterior AV conduction system. Complete AV block with junctional escape beats in Case 4 was due to the congenital interruption of the penetrating portion of the His

bundle.

Surgical Implication

Reduced surgical mortality and improved long-term results may be expected by avoiding the occurrence of AV block.³⁰ In balanced form CAVO with TGA, the location and course of the posterior AV conduction system are principally the same as in isolated CAVO. Surgeons should be careful around the area of the ostium of the coronary sinus, the lower margin of the defect and the papillary muscle of Lancisi or its equivalent muscle. In CAVO of the right dominant type, it is difficult to suture the prosthetic septum in the ventricle without damage to the anterior AV bundle. Procedures such as resection, bypass and/or patch of the stenotic infundibular or valvular areas may also result in heart block because of the inability to accurately or consistently define the course of aberrant AV conduction tissue.³¹ In order to avoid suturing the conduction tissue and to perform corrective surgery, mapping of the intraventricular conduction system during the operation could possibly be helpful. Successful surgery without producing heart block has actually been documented in several reports.^{30, 32}

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