

# ELECTROCARDIOGRAPHIC CHANGES IN A.S.D.

By

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## INTRODUCTION

Among the congenital heart diseases atrial septal defect is the best known, readily recognised, easily and safely correctable anomaly, with left to right shunt at the atrial level. The right ventricle is subjected to volume overload, resulting in characteristic electrocardiographic and echocardiographic patterns. The appearance of R in VI is thought to be due to the delayed activation of the hypertrophied crista supraventricularis, while complete RBBB is due to a conduction defect in the Right bundle itself. We have studied the QRS duration in thirty six cases of documented secundum A.S.D. and the progression of QRS duration appears to be an ageing phenomenon.

## MATERIAL AND METHODS

Since February 1975 ninety six patients were studied and operated for A.S.D. in the National Institute of Cardiovascular Diseases, Karachi. Out of these cases the records of eighty two were available for study. All patients had Catheterization via Rt. Ante-cubital vein cutdown. Samples were taken from High, Low SVC; High mid and low Rt. atrium, Lt. atrium, Lt. vent. and Pulmonary veins. Pressures were recorded by Hewlet Packard eight channel recorder utilizing 23 DB Transducer kept at midchest level. A 2 vol % step up at atrial level, was taken as indicative of a significant L to R

Shunt at atrial level. O<sub>2</sub> saturations were done utilizing the AO Oximeter.

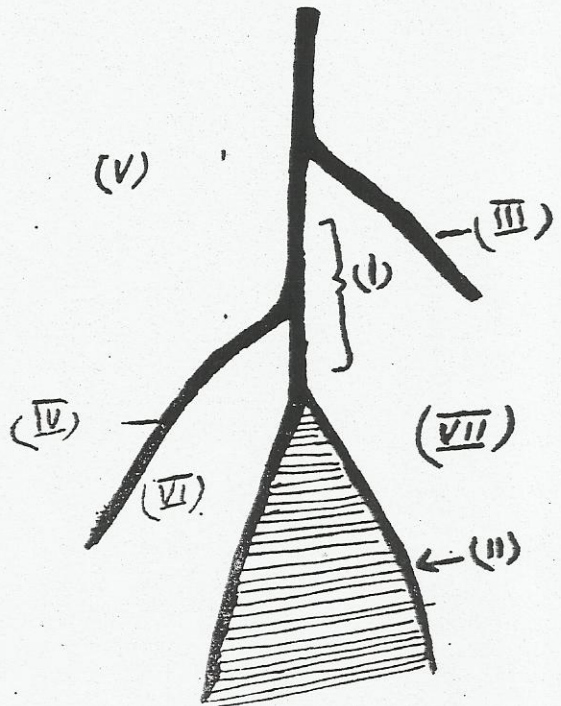


Diagram No. 1 Showing:

- (i) Membranous ventricular septum
- (ii) Muscular ventricular septum
- (iii) Attachment of mitral valve leaflet
- (iv) Attachment of tricuspid valve leaflet.
- (v) Rt. atrium.
- (vi) Rt. ventricle.
- (vii) Left ventricle.

From the National Institute of Cardiovascular Diseases (Pakistan), Karachi.



Diagram No: II Showing:

Buhl's type of defect in the membranous septum above the attachment of the tricuspid valve without leaflet fenestration resulting in direct left ventricular Rt. atrial communication.

## RESULTS

Table No. 1 shows the age and sex distribution of these cases. Thirty eight were males and forty four were females. The mean age for males was 21.2 and for females it was 21.4 years. The youngest patient was 6 years old and eldest was 47 years old.

Table No. II shows the types of defects seen. 14% were of sinus venosus type, 79% ostium secundum, 3.5% Primum type, 1.2% Gerbode type, one was found to have single atrium. 12 lead electrocardiograms were available in 36 cases and done at paper speed of 25 mm/sec., and standardized 1 mv = 10 mm. QRS Frontal axis was determined by measuring the amplitude of R and S waves in the 6 extremity leads. The lead containing the complex with maximum amplitude the axis was

taken as parallel to and the one with biphasic smallest was taken as perpendicular. If the complex was equal in 2 neighbouring leads the axis was taken to be lying in between. Table No. III & Fig. 1 shows the axis distribution of these cases, in 15 cases the axis was between  $+15^\circ$  and  $+90^\circ$ . In the rest there was Right axis deviation ( $> +110^\circ$ ). QRS duration was measured in lead II and VI and the longer duration was included. Table No. IV shows distribution of cases according to QRS morphology and durations. Incomplete RBBB was labelled when lead VI showed a rSR' or RSR' pattern and the duration of QRS complex was less than 0.11 sec. Complete RBBB was present when the duration of QRS was = 0.12 seconds and lead VI showed rSR' or RSR' pattern and lead I showed broad S waves.

## DISCUSSION

While a patent foramen ovale is very commonly encountered during Cardiac Cath. especially when performed from the leg, it is usually haemodynamically insignificant until associated with raised pressure in either atrium. Larger defects in the interatrial septum result in significant left to right shunting and volume overload of Right ventricle. Five distinct anatomical types of atrial septal defects are known (Diagrams I-IV). The most common of these is the A.S.D. of Secundum type. This defect is located in the region of fossa ovalis and generally is 1 cm or larger in size. The defect is surrounded by interatrial septum on all 4 sides but may reach the posterior wall in few cases. Eighty percent of our cases belonged to this category. The diagnosis is readily established by finding a step up of O<sub>2</sub> saturation in the M.R.A. or L.R.A. This step up should be generally more than 1.9 vol% over that of superior vena caval saturation in order to be associated with significant L to R shunt. The

The 5th is the rare type called the Raghieb defect this type of defect is postero-inferior to the fossa ovalis just near the opening of the coronary sinus which is absent, the left SVC drains into left atrium.

The secundum type of defect is most common and when cross sectional area of the defect is more than 2 cm, large amounts of blood are shunted from the L.A. to R.A. This results in volume overload of the Right Ventricle. There is eccentric hypertrophy of the Rt. Ventricle. Here the crista supraventricularis gets disproportionately hypertrophied. This hypertrophy of Crista results in Right and anterior-ward shift of the terminal forces resulting in rSR pattern in lead V1. Thus the initial r in V1 is due to vector I or midseptal depolarization, S is due to vector II or L.V. free wall forces and R is due to depolarization of the hypertrophied crista. This pattern is called the incomplete right bundle branch block pattern and is the most common finding in A.S.D. In our thirty six cases we have seen this in 18. As already mentioned this pattern is not due to a conduction defect in the right bundle but is due to cristal hypertrophy. In eleven of our cases complete RBBB was present. Our analysis of these cases shows that 72% cases of complete RBBB were more than 25 years of age and 80% cases with incomplete RBBB were less than 20 years of age. This shows that as the duration of volume overload increases it causes further cristal hypertrophy and further delay in conduction, through the hypertrophied crista. As shown in figure 2, we have plotted the duration of Q.R.S. complex in seconds with the age (in years) of the patients and the curve shows a linear progression of the Q.R.S. duration with the age of the patients. Thus it appears that increase in age of the patient in the A.S.D. is associated

with increase in Q.R.S. duration. Nasarallah A. et al., have found 45% cases with complete RBBB in old age group while in series with younger age groups only 10-15% were found to have complete RBBB. In their study all patients were above the age of sixty. It has also been found that complete RBBB rarely occurs below the age of forty years. However most of our patients with complete RBBB were between 25-47 years of age.

All our cases had normal P-R interval and this is the usual finding in Isolated Secundum A.S.D. However if patient gets digoxin then PR may increase. In some cases of familial A.S.D. the PR is reported to be prolonged. His bundle studies on these cases show that the conduction delay was above the A-V node, rather than in the A.V. node or below. It has been observed that in sinus venosus defect the axis is shifted to the left however in none of our cases we have noticed this, while all our patients were in sinus rhythm, in series where the ages are above 45 years the occurrence of At. Fibrillation becomes more common. As most of our patients were below the age of 47 years we have not seen a single case of A.S.D. with Atrial Fibrillation.

Table I  
A.S.D. Total No. of Cases by Age and Sex

	No.	Mean Age
Male	38	21.2
Female	44	21.4
Total	82	—

Table II  
Type of A.S.D.

	Post Op. Dx.	Pre Op. Dx.
Sinus Venosus Defect	12	9
Secundum Defect	65	70
Primum Defect	3	3
Gerbode	1	—
Prolapse Mitral Leaflet	3	5
Single Atrium	1	—

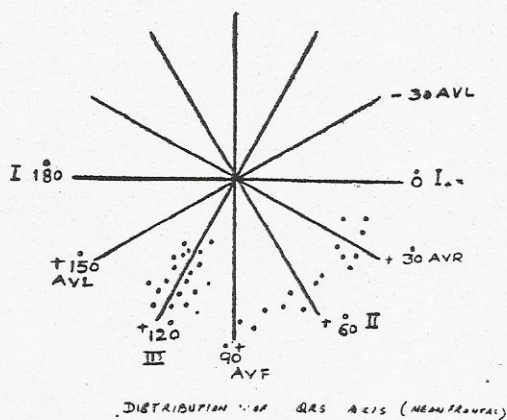


Fig. 1: QRS Axis.

One of our case had normal Electrocardiogram. No shift in the axis, duration or morphology of QRS was noted. In this case there was wide and fixed split second sound and a grade III/IV ejection systolic murmur along the left sternal border. X-Ray chest showed enlargement of the Cardiac Silhouette and pulmonary plethora. On Cardiac Catheterization a 12% step up was noticed in the mid Rt. atrium and at surgery a secundum type of A.S.D. was found measuring approximately 2 cm. He also had a persistent left superior vena cava.

Normal E.C.G. has been taken as evidence against a significant left to right shunt in A.S.D. In the past however in larger series it was found in about 6% cases. Interestingly this patient developed a bout of atrial fibrillation 3 months after the closure of his A.S.D. and had to be cardioverted. After this sinus rate remained normal. Chest X-Ray with Barium Swallow did not show any left atrial enlargement or any evidence of left ventricular failure. No further studies for the sinus function were done, however, this may be related to sick sinus syndrome especially in the presence of left superior vena cava.

The mean frontal QRS axis is an important clinical sign to differentiate the secundum type of defect from the primum type of defect, while in secundum type of defect the QRS axis is normal or to the right, in primum type of defects there is left axis deviation. In all our cases of secundum type of defect the axis ranged between  $+15^{\circ}$  to  $+150^{\circ}$ . We have not seen any left axis deviation in these cases. It is also interesting to note that in all five cases of secundum type of defects, who had significant mitral regurgitation due to prolapsed mitral valve of myxomatous type requiring valve replacement, did not have any left axis deviation. In one of this group there was indeterminate axis. All our primum type of defects had LAD ( $-30^{\circ}$ ).

Twenty one out of these 36 cases showed a peak systolic gradient of 20-30 mmHg across the RV inflow and out flow and sometimes out flow and pulmonary valve. There was no significant anatomical obstruction noticed in these cases and this was taken as functional. In two of our cases there was a peak systolic gradient of 70 and 75 mmHg. but no significant obstruction

was noticed at surgery. The Electrocardiogram in all these cases showed an rSR pattern, while 4 cases had gradients of 55 mm to 90 mmHg. and had significant out flow obstruction and in all these cases the E.C.G. showed tall R in V1 rather than an rSR pattern in V1. Thus it is a valuable sign to decide whether the gradient is functional or stenosis is present. If significant anatomical obstruction is present, the E.C.G. shows a tall R in V1 (pressure overload), if an rSR is present then the gradient is functional.

The development of tall R in V1 has also been attributed to existence of significant pulmonary hypertension in A.S.D. Thus when pressure overload pattern is present in association with A.S.D. then pulmonic stenosis or pulmonary hypertension may be present.

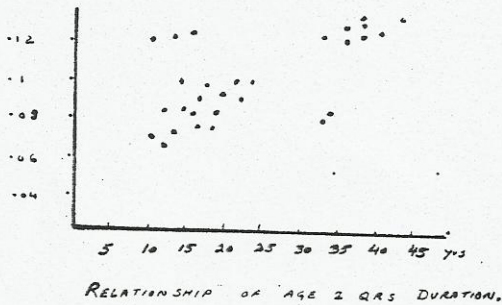


Fig. 2: Age and QRS duration.

Table III

Mean QRS Axis

	Normal Axis (+15° to +90°)	Right Axis (over +110°)
No.	15	21

Table IV

Distribution of Cases according to QRS Morphology and durations.

QRS Morphology	QRS Duration	Age <20	Age >20
1. Incomplete RBBB rsR Or RSR	≤0.11 sec	16 (p < .05)	2
2. Complete RBBB rsR	≥ 12 sec	3	8 (p < .05)
3. R.V.H. (Systolic over load) R or qR	<.1 sec	4	—
4. Normal	≤.09 sec	2	—

SUMMARY

The Electrocardiograms of 36 cases of secundum type atrial septal defect were analyzed out of total of 82 cases.

The P-R interval was normal in all cases; Incomplete Right Bundle Branch block (RBBB) was present in 18 cases; complete RBBB in 11 cases. In one case only Right axis deviation was present, and in 2 cases the E.C.G. was normal.

In 4 cases the QRS complex showed tall R instead of rSR pattern. These cases also had pulmonary stenosis in addition to A.S.D.

The Q.R.S. axis in 15 cases ranged between +15 and +90 degrees. All other showed R.A.D. (> +110°).

The durations of Q.R.S. complex measured in each case was plotted against the age and showed progressive Q.R.S. duration with age. It was also found that complete R.B.B.B. (Duration=0.12 Sec) was present in only 3 cases below the age of 20 years and 8 cases above the age of 20 years. While incomplete RBBB was present in only 2 cases above the age of 25 years.

Thus it appears that the development of RBBB pattern is not only dependant upon the presence of shunt (volume over load) but upon the age of the patient at presentation.

#### Acknowledgement:

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