Electrocardiographic Patterns of Atrial Septal Defects

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Objective: This study was designed to evaluate the electrocardiographic features of Atrial Septal Defect to establish an association with crochetage pattern and incomplete RBBB. **Materials and methods:** ASDs of Primum, Secundum and Sinus Venosus type were included in this study. From October 15, 2003 till January 15, 2004, a total of 104 consecutive patients of ASD were studied at Punjab Institute of Cardiology, Lahore. Patients were included in the study after confirmation of Atrial Septal Defect on transesophageal echocardiography. **Results:** The mean age of the study population was 26.28±11.40 years. Among these 56(53.8%) patients were females and 48(46.2%) patients were males. The study population consisted of 94(90.4%) Secundum ASD patients followed by Sinus Venosus ASD 8(7.7%) patients and Primum ASD in only 2(1.9%) patients. Only 59(56.7%) patients had crochetage pattern in any of the leads while it was absent in 45(43.3%) patients p=0.470. Incomplete RBBB was present in 92(88.4%) patients. It was observed in 2(1.9%) patients in ASD Primum, 82(78.8%) patients in ASD Secundum and 8(7.7%) patients in ASD Sinus Venosus type. P=0.483. **Conclusion:** Although we did not observe a statistically significant association between crochetage pattern or incomplete RBBB and ASD but the presence of any of these two considerably increases the specificity of the ECG for the diagnosis of ASD.

Key words: Atrial septal defect, Secundum ASD, Crochetage, In-complete Right Bundle Branch Block.

Atrial Septal Defect (ASD) initially characterized by Leonardo da Vinci in 1915 is the most common lesion found in adults after bicuspid Aortic valve[1]. ASDs comprise one third of all congenital cardiac lesions[1]. Main complications of undetected lesions are the occurrence of pulmonary hypertension, atrial arrhythmias, RV failure and congestive heart failure. Furthermore transient right to left shunting can also occur with the possibility of cerebral paradoxical embolism[1-4]. Because of these potential complications, some suggest that all atrial septal defects, ever those which are clinically silent, should be closed[2,5-7].

On examination of the ECG an M-shaped bifid notch on the ascending branch, or on the zenith of the R wave in Inferior leads (II, III, aVF), so called "crochetage" is an indicator of Ostium Secundum Atrial Septal Defects. The pathophysiology underlying this finding remains unknown[8]. Crochetage, a French word for notch was first reported in 1959, in a group of 11 patients with Secundum Atrial Septal Defects[9], but the clinical relevance of this pattern remains unknown. In this setting, an incomplete right bundle branch block may often lead towards an echocardiographic examination but it is lacking in specificity[2,10,11].

This study was designed to evaluate the electro-cardiographic features of Atrial Septal Defect for an association with crochetage pattern and incomplete RBBB.

Material and methods

From October 15, 2003 till January 15, 2004, a total of 104 consecutive patients of ASD were studied at the Punjab Institute of Cardiology Lahore. Patients were included in the study after confirmation of Atrial Septal Defect on transesophageal echocardiography. ASDs of Primum, Secundum and Sinus Venosus type were included in this study. After confirmation by echo , all patients had a standard 12 lead ECG with sensitivity of 10 mm/mV at 25 mm/Sec paper speed. Analyses of the tracings were performed in each case by two independent observers. Right bundle branch block on the ECG was defined as complete when QRS duration was ≥120 m Sec in adults with a r′ or R′ aspect in right precordial leads (V1 or V2) and with a deep S wave in lateral leads (V5, V6 and I, aVL). RBBB was defined as incomplete when QRS duration was less than 120 m Sec with a r′ or R′ in lead V1 or V2.[12] Crochetage pattern was defined as a rapid up and down motion or the R wave tracing on its ascendant branch or near its zenith with an M-shaped or a bifid pattern in the most typical form and always involving the initial 80 m Sec of the QRS complex. ECG was carried out to define patients for the absence or presence of a "Crochetage" aspect of R wave in one or more of limb leads II, III or aVF. (Figure 1 shows a classical ECG of crochetage pattren). A proforma was filled for each patient in which age, sex, type of atrial septal defect, crochetage pattern, QRS morphology and bundle branch pattern, if any, were noted.

Statistical Analysis

The data was analyzed by SPSS (Statistical Package for Social Sciences) for Windows Version 12.0. The categorical variables were expressed as percentages and continuous variables as mean±SD (Standard deviation). For ECG interpretation concordance between the two observers was calculated. Student t-test was used for the analysis of continuous variables and Chi square (χ^2) test was used for categorical variables. Pearson Chi square test was used to study the association between ASD and ECG patterns like Crochetage and Incomplete RBBB.

Results

After fulfilling the inclusion criteria, 104 patients of ASD were studied. The mean age of the study population was 26.28±11.40 years. Among these 56(53.8%) patients were females and 48(46.2%) patients were males. The study population consisted of three types of ASDs; Secundum ASD being observed in the majority of the patients 94(90.4%) followed by Sinus Venosus ASD 8(7.7%) patients and Primum ASD in only 2(1.9%) patients (Table 1).

Table 1. Epidemiological characteristics.

Characteristics	%age
Age mean years	26.28±11.40
Males	48(46.2%)
Females	56(53.8%)
ASD types	
Primum	2(1.9%)
Secundum	94(90.4%)
Sinus Venosus	8(7.7%)

The examination of 12 lead ECG revealed that the mean heart rate per minute on ECG was 88.45±18.07 beats. Majority of the patients 100(96.2%) had sinus rhythm, only 3(2.9%) patients had Atrial Fibrillation and 1(1%) patient had junctional rhythm.

Pearson Chi square was applied to study the association between crochetage pattern and ASD types. Only 59(56.7%) patients had crochetage pattern in any of the leads while it was absent in 45(43.3%) patients p=0.470. Table 2 shows the distribution of crochetage in individual leads. Crochetage pattern was present in only one lead i.e., either II or III or aVF in 21(20.2%) patients with a distribution of 1(1.0%) patients in ASD primum, 19(18.3%) patients in ASD Secundum and 1(1.0%) in Sinus Venosus type ASD. In two leads i.e. either II, III or II, aVF or III, aVF crochetage pattern was observed in 28(27%) patients with a distribution of 24(20.2%) patients with ASD Secundum and 4(3.8%) patients having ASD Sinus venosus type. Crochetage pattern in all three Inferior leads II, III and aVF was observed in 10(9.6%) patients, 1(1.0%) patients had ASD Primum and 9(8.7%) had ASD Secundum.

Table 2. Distribution of crochetage pattern in the study population.

Characteristics	%age
Crochetage pattern	59(56.7%)
Distribution of Crochetage in ECG leads	
II	6(5.8%)
III	8(7.7%)
aVF	7(6.7%)
II, III	1(1.0%)
II, aVF	13(12.5%)
III, aVF	14(13.5%)
II, III, aVF	10(9.6%)
Patients not having Crochetage pattern	45(43.3%)

We also studied the association of Incomplete RBBB with type of ASD. Table 3 shows the distribution of crochetage and Incomplete RBBB in different types of ASD. Incomplete RBBB was present in 92(88.4%) patients. It was observed in 2(1.9%) patients in ASD Primum, 82(78.8%) patients in ASD Secundum and 8(7.7%) patients in ASD Sinus Venosus type. P=0.483

Table 3. The distribution of crochetage and incomplete RBBB in different ASD types.

Characteristics	ASD Types			Total
	Primum	Secundum	Sinus venosus	
Crochetage pattern*	2(2%)	52(50.1%)	5(4.8%)	59(56.7%)
Crochetage in 1 lead	1(1%)	19(18.3%)	1(1%)	21(20.2%)
Crochetage in 2 leads	-	24(23.1%)	4(3.8%)	28(27%)
Crochetage in 3 leads	1(1%)	9(8.7%)	---------	10(9.6%)
Crochetage in none	1(1%)	41(39.4%)	3(2.9%)	45(43.3%)
Incomplete RBBB**	2(1.9%)	82(78.8%)	8(7.7%)	92(88.4%)

*P value: 0.470, **P value: 0.483

Discussion

Atrial Septal Defect is common lesion which if undetected may lead to the occurrence of pulmonary hypertension, arrhythmias, RV failure, cerebral abscess and cerebral paradoxical embolism. All these complications warrant an early detection of ASDs with an aim to early treatment, leading to a reduction in morbidity and mortality in patients having this lesion. ECG is a simple bedside tool which can point towards the potential diagnosis of ASD. Presence of incomplete RBBB in ECG has been known as a marker of ASD for at least 40 years[10], the reason for it to occur may be due to selective hypertrophy of basal portion of Right Ventricle or to stretching of the peripheral conduction fibres[9,10]. Another ECG pattern independent of incomplete RBBB in ASD is Crochetage. Crochetage when present in only one lead has a sensitivity of 73.1%, a specificity of 92.6% and a positive predictive value of 69% for the diagnosis of Ostium Secundum ASD and achieves a specificity of 100% if present in all three Inferior leads[13].

In the current study we observed that crochetage pattern was present in 59(56.7%) patients; in one lead it was observed in 21(20.2%) patients. This is consistent with Heller et al[13] who have reported 15% patients to have crochetage in one lead. We observed 10(9.6%) patients having crochetage in three leads while Heller et al[13] have reported 27.8% patients showing this pattern in three leads. Crochetage pattern in two leads was noted in 28(27%) patients which is similar to Heller et al[13] who have reported 30.3% patients having crochetage in two leads. Heller et al[13] have reported occurrence of crochetage pattern in Inferior leads in ASD, VSD, Pulmonary stenosis,

Mitral stenosis, Cor pulmonale and normal subjects while we studied patients of ASD diagnosed on TEE. Heller et al[13] have reported that the presence of crochetage and the number of leads exhibiting it correlated both with the degree of left to right shunting and with the size of the ASD. They included only patients who underwent catheterization, thus more benign atrial septal defects with smallest shunts may not have been studied while we included patients undergoing transesophageal echo.

We observed 93(82.4%) patients of ASD to have incomplete RBBB. Our results are consistent with other studies[2,10,11,13-15]. Borrow et al[2] have reported that the electrocardiogram in ASD can reveal supraventricular arrhythmias, QRS axis deviation, prolonged PR interval and right bundle branch block considered as a hallmark of the disease. However, according to the literature, similar pattern may be seen in normal subjects in upto 2.9% to 5% of the cases.[16,17]

Although we did not observe statistically significant association between atrial septal defect and crochetage pattern or incomplete right bundle branch block but in young patients with ASD the presence of crochetage pattern in ECG may lead to a high index of suspicion.[18] This can lead to an early diagnosis of ASD which can be confirmed by echocardiography or cardiac catheterization. Thus early repair of ASD can be done which is associated with excellent long term survival[2,4].

Conclusion

A crochetage pattern on the R wave in inferior ECG leads is frequently seen in ASD ; similarly incomplete RBBB is also frequently observed. The association of these two patterns considerably increases the specificity of the ECG for the diagnosis of an ASD. The findings of a crochetage pattern may serve as a readily available ECG marker to motivate the search for patients with Atrial Septal Defects.

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