Electrophysiological Study Characteristics in Patients With and Without Ebstein Anomaly With Accessory Pathway

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Abstract
Background: Ebstein's anomaly (EA) is a life-threatening rhythm disturbance, which is not frequent early in life. Symptomatic patients are well treated with radiofrequency catheter ablation.

Objectives: We assessed the prevalence, history and treatment of arrhythmias, in particular pre-excitation and Wolff-Parkinson-White (WPW) syndrome to provide a guide for ablation according to the results of electrophysiology study (EPS) and electrocardiogram (ECG) in patients with and without EA.

Patients and Methods: Forty-five patients with and without EA with accessory pathway had referred to our tertiary research center between 2004 and 2010. The two groups underwent 12 lead ECG at rest and QRS duration, PR interval, P wave amplitude, and all arrhythmia accidents and diagnostic pre-stimulation factors were measured. The EPS were performed and the reports were determined according A-H interval, H-V interval, and maximum delta to peak R, PR/Max delta to peak R before and after ablation.

Results: Fifty-four patients were enrolled [29 cases with EA (60% male; mean age: 29.07 ± 12.3; P > 0.05)]. Out of 29 cases with EA, 51.7% had pre-excitation (WPW), which were included in our study and the remaining had EA without Wolff–Parkinson–White (WPW). Wolff–Parkinson–White was diagnosed in all patients without anomaly. Mean amplitude of P wave in patients with and without EA were 0.14 ± 0.07 and 0.10 ± 0.03, respectively (P = 0.04). The PR interval before and after ablation in patients with and without Ebstein anomaly was 104.53 ± 23.91 and 182.67 ± 41.5, respectively (P < 0.05). The QRS mean after ablation in EA and non-EA in both groups was 131.53 ± 29.7 and 100 ± 16.8, respectively (P < 0.05). A-H interval mean before and after ablation in EA and non EA were 101.93 vs.79.68 and 111.53 ± 39.58, and 79.68 ± 21.7 vs. 81.36 ± 20 respectively, however after the ablation the results were statistically significant (P = 0.01). Regarding accessory pathway in EA and non-EA; 73.3% and 84% had right posteroseptal AP; 6.66% and 12% had right anteroseptal AP; 13.3% and 4% had right free wall AP.

Conclusion: In EA patients with accessory pathway, the most common location was right posterolateral. Comparison of the EPS between cases with and without anomaly showed no significant relationship regarding most of the EPS criteria. Since EA patients have a high potential for developing tachyarrhythmias, which is the most prevalent reason for death; diagnosis and treatment of those patients is critical.

Keywords: Ebstein Anomaly, Cardiac Arrhythmias, Preexcitation

1. Background

Ebstein anomaly (EA) accounts for 1% of all congenital heart diseases and is characterized by apical displacement of the posterior and septal leaflets of the tricuspid valve (1, 2). The downward displacement of the septal tricuspid valve leaflet is associated with discontinuity of the central fibrous body and septal atrioventricular ring and, hence, with direct muscular connections. As a consequence, a potential substrate for accessory atrioventricular connections and ventricular preexcitation is created (3). The results showed that preexcitation and Wolff–Parkinson–White (WPW) syndrome are more commonly associated with EA than with any other congenital heart defect (4). The reported prevalence of those is variable between 0 and 44% (5-11). The cardinal symptoms in EA are cyanosis, right-sided heart failure, arrhythmias and sudden cardiac death (12).

2. Objectives

The objective of this study was to assess the prevalence, history and treatment of arrhythmias, in particular preexcitation and WPW syndrome, in patients with EA to provide a guide for ablation by description of the results of EPS in patients with and without EA by assessing and comparison of the ECG and EPS and their coherence.
3. Patients and Methods

In this prospective study, 45 patients with and without EA with accessory pathway referring to our tertiary research center between 2004 and 2010 were enrolled. Patients with EA and accessory pathway and cases without EA with the same accessory pathway, having all their EMG data recorded, were included in this study. The patients with EA without accessory pathway were excluded. The control groups were patients without EA with the same accessory pathway. All groups underwent 12 lead ECG at rest and QRS duration, PR interval, P wave amplitude, and all arrhythmia accident and diagnostic pre-stimulation factors were measured. The EPS were performed and the report was determined according to A-H interval, H-V interval, and Maximum delta to peak R, PR/Max delta to peak R before and after ablation. The demographic data and past medical history and clinical data including all EPS and ECG findings of these patients were obtained from outpatient clinic and medical records collected form documents and questionnaires archived at our center of patients with accessory pathway and EA.

3.1. Statistical Analysis

All the statistical analyses were conducted using SPSS 17 (SPSS Inc. Chicago, Ill). The mean and standard deviations for the qualitative variables were determined. Differences between the two groups were analyzed with the Student t test and with log transformation for continuous and the chi-square test for categorical variables. P values < 0.05 (2 tailed) were considered significant.

4. Results

Fifty-four patients were enrolled in our study (29 cases with Ebstein Anomaly (EA); 60% male, mean age: 29.07 ± 12.3; P > 0.05). All demographic data are shown in Table 1. Out of 29 cases with EA, 51.7% had pre-excitation (WPW) and were included in our study. The remaining patients with EA without WPW were excluded from the study, 28.5% had AVNRT, 21.4% had AVRT, 21.4% had AT, 14.2% had AFL, 7.14% had transient complete heart block (CHB), and from the EPS in none of the 7.14% of cases arrhythmia was diagnosed. All the enrolled patients without anomaly were diagnosed with WPW arrhythmia.

Demographic results of patients with accessory pathway in cases with and without EA are depicted in Table 1. Overall, 26.7% of the patients with EA and 12% without EA had body mass index (BMI) of > 30 (P > 0.05).

None of the Ebstein anomaly patients had HTN and DM while in cases without anomaly HTN and DM were reported as 8% (P = 0.26). Overall, 33% of the patients with EA had a history of repair and surgical history while in cases with no EA no repair was observed and this relationship was statistically significant (P = 0.006). In total, 93.3% of the patients with EA and 100% of the cases without anomaly complained of palpitation yet statistically there was no significant relationship between palpitation and the presence of this anomaly (P = 0.19). In 33% of the patients with EA and in 12% of the cases with no EA, syncope was reported (P = 0.1).

4.1. Electrocardiogram Comparison in Patients With and Without Ebstein Anomaly

Mean amplitude of P wave in patients with and without EA was 0.14 ± 0.07 and 0.10 ± 0.03, respectively. There was a significant relationship between the mean of amplitude and having EA (P = 0.04). Mean P wave in cases with EA was 70.6 ± 18.3 and in patients without this anomaly was 70 ± 14, however no significant relationship was found (P = 0.89) (Table 2).

R wave amplitude in patients with and without anomaly was 1.42 ± 0.57 and 1.64 ± 0.54, respectively, no significant relationship was found (P = 0.43). The mean P/QRS in patients with and without EA were 0.09 ± 0.068 and 0.06 ± 0.03 (P = 0.06) (Table 2).

The PR interval before and after ablation in patients with and without EA was 104.53 ± 23.91 and 182.67 ± 41.5,
respectively; a significant relationship was found between these two groups regarding PR interval ($P < 0.05$) (Table 2).

The QRS mean before ablation in EA and non EA group was $145.40 \pm 25.13$ and $137.68 \pm 26.38$, respectively. No significant relationship was found ($P = 0.7$); while after ablation the results in both groups were $131.53 \pm 29.7$ and $100 \pm 16.8$, respectively, and a significant relationship between these two groups was found ($P < 0.05$) (Table 2).

Delta Wave in EA and non-EA group were measured and defined as $73.3\%$ vs. $60\%$ in lead II, $93.3\%$ vs. $92\%$ in lead III, $80\%$ vs. $84\%$ in lead aVF and $100\%$ in V1 were negative ($P > 0.05$). Transitional zone in patients with and without EA were $66.6\%$ vs. $88\%$ in V2, $20\%$ Vs $4\%$ in V3, $13.3\%$ vs. $8\%$ in V4 and no significant relationship was found ($P = 0.22$) (Table 3).

### 4.2. Comparing the Results of Ventricular Electrogram (EGM) in Patients With and Without Ebstein Anomaly

HV interval before and after ablation in patients with and without anomaly was $27.73 \pm 25.12$ vs. $14.08 \pm 14.02$ and $43.86 \pm 22.4$ vs. $46.4 \pm 10.4$ ($P = 0.1$ and $P = 0.6$), respectively.

The A-H interval mean before and after ablation in EA and non-EA were $101.93 \pm 39.85$ and $111.53 \pm 39.58$, and $79.67 \pm 21.7$ vs. $81.36 \pm 20$ respectively; no significant relationship was found ($P = 0.06$), however after the ablation the results were statistically significant ($P = 0.01$).

Max delta to peak R in patients with Ebstein anomaly was $78.6 \pm 19.21$ and in Ebstein without anomaly was $80.56 \pm 19.21$ ($P = 0.9$). The PR/Max delta to peak R was $1.18 \pm 0.46$ in Ebstein and $1.17 \pm 0.04$ in non Ebstein group ($P = 0.9$) (Table 4).

Overall mean duration in the EA group was $129.26 \pm 60.8$ and in cases without Ebstein was $134.06 \pm 41.6$, which was not significantly different ($P = 0.5$).

The A electrogram duration in the group with EA was $40.73 \pm 17.5$ and in the group without Ebstein was $49.52 +
The V electrocardiogram duration in patients with and without Ebstein was 46.22 ± 14.33 (P = 0.1). The V electrocardiogram duration in patients with and without Ebstein was 46.22 ± 15.97 and 88.96 ± 30.59, respectively, which was not statistically significant (P = 0.4).

4.3. The Results of Evaluation of Accessory Pathway in Patients With and Without Ebstein Anomaly

Regarding accessory pathway in EA and non EA group, 73.3% and 84% had right posteroseptal AP; 66.6 % and 12% had right anteroseptal AP; 13.3% and 4% had right free wall AP.

5. Discussion

Ebstein’s anomaly is a complex congenital anomaly with a broad anatomic and clinical spectrum. Management is complex and must be individualized (227,full). The R waves in leads V1 and V2 are small. Bizarre morphologies of the terminal QRS pattern result from infra-Hisian conduction disturbance and abnormal activation of the atrialized right ventricle (46227 full). Paroxysmal tachyarrhythmias in Ebstein’s anomaly are based on typical, fast-conducting atrioventricular accessory pathway with both antegrade and retrograde conduction properties in most patients (13).

In addition, wide QRS tachycardia over a septal accessory atrioventricular pathway, ventricular tachycardia, or flutter, as well as ectopic atrial tachycardia, atrial flutter and atrial fibrillation, can occur (13, 14).

The estimated prevalence of the WPW pattern in the general population is reported to be 0.01 - 0.3%. However, this might be an underestimation because an intermittent type of WPW pattern is common (15). The prevalence of WPW increases in a population with congenital heart defects, in particular EA (4).

Five of the EA patients with preexcitation were detected during follow-up because of arrhythmia-related symptoms. Most probably, preexcitation was not detected at the time of EA diagnosis because of the intermittent nature of the WPW pattern, as already demonstrated by Celermajer et al. (16) and Dearani et al. (17). The clinical presentation and natural history of patients with accessory pathways is highly variable.

Cardiac arrhythmias, most frequently paroxysmal supraventricular tachycardia, occur in approximately 50% of individuals who have ventricular preexcitation (16-18). Furthermore, only half of the patients with accessory pathways have their first tachycardia at 20 years of age (19).

The present study showed among the patients referring to EPS center at Rajaie cardiovascular medical and research center, Iran University of Medical Sciences between 2004 and 2010, more than half of the cases with EA had arrhythmia because of WPW syndrome. Further arrhythmia according to their prevalence was AT, AFL/AFL, transient CHB, AVNRT and AVRT. Chauvaud et al. (20), in a study showed less than half of the EA cases had known arrhythmia regarding their prevalence, which was PSVT, AF/AFL, WPW and NSVT, respectively.

The present study demonstrated that in the basic ECG regarding PR interval and QRS and also P wave amplitude before and after ablation no significant relationship was found.

By comparison of the study of Iturralde et al. (21) and our investigation, it was found that the PR interval and QRS duration before and after ablation had some similarity; however no significant differences were found between the patients with and without EA.

In the present study, by assessing the EPS results, it was determined that A-H interval in patients with and without EA were significantly different, while no difference regarding HV interval and other mentioned criteria was found. Thus far, there was no specific study in this field.

In the present it was shown that accessory pathway in all EA patients was on the right side. Delhaas et al. (22) in 2010 showed that the only accessory pathway in EA infants was also on the right side.

Cappato et al. (23) showed that all accessory pathways were on the right side, with the most prevalent being posteroseptal, posterior and posterolateral. In previous studies, multi-fragmented signals in EA patients in tricuspid ring were determined as one of the major ablation problems.

As a result, in the present investigation, assessing the morphology of the signal in tricuspid ring in patients with and without EA was performed, yet no significant difference was found (P > 0.05). Consequently, regarding ECG characteristics, it seems that the complexity in this group was not related to EGM, which was recorded in the tricuspid ring.

In the present study no association was found regarding ECG in tricuspid ring in the two groups, while comparison of these two groups showed that there was distinction in successful signals. As most of the patients had posteroseptal accessory pathway, we could not generalize these findings for all EA patients and accessory pathway in right free wall of the ventricle, thus we need more information from patients with accessory pathway in their right free wall. It seems that with concentration on unipolar EGM, the most fused AV in tricuspid ring; there was no significant difference regarding successful ablation between patients with and without EA.
5.1. Conclusions

It can be suggested that, in patients with EA with accessory pathway, the entire accessory pathway is on the right side and the most prevalent one is right posteroseptal. The comparisons of the EPS characteristics between cases with and without anomaly showed no significant relationship. Since the EA patients have a high potential for developing tachyarrhythmias, which is the most prevalent reason for death; patient's diagnosis and treatment are very important.

5.2. Suggestions

Seeing that there was no study in this field thus far, larger studies in the future are needed to acquire a more detailed algorithm considering EPS characteristics of the most prevalent arrhythmias particularly WPW in EA patients.

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Footnotes

Authors’ Contribution: Study concept and design: Abolfath Alizadeh; acquisition of data: Safieh Razazadeh Lavaf; analysis and interpretation of data: Mona Heidarl; drafting of the manuscript: Mona Heidarl; critical revision of the manuscript for important intellectual content: Abolfath Alizadeh; technical and material support: Abolfath Alizadeh.

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