ORIGINAL ARTILE

LOCALIZATION OF ACCESSORY PATHWAY IN PATIENTS WITH WOLFF-PARKINSON-WHITE SYNDROME FROM SURFACE ECG USING ARRUDA ALGORITHM

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Background: To ablate accessory pathway successfully and conveniently, accurate localization of the pathway is needed. Electrophysiologists use different algorithms before taking the patients to the electrophysiology (EP) laboratory to plan the intervention accordingly. In this study, we used Arruda algorithm to locate the accessory pathway. The objective of the study was to determine the accuracy of the Arruda algorithm for locating the pathway on surface ECG. **Methods:** It was a cross-sectional observational study conducted from January 2014 to January 2016 in the electrophysiology department of Hayat Abad Medical Complex Peshawar Pakistan. A total of fifty nine (n=59) consecutive patients of both genders between age 14-60 years presented with WPW syndrome (Symptomatic tachycardia with delta wave on surface ECG) were included in the study. Patient's electrocardiogram (ECG) before taking patients to laboratory was analysed on Arruda algorithm. Standard four wires protocol was used for EP study before ablation. Once the findings were confirmed the pathway was ablated as per standard guidelines. **Results:** A total of fifty nine (n=59) patients between the age 14–60 years were included in the study. Cumulative mean age was 31.5 years±12.5 SD. There were 56.4% (n=31) males with mean age 28.2 years±10.2 SD and 43.6% (n=24) were females with mean age 35.9 years±14.0 SD. Arruda algorithm was found to be accurate in predicting the exact accessory pathway (AP) in 83.6% (n=46) cases. Among all inaccurate predictions (n=9), Arruda inaccurately predicted two third (n=6; 66.7%) pathways towards right side (right posteroseptal, right posterolateral and right antrolateral). **Conclusion:** Arruda algorithm was found highly accurate in predicting accessory pathway before ablation.

Keywords: accessory pathway; Arruda algorithm; electrophysiology; Ablation, Electrocardiogram

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INTRODUCTION

Patients with a pre-excitation syndrome have an additional pathway, known as an accessory pathway (AP), which directly connects the atria and ventricles, thereby allowing electrical activity to bypass the AV node. Tissue in the accessory pathways, which are usually congenital in origin conducts electrical impulses more quickly than the AV node, resulting in the shorter PR interval seen on the surface ECG. It has been estimated that most accessory pathways (60–75%) are capable of bidirectional conduction (anterograde and retrograde) between the atrium and ventricle. However, some accessory pathways (17–37%) are only capable of conduction in a retrograde fashion from ventricle to atrium.[1] Cure in cardiology is rare most of the time but electrophysiology is very rewarding particularly in tachy arrhythmias where ablation is applicable. Its efficacy increases to almost above 95% in the case of supraventricular tachycardia (SVT).[2,3] In SVT almost 60% is covered by atrioventricular nodal re-entry tachycardia (AVNRT) and 30% by accessory pathway (AP).[4–6] Ablation of both these tachycardia is anatomical and as well as signal based.[7] In case of accessory pathway it is mandatory to provisionally locate the area of ablation so the ablation is not only successful but convenient at the same time.[8] Different people use different algorithm to predict the location of the pathway before going to the laboratory so they make their mind before ablation. However, they are somewhat complicated. On the other hand, some algorithms based on the QRS polarity have been reported[9,10] but their accuracy is still limited. In our study we used Arruda Algorithm for predicting the location of the accessory pathway as its yield was reported to be more than 80%.[11] The objective of the study was to determine the accuracy of the Arruda algorithm for locating the pathway on surface ECG.

MATERIAL AND METHODS

It was a cross sectional study carried out at Department of Cardiology, Hayatabad Medical Complex Peshawar, during January 2014 to January 2016. The study was approved by hospital ethical committee. All adult patients irrespective of gender presented with Wolf Parkinson White (WPW) syndrome (Symptomatic tachycardia with delta wave on surface ECG) were included in the study. Patients who had concealed pathways, history of previous

radiofrequency (RF) ablation and who had congenital heart disease diagnosed on echocardiography were excluded from study. A fully informed, understood and voluntarily written consents was taken from all the patients. A resting 12-lead ECG with the most overt pre excitation was selected for interpretation and Arruda algorithm was used for predicting the accessory pathway (AP). Two consultant cardiac electrophysiologist experienced in electrophysiology analysed patients' ECGs according to the Arruda algorithm. The exact localization of the AP was determined by mapping of signals at the time of catheter ablation by same cardiologists blinded to preliminary patients' data. Pathway potential visualization and ventriculo-atrial (VA) fusion were the two parameters used for localization of AP during pathway mapping. Radiofrequency ablation was then given and exact location of AP was confirmed post ablation by visualization of signal for VA separation, non-inducibility of tachycardia and absence of delta wave on surface ECG. Predictive accuracy of Arruda algorithm was determined by comparing the predicted AP before ablation using the algorithm with the confirmed exact location of pathway post ablation. SPSS version 17 was used for description and statistical analysis of results.

RESULTS

A total of fifty nine (n=59) patients of both genders between age 14–60 years full filled our inclusion criteria. Four (n=4) patients were diagnosed with congenital heart disease on Echocardiography and were excluded from the study. Fifty five (n=55) patients were further analysed. There were 56.4% (n=31) males with mean age 28.2 years±10.2 SD and 43.6% (n=24) were females with mean age 35.9 years±14.0 SD. Cumulative mean age was 31.5 years±12.5 SD. There were 56.4% (n=31) patients who presented with orthodromic tachycardia, 23.6% (n=13) presented with antidromic tachycardia and 20% (n=11) presented with pre-excited atrial fibrillation. We were able to choose proper hardware before start of the procedure and when to give medicine like does the patient be anticoagulated at the start of procedure or when the left side of the heart is entered after septal ablation. In our study population most frequent AP was predicted on surface ECG using Arruda algorithm was right postero-septal (n=19; 34.5%) followed by left antro-lateral (n=10; 18.2%). Other pathways predicted are tabulated in table-1. Approaches used for exact localization of pathways followed by radiofrequency ablation are tabulated in table-2. Arruda algorithm was found to be accurate in predicting the exact AP in 83.6% (n=46) case. Among all inaccurate predictions (n=9), Arruda inaccurately predicted two third (n=6; 66.7%) pathways towards right side (right postero-septal, right posterolateral and right antro-lateral). Results are tabulated in detail in table-3.

Table-1: Accessory pathways predicted on surface ECG using Arruda algorithm

Pathway on surface ECG	Frequency	Percent
Right postero-septal	19	34.5
Left anterolateral	10	18.2
Left lateral	4	7.3
Antero-septal	3	5.5
Left posterolateral	3	5.5
Right anterolateral	3	5.5
Right posterolateral	3	5.5
Left antero-septal	2	3.6
Left postero-septal	2	3.6
Right lateral	2	3.6
Right antero-septal	1	1.8
Left anterior	1	1.8
Mid septal	1	1.8
Right anterior	1	1.8
Total	55	100.0

ECG: Electrocardiogram

Table-2: Approaches used for RF ablation

Approach	Frequency	Percent
Tricuspid valve annulus	27	49.1
Trans septal	19	34.5
Patent foramen ovale	7	12.7
Retrograde aortic	2	3.6
Total	55	100.0

RF: Radiofrequency

Table-3: Inaccurate predictions of AP by Arruda algorithm

Pathway	Frequency	Percent
Right postero-septal	3	33.3
Right posterolateral	2	22.2
Right anterolateral	1	11.1
Left lateral	1	11.1
Left antero-septal	1	11.1
Left anterolateral	1	11.1
Total	9	100.0

AP: Accessory pathway

DISCUSSION

Since1930, Louis Wolff, Sir John Parkinson, and Paul Dudley White first publication on Wolf Parkinson White Syndrome[12], it was realized soon that most accessory pathways (60–75% percent) are capable of conduction and mostly in bi-direction, i.e., anterograde and retrograde, between the atrium and ventricle. However, some accessory pathways (17–37%) are only capable of conduction in a retrograde fashion from ventricle to atrium and they were correlated with tachycardia.[13] In 1943, the ECG features of pre-excitation were correlated with anatomic evidence for the existence of anomalous bundles of conducting tissue that bypassed all or part of the normal atrioventricular (AV) conduction system.[14] The most frequent locations are left lateral (50%), postero-septal (30%), right antero-septal

(10%), and right lateral (10%). Many studies have attempted to correlate the site of the accessory pathway with the ECG pattern. However, the electrocardiographic appearance of activation depends upon the extent of pre-excitation and fusion and, as a result; the same pathway may not always produce the same ECG pattern. Furthermore, up to 13 percent of individuals with pre-excitation have more than one accessory pathway.[15] It is therefore not possible to make a simple rule to locate the accessory pathway on surface ECG. In 1998 Arruda, *et al*[11] published their article in Journal of Cardiovascular Electrophysiology and introduced the Arruda algorithm. We conducted a study in our centre for locating the accessory pathway on surface ECG using the same Arruda algorithm. Predictive accuracy of Arruda algorithm was determined by comparing the predicted AP before ablation using the algorithm with the confirmed exact location of pathway post ablation. In our study population most frequent AP was predicted on surface ECG using Arruda algorithm was right postero-septal (n=19; 34.5%) followed by left antro-lateral (n=10; 18.2%). Arruda algorithm was found to be accurate in predicting the exact AP in 83.6% (n=46) case. Among all inaccurate predictions (n=9), Arruda inaccurately predicted two third (n=6; 66.7%) pathways towards right side (right postero-septal, right posterolateral and right antro-lateral). Many investigators used different signs on the surface ECG to locate the presence of accessory conducting fibres at particular location with variable success rate. However in the presence of previous myocardial infarction (MI), hypertrophy or congenital heart disease, the situation will become worse. Since the ECG pattern of WPW depends on the vector of activation so any change in the position of the heart inside the thoracic cavity due to congenital or acquired causes will affect the appearance of pre-excitation on the surface ECG. Not only this but application of ECG leads on the body surface in slight different position will affect the appearance of the pathway and so application of the algorithm will be difficult. Keeping all this in view no one single algorithm has 100% sensitivity and specificity. Noriko Taguchi reported their algorithm[16] for some pathways as 93% accurate in the retrospective analysis, and 94% accurate in the prospective assessment in their study.

In 1994 Adam P published their article for location of pathway with variable success. Moss JD *et al*, using their new ECG criteria, recently reported 87% accuracy and 100% inter-observer agreement in prediction of anterior and posterior location of a left lateral AP location.[17] We found the Arruda Algorithm reasonably good for prediction of pathway but still very much deficient. One of the reasons might be the sample size. Since our sample size was small so it may the cause of poor yield. Nonetheless it guides the operator to quite reasonable ratio. Further work is needed on the topic for significant results.

CONCLUSION

Successful ablation of accessory pathway in WPW syndrome needs pre ablation proper identification and proper degree of temperature at reasonable power. We found Arruda algorithm very much helpful for localization of accessory pathway on surface ECG. Such localization may facilitate procedural planning.

AUTHORS' CONTRIBUTION

SS: collected the data and wrote the manuscript. BS, HU: and ZA: critically reviewed the manuscript. MAK: consulted the references and statistically analyzed the data.

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