PROSPECTIVE VALIDATION OF A SEZER ECG ALGORITHM FOR LOCALIZATION OF ACCRSSORY PATHWAYS IN PATIENTS WITH WOLFF-PARKINSON – WHITE SYNDROME

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ABSTRACT

Background: *Several algorithms based on ECG criteria have been published predicting locations of accessory pathways in patients with WPW syndrome. One of the last published algorithms (Sezer et al.1999) claimed high accuracy (92.3%) in predicting AP location in seven sites.* ***Aim of the Work:*** ***this*** *algorithm was tailored after analysis of ECGs of certain group of patients; however, this algorithm has never been tested on an independent group of patients till now, which was the aim of this study.* ***Patient And Methods*** *: A total of 127 12-lead ECGs obtained from patients underwent successful RFCA of a single manifest AP responsible for WPW syndrome were analyzed by two independent observers. QRS complex polarity in V1, V2, LIII and aVF; morphology of QRS in LIII; Delta wave polarity in aVF (positive, negative, isobiphasic or isoelectric) and amplitude of QRS in LII (≤ 0.2mV or >0.2mV) were the ECG variables used to localize the accessory pathways in this algorithm. The observers then compared their notes and a consensus was reached, forming a consolidated database used for testing the algorithm.* ***Results :*** *Mean age of the study population was 32±14 years. There were 85(67%) male. Seventy seven patients had left sided APs while 50 had right sided APs. Global PPV of the algorithm was 44% and 60% when neighboring*

sites were added to the correctly predicted sites. A significant difference was observed between the predictive power of the algorithm for left sided, right sided or posteroseptal APs [44.4 % 32% and 66.6% respectively (p value <0.05)]. Maximum preexcitation (QRS duration >110ms) has no significant impact on global accuracy of the algorithm (46%) (p value= 0.717). The success of the algorithm was significantly lower for localizing left sided APs with limited preexcitation reaching 25% versus 57% with QRS duration >110ms (P=0.04). A statistically significant difference was not found between localizing right sided APs with QRS duration ≤ and > 110 ms. (p=0.24). The lowest predictive power of the algorithm was in left posterolateral APs (0%) and the greatest predictive power attained on posteroseptal APs (77%). ***Conclusion:*** *The predictability of the algorithm for AP location was not as proclaimed by the corresponding author. Algorithms should be tested on an independent group of patients for accuracy before subjecting them for clinical use.*

Keywords*: Wolff-Parkinson-White syndrome, accessory pathways, electrocardiography, algorithm.*

INTRODUCTION

Radiofrequency catheter ablation (RFCA) of accessory pathway (AP) requires precise localization of the AP along the mitral and tricuspid annulus. Evaluation of the 12-lead surface ECG still, till now, is the first step for localization of AP in patients with WPW syndrome. The data obtained from the ECG can be helpful in planning and shortening the RCFA procedure.

Several algorithms based on ECG criteria have been published predicting locations of accessory pathways (Fitzpatrick 1994, Xie 1994, D'Avila 1994, Chiang 1995, Ituuralde 1996 and Arruda 1998).

The last published study dealing with localization of AP from ECG criteria (Sezer et al.1999) claimed superiority in predicting AP location in seven sites. The construction of this algorithm depends mainly on analysis of QRS complex polarity forming its main skeleton, delta wave polarity and QRS complex amplitude were considered as assisting ECG parameters. This algorithm was tailored after analysis of ECGs of certain group of patients; claimed high accuracy on predicting AP location. However, this algorithm has never been tested on an independent group of patients till now, which was the aim of this study

SUBJECTS AND METHODS

ECG analysis

One hundred twenty seven 12-lead ECGs obtained from patients underwent successful RFCA of a single manifest AP responsible for WPW syndrome were reviewed. Electrocardiograms were recorded with 25 mm/sec paper speed, 10 mm/mV gain and filter band settings from 0.05 to 150 Hz. Two independent observers unaware of exact AP location reviewed the 127 ECGs to determine and measure the following criteria that were utilized in building the algorithm (1) QRS complex polarity in V1, V2, LIII and aVF (2) morphology of QRS in LIII. (3) Delta wave polarity in aVF (positive, negative, isobiphasic or isoelectric) as described by Sezer et al. (4) Amplitude of QRS in LII ($\leq$ 0.2mV or >0.2mV).

The observers then compared their notes and a consensus was reached, forming a consolidated database.

Test procedure

The algorithm was tested on the database obtained from analysis of the 127 ECGs. The test was done by an observer unaware of the location of the AP.

Electrophysiology study and RFCA

All patients underwent electrophysiologic study and successful radiofrequency catheter ablation after giving informed consent. Right-sided pathways were ablated with the use of transvenous atrial approach through the femoral vein. Left-sided pathways were ablated with retrograde arterial approach; if this approach failed the pathway was ablated using antegrade trans-septal approach. A local electrogram showing the AP potential or continous activation or an A-V interval shorter than 40 ms with V wave at least 5 ms earlier than the delta wave indicated a good site for energy delivery.

Accessory pathway location

Location of AP was defined by the site were RF energy application successfully abolished conduction. Ablation site were subsequently refers to the mitral or tricuspid annulus according to the clock position (fig. 1) prescribed by Basiouny et al. 1999. The location of a given AP corresponds to the closest label, with the exception of T3 site whose borders are precisely defined by catheter recording the His bundle electrogram and that marking the coronary sinus ostium.

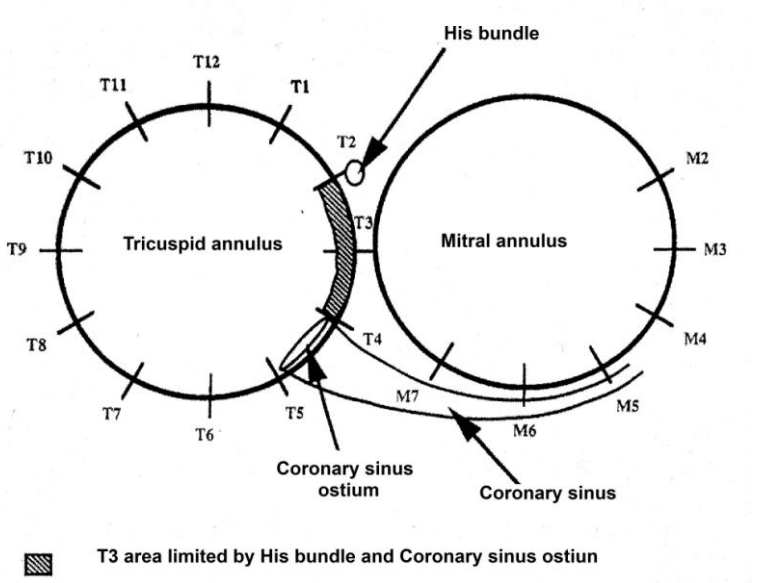

Figure 1: Accessory pathway label site along the mitral and tricuspid annuli. Schema correspond to the mitral and tricuspid annuli viewed under a 45* left anterior oblique fluoroscopic projection. (From Basiouny et al.1999)

-Normalization of the classification and labels prescribed by the algorithm in relation to the position of the AP along the tricuspid or mitral annulus were done.

-Matching results of testing the algorithm with the results of RFCA.

Statistical Analysis:

Results are expressed as mean ± SD. The sensitivity, specificity and PPV of the algorithm for each AP location were determined. Chi-square test was used to compare results. P value <0.5 was considered significant.

RESULTS

Mean age of the study population was 32±14 years. There were 85(67%) male with approximate male to female ratio of 3:1.

Accessory pathway locations in our patient population were distributed along the mitral and tricuspid annulus according to the schema proposed by Basiouny et al. 1999 and represented in Fig. 2.

Normalization of the classification and labels prescribed by the algorithm in relation to the position of the AP along the tricuspid or mitral annulus were done and represented in table 1.

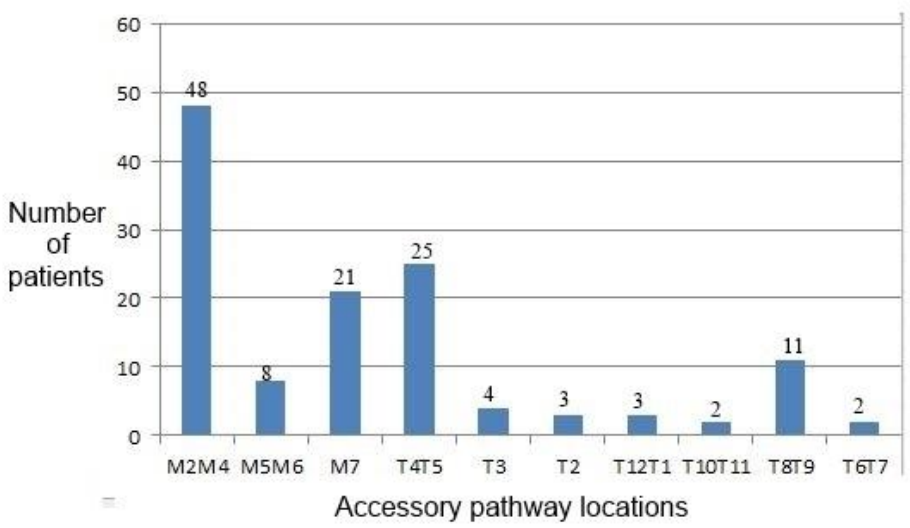

Figure 2: Represents distribution of exact localization of AP along the mitral and tricuspid annulus defined by RFCA.

Table 1: Results of normalization of the classification and labels prescribed by the algorithm in relation to the position of the AP along the tricuspid or mitral annulus:

	Normal annulus position	No. of APs	Classification and labels of the algorithm
Left sided APs. (77 Pts.)	**M2M4**	**48**	**LAL**
	M5M6	**8**	**LPL**
	M7	**21**	**PS**
Right sided APs. (50 Pts.)	**T4T5**	**25**	
	T3	**4**	**MS**
	T2	**3**	**AS**
	T12T1	**3**	**RAL**
	T10T11	**2**	
	T8T9 (T9)	**11**	**RPL**
	T6T7 (T7)	**2**	

LAL: left anterolateral, LPL: left posterolateral, PS: posteroseptal, MS: midseptal, AS: anteroseptal, RAL: right anterolateral, RPL: right posterolateral. (T8T9 shortened to T9 and T6T7 shortened to T7 for facilitation)

Among 50 right sided accessory pathways posteroseptal (T4T5) was the most common location as it was found in 25 patients contributing 50% among right sided and 19.7% among total number of patients. 13 patients had right posterolateral (11T8T9, 2T6T7) (26%, 10.2%). Five had right anterolateral (3T12T1 and 2 T10T11) (10%, 3.9%), 4 patients had midseptal (T3) accessory pathways (8%, 3.1%). and only 3 anteroseptal (T2) (6%, 2.4%).

Among 77 left sided accessory pathways 48 patients had anterolateral location (M2M4) contributing 62.3% among left sided and 37.8% among total number of patients. Eight had posterolateral (M5M6) and 21 had posteroseptal (M7) contributing 10.4% and 27.3% among left sided pathways and 6.3% and 16.5% among total number of patients respectively.

Classification of ECGs according to QRS duration ≤ and > 110 ms:

- Fifteen APs had ECGs with QRS duration ≤ 110 ms (15/127) (11.8%), 12 of them were left sided APs (12/15) (80%) (7 M2M4, 4 M5M6, 1M7) and 3 were right sided (3T4T5) (3/15) 20%.

- One hundred twelve APs had ECGs with QRS duration >110ms (112/127) (88.2%), 65 APs were left sided (65/112)(58%) and 47 were right sided APs (47/112) (42%), distributed as following: 41M2M4, 4M5M6, 20M7, 22T4T5, 4T3, 3T2, 3T12T1, 2T10T11, 11T9, 2T7. (fig. 3)

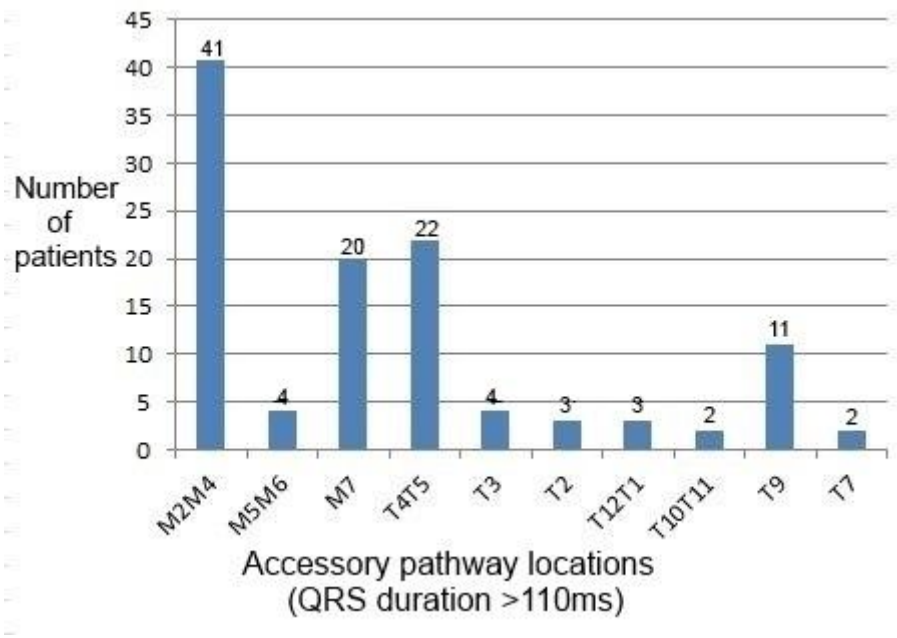

Figure 3: Represents AP distribution along the mitral and tricuspid annulus in 112 patients having ECGs with QRS duration >110ms.

Results of testing the algorithm :

The algorithm was composed of three steps:

- First step (algorithm 1):

This step of the algorithm was based on QRS complex polarity in V1, LIII, V2 and aVF and QRS morphology in LIII.

According to this algorithm seventy three sites were diagnosed as left anterolateral, 40 were correctly diagnosed and 33 locations were falsely defined

as left anterolateral, 14 of the misdiagnosed were right sided, 12 were left posteroseptal and 7 were left posterolateral APs. Among the 48 APs that were left anterolateral on ablation 8 APs were mislocated; 1 was misdiagnosed as an anteroseptal AP, 3 as right anterolateral and 4 as left posterolateral, giving sensitivity of 83% (40/48), specificity of 47.8% (48/79) and positive predictive value (PPV) of 54.7% (40/73). On adding the neighboring sites to the correctly diagnosed left anterolateral APs (seven left posterolateral APs that were misdiagnosed as left anterolateral) the PPV for the extended segment raised to 64.4% (47/73).

Sensitivity, specificity, PPV and PPV of extended segment for each AP site defined by the algorithm are summarized in table 2.

Table 2: Represents sensitivity, specificity, PPV and PPV of extended segment for each AP site defined by the algorithm:

Site	Sensitivity	Specificity	PPV	PPV of extended segment	P-value
LAL	83% (40/48)	87% (46/79)	54.7% (40/73)	64.4% (47/73)	0.238
LPL	0% (0/8)	85.7% (102/119)	0% (0/17)	29.4% (5/7)	**0.000**
PS	17.4% (8/46)	95% (77/81)	66.6% (8/12)	83.3% (10/12)	0.346
MS	0% (0/4)	99.2% (122/123)	0% (0/1)	100% (1/1)	0.157
AS	0% (0/3)	97% (121/124)	0% (0/3)	0% (0/3)	test not applicable
RAL	0% (0/5)	94.2% (115/122)	0% (0/7)	14.3% (1/7)	0.299
RPL	61.5% (8/13)	90.7% (108/114)	57.1% (8/14)	92.8% (13/14)	**0.029**
Global	44.1% (56/127)	95.2% (691/726)	44.1% (56/127)	60.1% (77/127)	**0.008**

LAL: left anterolateral, LPL: left posterolateral, PS: posteroseptal, MS: midseptal, AS: anteroseptal, RAL: right anterolateral, RPL: right posterolateral.

According to the algorithm seventeen sites were diagnosed as left posterolateral, none of them were correctly diagnosed; 8 were right posteroseptal, 5 left posteroseptal and 4 left anterolateral APs. giving sensitivity of 0% (0/8), specificity of 85.7% (102/119) and PPV of 0% (0/17). On adding contiguous sites (5 left posteroseptal) PPV for extended segment raised to 29.4% (5/17).

From the 127 sites 12 were diagnosed as posteroseptal APs.. Eight of them were correctly diagnosed (1 left posteroseptal and 7 right posteroseptal) and 4 were misdiagnosed as posteroseptal APs (2 midseptal and 2 right posterolateral) giving a sensitivity of 17.4% (8/46), specificity of 95% (77/81) and a PPV of 66.6% (8/12).Two of the 4 mislocations were in the neighbouring AP sites (midseptal), the PPV of the extended segment became 83% (10/12).

According to the algorithm only one AP was diagnosed as midseptal yet was wrong as it was a right posteroseptal pathway on ablation (T4T5), giving sensitivity of 0% (0/4), specificity of 99.2% (122/123) and a PPV of 0% (0/1). T4T5 region was contiguous to midseptal site therefore the PPV of the extended segment reached 100% (1/1).

Three sites were diagnosed by this algorithm as anteroseptal pathways; however, none of them were correct on ablation as all were left sided pathways (2 left posteroseptal and 1 left anterolateral) giving sensitivity and PPV of 0% and specificity of 97% (121/124). None of the predicted sites were contiguous to anteroseptal pathways.

Seven sites were diagnosed as right anterolateral. None of them were correctly predicted. Five of them were left sided pathways on ablation (3 left anterolateral, 1 left posterolateral and 1 left posterseptal), one was a right posteroseptal and one was an anteroseptal pathway. Giving sensitivity and PPV

of 0% and specificity of 94.2% (115/122). Only one was a contiguous site (anteroseptal) making a PPV of 14.3% (1/7) for extended segment.

Fourteen APs were judged by the algorithm to be right posterolateral, 8 were correct on ablation (8 out of 13 true right posterlateral) and 6 were misdiagnosed (5 right posteroseptal and 1 anteroseptal), giving sensitivity of 61.5% (8/13), specificity of 90.7% (108/114) and PPV of 57.1% (8/14). Five of the 6 mislocations were in the neighbouring AP sites (right posteroseptal), their addition to the correctly predicted right posterolateral APs gave a PPV of 92% (13/14) for extended segment..

As a result, this algorithm gave a global sensitivity of 44.1% (56/127), a global specificity of 95.2% (691/726), a PPV of 44.1% (56/127) and a PPV for the extended segment of 60.1% (77/127).

A significant difference was observed between the predictive power of the algorithm for left sided, right sided or posteroseptal APs (p value < 0.05); Out of 90 sites predicted as left sided APs (left anterolateral and left posterolateral) 4o were correctly located (all of them were left anterolateral APs), giving a PPV of (40/90) 44.4 %. From 25 sites predicted by the algorithm as being right sided APs 8 were correctly located (8/25) giving a PPV of 32% (all of them were right posterolateral APs). For posteroseptal location, 12 sites were predicted, eight of them were correctly located (1 M7, 7 T4T5) (8/12) giving a PPV of 66.6%.

- Second step (algorithm 2) :

The result of testing the algorithm2 is the same as algorithm 1 regarding the left anterolateral, left posterolateral, posteroseptal, midseptal and anteroseptal sites, as no changes added to the architecture of the algorithm till these steps.

In algorithm 1 the authors used negative polarity of QRS in V1, negative polarity of QRS in LIII, absence of Qrs in LIII, negative polarity of QRS in V2 and lastly QRS polarity of aVF to predict right anterolateral and right posterolateral APs. In algorithm 2 the authors Integrated delta wave polarity in lead aVF to this last step to discriminate right anterolateral from right posterolateral (right anterolateral pathways distinguished by positive QRS complex and delta wave polarity in lead aVF while right posterolateral pathways distinguished by negative or isobiphasic QRS complex and delta wave polarity in lead aVF)

In algorithm 1 seven sites were mislocated to right anterolateral region, one of them was left posteroseptal AP. Applying delta wave polarity in the algorithm mislocated this AP to the right posterolateral region, so a new error appeared and the pathways predicted in the right anterolateral region decreased one site i.e. from being 7 sites to 6 sites. However none of these sites were correct according to RFCA. Three were left anterolateral, 1 left posterolateral and 1 right posteroseptal APs, giving a PPV of 0% (0/6). Similar to algorithm 1 only one anteroseptal was contiguous site giving a PPV of 16.7% (1/6) for the extended segment.

For the right posterolateral region, as we mentioned previously, the left posterseptal AP that was mislocated by algorithm 1 to the right anterolateral region and was mislocated again, after applying the delta wave polarity, to the right posterolateral region increased the right posterolateral sites from being 14 sites to 15 sites. Eight of them were correctly located (2 T7 and 6 T9) in the right posterolateral region and 7 were misdiagnosed (5 right posteroseptal, 1 left posteroseptal and 1 anteroseptal) giving a PPV of 53.3% (8/15). On adding contiguous sites (5 right posteroseptal) to the 8 correctly predicted right posterolateral APs the PPV for extended segment increased to reach 86.6% (13/15).

-Third step (algorithm 3) :

In algorithm 3 the authors used QRS amplitude in LII to discriminate right anterolateral and right posterolateral from posteroseptal APs. The posteroseptal APs in this algorithm were characterized by QRS amplitude in LII ≤ 0.2 mV. Right anterolateral and right posterolateral APs were characterized by a QRS amplitude in LII > 0.2 mV. The results obtained from this step were subsequently differentiated again by using QRS complex and delta wave polarity of Lead aVF, a step that was already added in algorithm 2.

As in algorithm 1 twelve sites were diagnosed as posteroseptal APs [eight of them were correctly diagnosed (1 left posteroseptal and 7 right posteroseptal) and 4 were mislocated to posteroseptal region (2 midseptal and 2 right posterolateral)].

In algorithm3 and after applying the criteria of QRS amplitude in LII ≤ or > 0.2mV on the 12 sites diagnosed as posteroseptal, 9 sites remained in the posteroseptal region (QRS amplitude in LII≤ 0.2mV) and 3 sited switched their diagnosis to right anteroateral or right posterolateral (QRS>0.2mV). These three sites were subsequently differentiated by QRS complex and delta wave polarity of aVF into one right anterolateral and 2 right posterolateral. Changes occurring in predicted sites of APs with the utilization of algorithm1, 2 and 3 are represented in table 3.

As a result of applying this criteria (QRS amplitude in LII) in algorithm3 the 12 posteroseptal sites predicted by algorithm1 (which remained the same in algorithm2) decreased to be 9 sites, seven of them were correctly located (all of them were right posteroseptal and none was left posteroseptal) and two were misdiagnosed [both were right posterolateral APs (T9)]. So PPV for this site increased to be 77% (7/9). The PPV for extended segment became 100% (9/9) when contiguous sites were added (2T9).

For the right anterolateral region, algorithm 1 predicted 7 sites in this region, decreased after addition of delta wave polarity of aVF in algorithm 2 to be 6 sites. The application of QRS amplitude in algorithm 3 raised the predicted right anterolateral sites to become 7 again. None of these seven sites were correctly located (4 left APs: 3 left anterolateral, 1 left posterolateral and 3 Right APs: 1 right posteroseptal, 1 anteroseptal, 1 midseptal). So PPV for right anterolateral in algorithm 3 was also 0% (0/7). On adding anteroseptal site as being contiguous to right anterolateral the PPV became 14% (1/7) for extended segment.

Regarding right posterolateral region, 14 sites were located by algorithm1, increased to 15 after the introduction of delta wave polarity of aVF in algorithm2, which increased again to 17 with the introduction of QRS amplitude criteria in algorithm 3. Eight of the 17 predicted as right posterolateral by algorithm3 were correctly diagnosed [same as in algorithm1 and 2; the two added sites were M7 and T3 in ablation mislocated to the right posterolateral region] so the PPV was not improved but it decreased from 53.3% (8/15) in algorithm2 to 47% (8/17) in algorithm3. The addition of contiguous sites (5 right posteroseptal) to the correctly predicted right posterolateral APs improved the PPV to be 76.4% (13/17).

Tables 4 and 5 show PPV of changed locations in the three algorithms and changes in PPV with extended segment.

Table 3: Represents changes occurring in predicted sites of APs with the utilization of algorithm1, 2 and 3 and their exact location during RFCA

Real AP Location according to RFCA	Algorithm 1 (QRS polarity in V1, LIII, V2 and L aVF)	Algorithm 2 (delta wave polarity in L aVF)	Algorithm 3 (QRS amplitude L II ≤ or > 0.2mV)
T3 (MS)	PS	PS	RPL
T3 (MS)	PS	PS	RAL
M7 (PS)	PS	PS	RPL
M7 (PS)	RAL	RPL	RPL

T3: 3 O'clock at the tricuspid annulus (midseptal), M7: 7 O'clock at the mitral annulus (left posteroseptal), MS midseptal, PS posteroseptal, RAL: right anterolateral, RPL right posterolateral.

Table 4: Represents changes in PPV of locations when different criteria added for each algorithm:

AP location	Alg.1	Alg. 2	Alg. 3	P Value
PS	66.6% (8/12)	No criteria added	77% (7/9)	0.66
RAL	0% (0/7)	0% (0/6)	0% (0/7)	Test not applicable
RPL	57.1% (8/14)	53.3% (8/15)	47% (8/17)	0.32

PS: posteroseptal, RAL: right anterolateral, RPL right posterolateral,

Table 5: Represents PPV and PPV of extended segments for locations changed in each algorithms

AP location	Alg.1	Extend segmen	P Value	Alg. 2	Extend segment	P Value	Alg. 3	Extend segment	P Value
PS	66.6% (8/12)	83.3% (10/12)	0.346	No criteria added	No criteria added	----	77% (7/9).	100% (9/9)	0.134
RAL	0% (0/7)	14.3% (1/7)	0.333	0% (0/6)	16.7% (1/6).	0.296	0%(0/7)	14% (1/7)	0.299
RPL	57.1% (8/14)	92.8% (13/14)	**0.029**	53.3% (8/15)	86.6% (13/15)	**0.046**	47%(8/17)	76.4% (13/17)	0.078

PS: posteroseptal, RAL: right anterolateral, RPL right posterolateral,

No significant improvement was observed in global PPV of the algorithm 1 after the addition of each criteria in algorithm 2 and 3 (44.1%, 44.1%, 43.3% respectively, p value=0.899)

A very significant Improvement was observed in global PPV of each algorithm when extended segment maneuver was applied (60.6 %, 60.6%, 59.8% respectively) (p value = 0.008), however, no significant difference between global PPV of extended segment of algorithm 1, 2 or 3 (p value 0.898) Table 6.

Table 6: Represents global PPV of each algorithm with and without extended segment:

	Algorithm 1	Algorithm 2	Algorithm 3	P Value
Global PPV	44.1 (56/127)	44.1(56/127)	43.3 (55/127)	0.899
Global PPV with extended segment	60.6 (77/127)	60.6(77/127)	59.8(76/127)	0.898
P Value	0.008	0.008	0.008	

As a result of algorithm 3: The lowest predictive power was in left posterolateral 0%(0/17), The greatest predictive power attained on posteroseptal 77% (7/9). Sorting in order of decreasing PPVs finds posteroseptal (M7 and T4T5) with a PPV of 77% (7/9) followed by right posterolateral (T7 and T9) PPV of 47%, 8/17, left anterolateral 54.7%(40/73), left anterolateral plus left posterolateral 44.4% (40/90), midseptal 0%(0/1), anteroseptal 0%(0/3), right anterolateral 0%(0/7) and left posterolateral 0%(0/17) which was the lowest PPV of all locations.

QRS duration and pathway locations:

- Fifteen APs had ECGs with QRS duration ≤110 ms (15/127) (11.8%) and 112 APs had ECGs with QRS duration >110ms (112/127)(88.2%). Using Chi-squared test, accuracy of the algorithm tends to be lower in ECG of patients with limited preexcitation, it was 20% (3/15) in patients with QRS duration of ≤110 ms and 46.4% in patients with QRS duration of >110 ms (52/112)

(P=0.052). However, the predictive power of the algorithm using only ECGs with QRS duration >110ms (46.4%) did not differ significantly from the global accuracy of the algorithm (44.1%) (p value= 0.717).

-The success of the algorithm was significantly lower for localizing left sided APs with limited preexcitation. It was 25% in 12 patients (3/12) with a QRS duration of ≤110ms and 57% in the remaining (37/65 patients) (P=0.04).

-Accuracy of the algorithm for localizing APs in left anterolateral sites (M2M4) was very significantly lower with limited preexcitation. It was 42.8% in 7 patients (3/7) with a QRS duration of ≤110ms and 90.2% in the remaining (37/41).(P=0.002)

-Chi-squared test was not applicable as no APs were correctly predicted in M5M6 (0/4) or M7 (0/1) regions when QRS≤110ms, and no APs were predicted at all in these regions with ECGs possessed a QRS duration >110ms.

-A statistically significant difference was not found between localizing right sided APs with QRS duration ≤ and > 110 ms (0/3, 15/47 respectively) (0%, 32%) (p=0.24),

-Chi-squared test was not applicable as no AP was predicted from the start in right sided regions other than T4T5, no statistical significant difference found for predicting power of the algorithm between APs in posteroseptal region (T4T5) with QRS duration ≤ and >110 ms (0/3, 7/24 respectively) (P=0.25).

Among the 112 APs that had ECGs with QRS duration >110ms 65 were left and 47 were right sided APs. Twenty eight out of 65 left sided APs were misdiagnosed (28/65)43% and 32 out of 47 right sided APs were misdiagnosed (32/47) 68% with a total of (60/112) 53%. (p value =0.009)

DISCUSSION

The algorithm of Sezer et al, like most of other algorithms (Fitzpatrick 1994, Xie 1994, D'Avila 1994, Chiang 1995, Ituuralde 1996 and Arruda 1998) is based on discriminating stepwise analysis, with a results either positive, negative or isobiphasic and orienting the subsequent steps with each step classifying an ECG to fit either one of branches of the scheme.

The development of the algorithm was on three steps. 1) Algorithm 1: depending mainly on QRS complex polarity in four leads (V1, LIII, V2 and aVF) and QRS morphology in one lead (Qrs in LIII). 2) Algorithm 2: the same as algorithm 1 with the integration of QRS complex amplitude in LII (< or > 0.2mV) to the right limb of the algorithm. 3) Algorithm 3: where he added delta wave polarity in only one lead (aVF).

Hence, the final algorithm of Sezer et al. was based mainly on QRS complex polarity in four leads (V1, LIII, V2 and aVF), delta wave polarity was used in only one lead (aVF).

According to Sezer et al. the use of QRS complex polarity criteria alone (first algorithm) was able to correctly diagnose 87% of the APs of his series, this increased to 89.2% when integrating delta wave polarity of lead aVF (second algorithm) and increased to 92.3% when QRS amplitude in LII was added to the algorithm (third algorithm). i.e. increase in total accuracy of algorithm by 4%.

Testing the algorithm on our patient's group gave a very low total success rate in predicting the correct location of APs. On the contraire for what was stated in the study the integration of these tow additions did not increase the success rate in predicting exact location of APs but it relatively decrease it in a very mild way, the first algorithm yield accuracy of 44.1% (56/127) while

integrating delta wave polarity of lead aVF (second algorithm) yield the same accuracy [44.1%(56/127)], the addition of QRS amplitude in LII to the second algorithm decreased PPV to 43.3% (55/127).

Low accuracy of the algorithm could be attributed to many factors, one of these factors is the non us of delta wave in the construction of the algorithm. In earlier days of EPS Yaun et al. in 1992 evaluated ECG criteria of 182 patients with manifest single AP and concluded that the polarity of the delta wave is the most important ECG feature for predicting AP location.(Yaun et al. 1992). However this study was done before the era of RFCA and was conducted over algorithms localizing less AP locations (4 regions).

In a more recent study Basiouny et al. in 1999 included 266 Patients with manifested APs in a study that tested 11 algorithms, he concluded that the accuracy of the algorithm tends to be lower when delta wave polarity is not included in the algorithm's architecture. Delta wave was integrated in the last branch of the algorithm tested in this study. This could explain the low accuracy of the algorithm in our results and the low benefit obtained (4% increase in accuracy) in the literature.

The low accuracy of the algorithm could be also attributed to the interobserver variability. Lopez et al. in 1996 reviewed ninety-six electrocardiograms obtained from patients who underwent successful ablation of a single accessory pathway. The location of each pathway was predicted by two independent observers according to three different reported electrocardiographic algorithms. The interobserver agreement varied between 64 and 79% and the accuracy of prediction varied between 38 and 67%. The best results were obtained in the left lateral accessory pathways (69 to 89% correctly located). He also concluded that the algorithms that he studied presented critical steps at

which more than 20% of pathways were incorrectly classified (Alvarez López et al.1996).

Localization of AP using surface ECG has also some limitations. The position of chest electrodes and the orientation of the heart in the thorax may be different for different patients and these influence the surface ECG. Thus the QRS morphologies will not be consistent for all patients with the same AP location (Reddy et al.1987, Lindsay et al.1987)

Small number of patients (65 patients) would not give a sufficient data for building criteria for predicting regions with small number of AP, this small sample size precluded the determination of reliable criteria for the diagnosis of certain pathway locations. In Sezer et al the group of patients included 8 anteroseptal, 2 midseptal, 3 right anterolateral, 4 left posteroseptal and 9 left posterolateral. Increasing the number of patients in each region would increase the data obtained to build the algorithm and may improve its accuracy.

Minimal preexcitation could also be thought to be the cause of discrepancy between our results and the results stated in the literature by Sezer et al., however this was not the reason for low successful predictability of the algorithm. The PPV of the algorithm was found to be low for ECGs with QRS≤110ms (20%) (3/15) however, the PPV of the algorithm on using ECGs with QRS duration >110ms did not reach what was published in Sezer's algorithm as 52 out of 112 ECGs with QRS duration >110ms were correctly located giving a PPV of 46% only.

In this algorithm APs were differentiated into seven sites. Basiouny et al. 1999 asserted that there is a tendency for PPV to increase with algorithm relying on< 6 segments and more septation will decrease accuracy of the algorithm (Basiouny et al.1999); rendering this algorithm fit within category of algorithms that has low accuracy. This explain the increase of PPV when applying

extended segment maneuver from 44.1%, 44.1% and 43.3% to 60.6 %, 60.6%, 59.8% in algorithm 1,2 and 3 respectively.

In spite of increase of success rate of the algorithm in predicting AP locations with using extended segment still its accuracy is lower than what stated by the authors (The accuracy of any of the three algorithms in the literature were >85%). In our patients group the accuracy of the algorithm did not reach more than 60.6% (algorithm 2). Based on Basiouny et al. the PPV tends to be also lower with extended segment localization when Delta wave polarity is omitted from the algorithm's architecture

In the 3rd step of the algorithm (algorithm 3) three AP locations had 100% predictability (anteroseptal, midseptal, right anterolateral), the opposite was found with our group of patients as the algorithm was not able to predict correctly any of these sites (0%), the same was for left posterolatewral APs as none of them was correctly located in spite of 89% predictability stated by the authors.

The inability of predicting correctly these sites could be due to the presence of some patients with abnormal anatomical cardiac structure among the group of patients utilized in constructing the algorithm; two of these patients were having HOCM and two with Ebestien's anomaly. The authors pointed out that one the patients with Ebestien anomaly had anteroseptal pathway but they did not mention the location of other 3 pathways. Several locations in their study had minimal number of patients: the right anterolateral location was based on analysis of ECGs from 3 patients, the midseptal was based on analysis of ECGs of 2 patients, 4 patients only for left posteroseptal and 8 patients with anteroseptal APs. If the ECGs of APs of the patients that had the aforementioned abnormal anatomy were present in analysis of any of the previously mentioned locations it would affect the reliability of the algorithm

because the orientation of the heart in the thorax will affect the morphology of QRS complex and also the orientation of delta wave. It would be better for algorithm reliability not to include these patients in the data used for building the algorithm.

The predictability of the algorithm in our group of patients for other sites was also less than what have been proclaimed by the authors. The predictability for posteroseptal sites was 77% in return to 93% reported by the authors, 47% for right posterolateral sites in return to 91% and 54.7% for left anterolateral sites in return to 89% reported by the authors

In Basiouny et al. 1999, the accuracy of the algorithms is related to AP location with the greatest predictive power attained on the M2M6 segment (left anterolateral plus left posterolateral) (86.3%) and the lowest predictive power for APs on the T6T10 segment (≈ right posterolateral) with a PPV of 23.4%. Predictability for posteroseptal APs were 65.2% and 45.2% for T11T3 (sorting in order of decreasing PPV M2M6—M7and T4T5----T11T3----T6T10).

Results from testing this algorithm showed that posteroseptal accessory pathways (M7 and T4T5) possessed the highest PPV (77%), while left posterolateral alone account for the lowest PPV of all locations (0%) (0/17). Left anterolateral when added to left posterolateral (M2M6) possessed 44.4% (40/90) predictability while left anterolateral alone had 54.7% (40/73). Right posterolateral (T7 and T9) had PPV of 47% (8/17).

The authors identified criteria in the algorithm for posteroseptal APs and did not separate left posteroseptal from right posteroseptal APs. They could not find a reliable delta wave polarity criterion or QRS amplitude that can distinguish between right and left posteroseptal pathways. (Sezer et al.1999)

CONCLUSION

The accuracy obtained by the algorithm (in our patient population) was clearly lower than that represented by the corresponding author. The algorithm was based on ECG criteria from certain group of patients that gave a high accuracy when tested on the same group. Testing the algorithm on an independent group of patients yield a different accuracy. Algorithms should be tested for accuracy on a separate group of patients before subjecting them for clinical use.

Limitations:

The small number of patients used for testing the algorithm constitutes a limitation of this study. A 100% PPV with one patient at one localization should not weigh as much as 60% PPV with 50 patients.

The authors in the literature did not define whether APs in T9 position considered as right posterolateral or right anterolateral pathways. During our analysis, none of the right anterolateral APs predicted by the algorithms were true T9 at ablation.

Considering them as posteroseptals gave some positive results showed in our reported results.

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كان متوسط عمر المرضى فى هذه الدراسة ٣٢ ± ١٤ عاما، وكان ٨٥ منهم (٦٧٪) من الذكور.

سبعة وسبعون مريضا كانت لديهم مسارات أذين- بطينبه إضافيه بالناحيه اليسرى من القلب بينما الخمسون اللآخرون بالناحيه اليمنى من القلب.

كان التوقع الإجمالى للخوارزميه دقيقآ بنسبة ٤٤% زاد إلى ٦٠% عند إضافة المواقع المجاوره للمواقع المتوقعه الصحيحه.

تم ملاحظة فروق بين القوة التنبؤية للخوارزمية لمواقع المسارات الإضافيه بالناحيه اليسرى و الناحيه اليمنى والواقعه خلف حاجزالقلب البطينى. (٤٤,٤% ، ٣٢% ،٦٦,٦ % على التوالى)

لا يوجد تأثير كبير على الدقة الإجماليه للخوارزمية بزيادة معدل الإستثاره (زمن QRS > ١١٠ مللي ثانيه)

حيث وصلت الدقه الإجماليه إلى ٤٦% فقط.

كان نجاح الخوارزمية ضعيفا فى تحديد مواقع المسارات الإضافيه بالناحيه اليسرى من القلب أثناء معدل الإستثاره المحدود (≥ ١١٠ مللى ثانيه) (٢٥%) بالمقارنه بنفس الجهه أثناء معدل الإستثاره > ١١٠ مللى ثانيه (٥٧%).

لم يتم العثورعلى فروق ذات دلالة إحصائية معتبرة فى معدل توقع الخوارزميه لمواقع المسارات الإضافيه بالناحيه اليمنى من القلب عند معدل إستثاره > أو ≥ ١١٠ مللى ثانيه.

وكانت أدنى قوة تنبؤية للخوارزمية في المسارات الإضافيه الخلفبه الجانبيه اليسرى (٠٪)، وأعلى قوة تنبؤية تحققت للخوارزميه كانت فى المسارات الإضافيه الواقعه خلف الحاجز البطينى (٧٧%)

ونستخلص من هذة الدراسه أن معدل التوقع الصحيح لمواقع مسارات الأذين- بطينبه الإضافيه بهذه الخوارزميه ليست كما أعلن عنها المؤلف . وعلى ذلك، ينبغي اختبار الخوارزميات على مجموعة مستقلة من المرضى للتأكد من دقتها قبل عرضها للإستخدام الإكلينيكى.

. No significant difference was observed between the predictive power of the algorithm for left sided, right sided or posteroseptal APs [44.4 % 32% and 66.6% respectively (p value =0.177)].

التحقق من فاعلية خوارزمية سيزير المعتمدة على خصائص رسم القلب فى تحديد مواقع المسارات الأذين- بطينبه الإضافيه المصاحبه لمرضى متلازمة وولف-باركنسون-وايت

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تم نشر العديد من الخوارزميات التي تعتمد على خصائص رسم القلب لتحديد مواقع المسارات الأذين- بطينيه الإضافيه فى مرضى متلازمة وولف باركنسون وايت.

واحدة من هذه الخوارزميات، والتي نشرت لاحقا، إدعى مؤلفها دقة عالية، تصل إلى ٩٢.٣٪، في التنبؤ باماكن هذه المسارات الإضافيه في سبعة مواقع .

تم الإعتماد فى تصميم هذه الخوارزمية على تحليل رسم القلب المإخوذ من مجموعة من المرضى ، ومع ذلك لم يتم اختباركفاءة هذه الخوارزمية على مجموعة مستقلة من المرضى حتى الآن، وكان هذا هو هدف هذه الدراسة.

تم الحصول علي رسومات القلب من ١٢٧ مريضآ أجري لهم جميعآ بنجاح إجتثاث لمسار أذين- بطينى إضافى واحد ظاهر برسم القلب بواسطة موجات التردد الحراريه باستخدام القسطرة.

خضعت جميع هذه الرسومات للتحليل من قبل اثنين من المراقبين المستقلين.

تمت مقارنة ملاحظاتهم وتم التوصل إلى توافق في الآراء وتشكيل قاعدة بيانات موحدة والتى من خلالها تم اختبار الخوارزمية.

كانت متغيرات رسم القلب المستخدمه في هذه الخوارزمية كالآتى :

- قطبية موجة QRS فى الأقطاب V1, V2, LIII وaVF
- قطبية موجة دلتا في موجة aVF (إيجابية، سلبية ، ثنائية الإشاره أو متعادله)
- مورفولوجية موجة QRS فى LIII
- مدى إرتفاع موجة QRS في LII (≥ ٠.٢ مللى فولت أو> ٠.٢ مللى فولت)