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Evaluation of the Effect of Maximal Preexcitation Provoced by Rapid Atrial Pacing on the Validity of A Sezer ECG Algorithm for Localizing Accrssory Pathways in Patients With Wolff-Parkinson-White Syndrome

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ABSTRACT

Introduction*:** Rapid atrial pacing increases preexcitation in Wolff-Parkinson-White syndrome (WPW syndrome). Suggestions have been proposed that significant preexcitation lead to better localization of atrio-ventricular accessory pathway (AP) by ECG algorithms. Testing Sezer's algorithm on an independent group of patients with WPW syndrome have shown low accuracy (<45%). The aim of this study was to evaluate the effect of maximal preexcitation, provoked by rapid atrial pacing, on the accuracy of Sezer's algorithm. ***Subjects and methods: Twelve-lead surface ECGs were obtained from 138 patients prior to undergoing successful radiofrequency catheter ablation (RFCA) of a single manifest AP. Two ECG tracings were obtained for each patient; one with preexcitation in sinus rhythm (Sprex) and another in maximal preexcitation during rapid atrial pacing (Mprex). Analysis of QRS and delta wave polarity were done and Sezer's algorithm was applied on each ECG tracing, once in Sprex and another in Mprex. ***Results:*** Accuracy of the algorithm was higher in Mprex (57.2%) than Sprex (44.2%) (P<0.05), accuracy of the algorithm for APs in LAL position was higher in Mprex (94%) than Sprex (56.8%) (P<0.0001). No significant differences were found in accuracy of the algorithm for other AP locations. ***Conclusion:*** The changes in QRS polarity and cardiac axis during maximal preexcitation, obtained by rapid atrial pacing, improve the positive predictive value of Sezer's algorithm only for left lateral APs and has no value in improving prediction of other locations.

Key words: Wolff-Parkinson-White Syndrome, Electrocardiography, Algorithm, Maximal preexcitation.

Introduction

Certain authors suggest that the duration of QRS complex of a preexcited electrecardiogram (ECG) should exceed certain duration for permitting application of algorithms localizing manifest atrioventricular accessory pathways (AP) which are based on the analysis of 12 leads surface ECG (Lemery *et al.,* 1987; Fitzpatrick *et al.,* 1994; Arruda *et al.,* 1998). The importance of preexcitation, therefore the width of the QRS complexes depends on the result of the relative competition in conduction between the accessory pathway and the normal conductive system (His-Purkinje network). Rapid atrial stimulation leads to physiological prolongation in nodo-ventricular conduction time and consequently increase the degree of preexcitation which corresponds to more ventricular activation through the AP (Teo *et al.,* 1991). This is translated by a measurable changes on the surface ECG with characteristically ventricular depolarization and repolarization in relation to the site of insertion of the accessory pathway (Steurer *et al.,* 1994).

Suggestions that significant preexcitation leads to better localization of APs by the algorithms have been early proposed (Lemery *et al.* 1987)

In the year 2012, an algorithm appeared on the world wide web published by Sezer et al. (1999). In their third revised step (fig.1) Sezer *et al.* (1999) proposed an algorithm for predicting AP location in seven sites. He claimed high accuracy (92.3%) based on analysis of QRS complex polarity in four ECG leads (V1, V2, LIII and aVF) , morphology of QRS in LIII , delta wave polarity in aVF and amplitude of QRS in LII (≤0.2mV or > 0.2mV). Testing this algorithm on an independent group of patients (Basiouny, 2012) did not yield the same accuracy as proclaimed by Sezer *et al*. (1999) (<45%).

The aim of this study was to test whether maximal preexcitation produced by atrial pacing will improve Sezer's algorithm accuracy or not.

Subjects and Methods:

Twelve-lead surface ECG traces of 138 patients with Wolff-Parkinson-White syndrome (WPW syndrome) were collected in the period between January 1999 to May 2012 from Cardiology department of Nancy central hospital (France) and Alhussein University hospital (Egypt). Two ECG tracings were obtained prior to RFCA

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from each patient, one with preexcitation in sinus rhythm (Sprex) and the second during incremental atrial pacing (Mprex) that was used for induction of supraventricular tachycardia. These traces were preserved in order to use them in the future for establishing a valuable algorithm. Analysis of these traces and applying the algorithm of Sezer on these traces was done after the year 2012 following the appearance of Sezer's algorithm on the electronic network.

All patients had successful radiofrequency catheter ablation (RFCA) for a single manifest AP. The ECGs 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 reviewed the ECGs in Sprex and in Mprex separately. The two observers were unaware of exact AP location. They determine and measure QRS polarity with more stress on the criteria that were utilized in building the algorithm of Sezer *et al*. (1999): (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) as described by Sezer *et al*.(1999) (4) Amplitude of QRS in LII (≤ 0.2mV or >0.2mV).
The observers then compared their notes and a consensus was reached, forming a consolidated database.

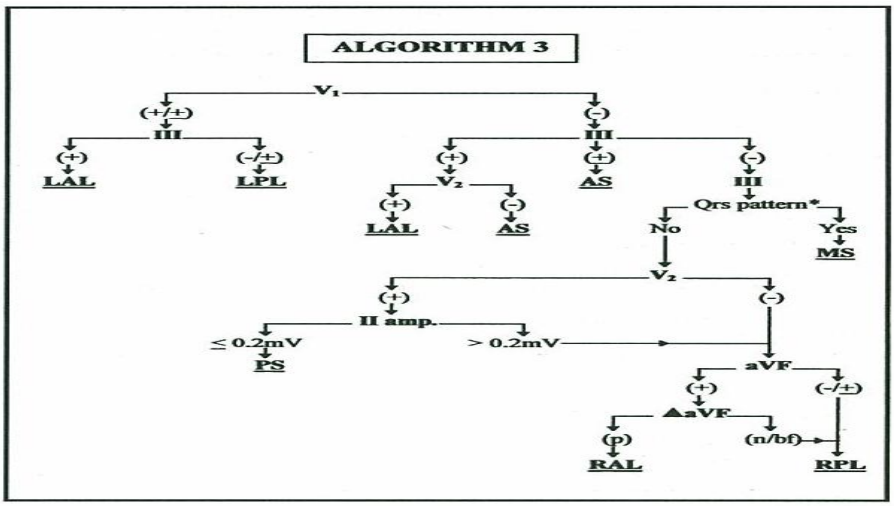

Fig. 1: Third step of Sezer's algorithm after integration of delta wave polarity criterion in lead aVF [(p): positive ,(n): negative, (n/bf): isobiphasic] and QRS complex amplitude criterion in lead II (≤ or >0.2mV) (*Qrs pattern was originally described by D'Avila *et al*.(1995); abbreviations: LAL: left anterolateral, LPL: left posterolateral, PS: posteroseptal, MS: midseptal, AS: anteroseptal, RAL: right anterolateral, RPL: right posterolateral (Sezer *et al*. 1999).

Test procedure

The third revised step of Sezer's algorithm was tested on the database obtained from analysis of the 138 ECGs of Spex then Mprex. The test was done by an observer unaware of the location of the AP. When the results predicted by the algorithm were identical in Sprx and Mprex for the same patient, the pair of traces was considered concordant in this patient.

Electrophysiologic 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 sites were determined by radiographic criteria and have been given the standardized nomenclatures that has been already adopted in Basiouny *et al*. (1999) to define their locations (fig. 2).

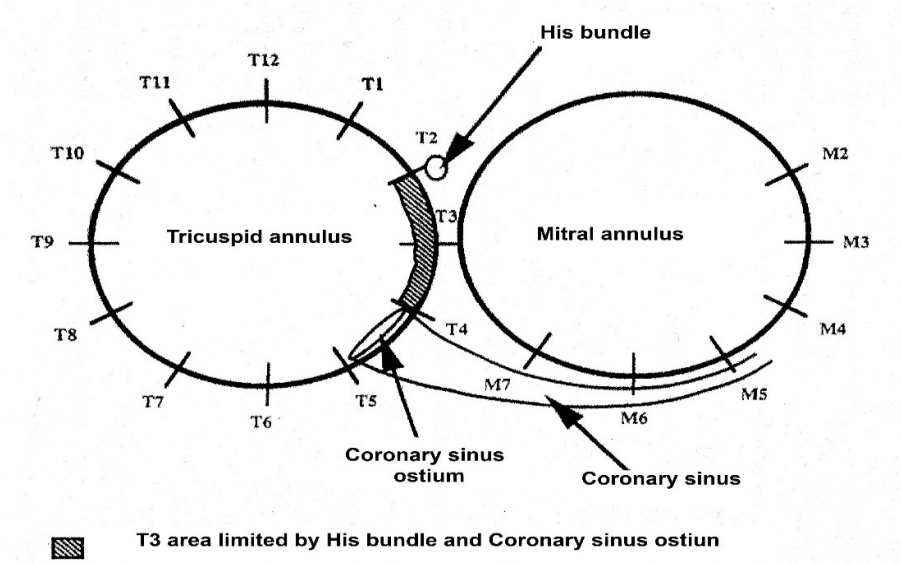

Fig. 2: Accessory pathway label site along the mitral and tricuspid annuli. Schema correspond to the mitral and tricuspid annuli viewed under a 45° left anterior oblique fluoroscopic projection. (Basiouny et al.1999).

-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 <0.05 was considered significant.

Results

Mean age of the study population was 35±16 years. There were 92 (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. 3.

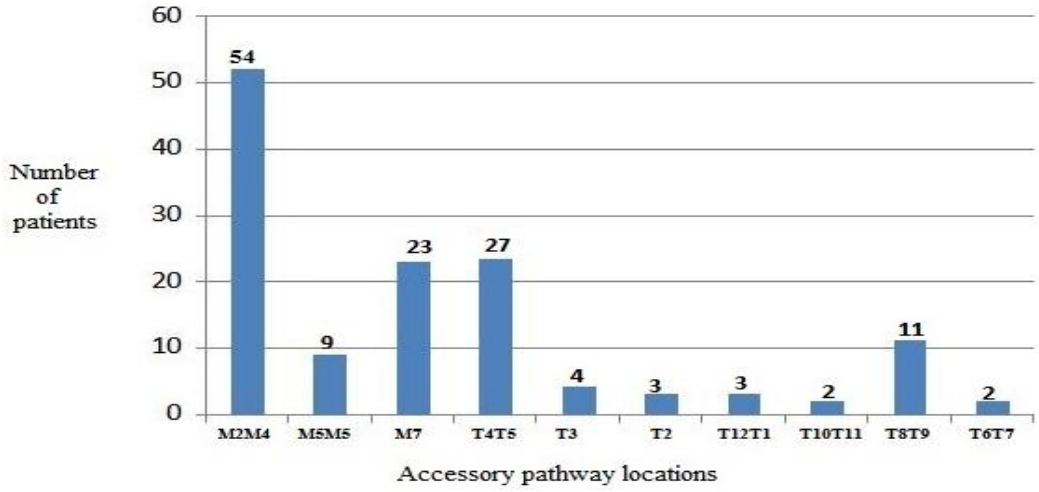

Fig. 3: Represents distribution of exact localization of AP along the mitral and tricuspid annulus defined by RFCA.

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.

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 and mitral annulus:

	Normal annulus position (clock wise)	No. of APs	Classification and labels of the algorithm
Left sided APs. (77 Pts.)	M2M4	54	LAL
	M5M6	9	LPL
	M7	23	PS
Right sided APs. (50 Pts.)	T4T5	27	
	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)

ECG analysis in Sprex and in Mprex:

In sinus rhythm, mean heart rate was 74±16/min and 143±18/min in atrial pacing. Duration of QRS complex increased significantly under the effect of atrial pacing from 139.6±17.6 ms in sinus rhythm to 169.3±16.9 ms (P<0.001).

In sinus rhythm, QRS duration of right AP was similar to left AP (137±17.9 ms and 141±22.9 ms respectively) (P=0.107). On the other hand, the increase in QRS duration under the effect of atrial pacing was more marked in left APs compared to right APs with average increase of 34.6±17 ms and 25±16.7 ms respectively (P<0.0001).

The QRS complex polarity changes under the effect of atrial pacing (see figures 4 and 5) are expressed in table 2. The variations observed in the morphology of QRS complexes were towards less positive polarity (or downright negative) in leads I, II and aVF, whereas changes toward positivity were observed in leads aVR and V1. The morphology of these 5 leads was frequently affected by atrial pacing more than the other leads. Morphology changes in these leads reached more than 20% of ECG traces concerning these 5 leads, whereas similar changes encountered in less than 10% of ECG traces in the other seven ECG leads.

Table 3 shows that these morphological modifications were characteristic of some AP locations essentially left sided APs. In fact, the QRS modification observed in lead I exclusively corresponded to APs located topographically in M2-M6 region, the changes observed in leads aVR and V1were characteristic of APs situated in M2-M7 and T4-T5 regions, changes in lead II were observed in APs located in M2-M7 and T3-T5 regions, while changes in aVF were seen in APs situated in M2-M7, T3-T5 and T9 regions.

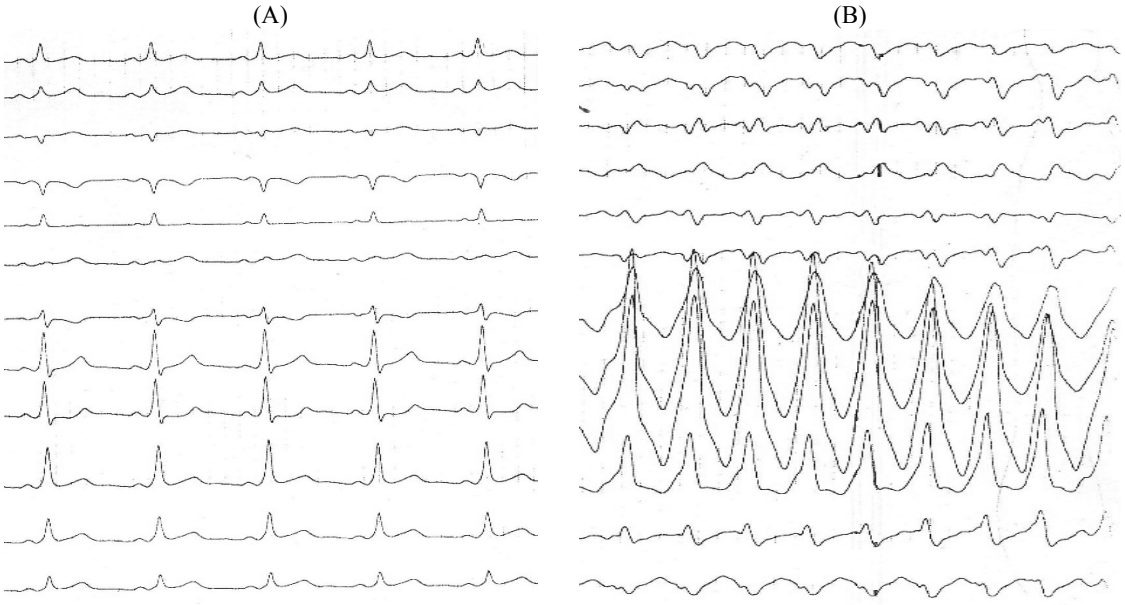

Fig. 3: 12-lead surface ECG with preexcitation in sinus rhythm (A) and during rapid atrial pacing (B). The AP is located in M3 position.

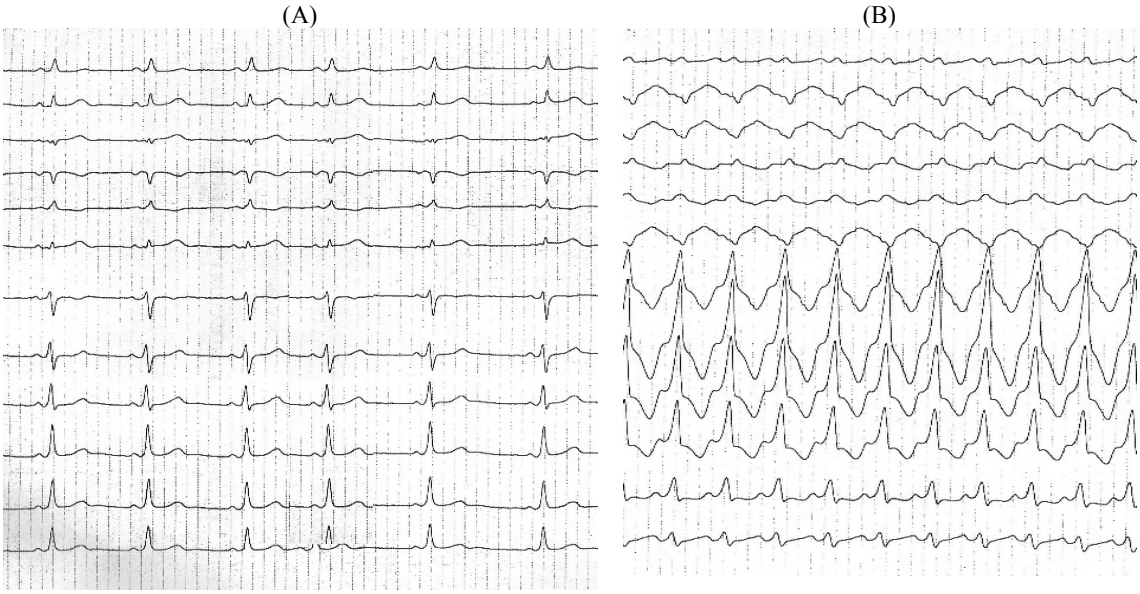

Fig. 4: 12-lead surface ECG with preexcitation in sinus rhythm (A) and during rapid atrial pacing (B). The AP is located in M6 position.

Table 2: Represents percentage of ECGs showing changes in QRS polarity in each ECG lead during Mprex:

	PN	NP	PI	IP	NI	IN	No changes
I	23%	-	1%	-	-	-	76%
II	32%	-	2%	-	-	-	66%
III	13%	2%	-	-	-	-	85%
AVR	-	20%	5%	-	1%	-	74%
AVL	7%	3%	-	1%	-	-	89%
AVF	23%	-	-	-	-	-	77%
V1	2%	23%	-	-	-	-	75%
V2	6%	10%	-	-	-	-	84%
V3	8%	-	-	-	-	-	92%
V4	6%	-	-	-	-	-	94%
V5	8%	-	-	-	-	-	92%
V6	12%	-	-	-	-	-	88%

Table 3: Represents percentage of ECGs that showed changes in QRS polarity in each lead in relation to AP location:

	M2-M4	M5-M6	M7	T4-T5	T3	T2	T12-T1	T10-T11	T9	T7
I	62%	13%	-	-	-		-	-	-	-
II	22%	50%	71%	48%	25%		-	-	-	-
III	10%	13%	19%	12%	-	67%	-	50%	27%	-
AVR	23%	75%	29%	36%	-	-	-	-	-	-
AVL	19%	-	10%	-	-	-	67%	-	-	-
AVF	17%	38%	48%	24%	25%	-	-	-	18%	-
V1	28%	38%	33%	28%	-	-	-	-	-	-
V2	23%	13%	5%	4%	-	33%	-	-	45%	50%
V3		-	-	20%	-	-	-	-	45%	-
V4		-	-	12%	-	-	-	-	18%	100%
V5	4%	13%	-	12%	25%	-	-	-	18%	50%
V6	17%	50%	-	8%	-	-	-	-	-	50%

Globally, there were significant changes in cardiac axis during Mprex, (from 29.28±54.94 during Sprex to16.7±82.79 during Mprex) with a P-value <0.01).

Cardiac axis changed significantly in M2M4, M5M6, M7, T4T5 and T9 locations while the changes in cardiac axis of other AP locations were not significant (table 4).

According to the segmentation done by Sezer et al. (1999) (table 5) Left anterolateral (LAL) APs had within normal QRS cardiac axis during Sprex (77.8°±32.76) that showed tendency to deviate towards right side

during Mprex (93.7°±68.13) (P<0.05), left posterolateral (LPL) APs had normal cardiac axis during Sprex (26°±55.26) that tended significantly to deviate towards right axis during Mprex (-34.33°±87.74) (P<0.05), while posteroseptal APs had left axis QRS complex during Sprex (-11.24°±38.29) that increased significantly to (-45.34°±26.68) during Mprex (P<0.0001). The midseptal, anteroseptal and right anterolateral APs didn't show any significant changes in the QRS cardiac axis during atrial pacing. Right posterolateral APs had left axis deviation of QRS complex during Sprex that increased significantly during rapid atrial pacing from -15.92°±31.10 to -35.46°±25.32 (P<0.001).

Table 4: Represents QRS cardiac axis during Sprex and Mprex for different AP location:

AP location	Cardiac axis Sprex	Cardiac axis Mprex	P-value
M2M4	77.8±32.76	93.7±68.13	<0.05
M5M6	26±55.26	-34,33±87.74	<0.05
M7	6.43±41.63	-40.13±36.42	<0.001
T4T5	-26.30±28.02	-49.78±13.22	<0.0001
T3	-2.50±36.50	-17.75±35.31	0.10
T2	44.67±15.14	38.33±14.84	0.35
T12T1	53.33±16.50	56.67±10.41	0.51
T10T11	45.50±28.99	33.50±38.89	0.34
T9	-16.27±33.82	-34.27±26.61	<0.01
T7	-14.00±12.73	-42.00±22.63	0.16
Global	29.28±54.94	16.7±82.79	<0.01

Table 5: Represents cardiac axis during sinus rhythm (Sprex) and changes occurring in cardiac axis during rapid atrial pacing (Mprex) with P-value for different AP location according to Sezer's segmentation:

AP location	Cardiac axis Sprex	Cardiac axis Mprex	P-value
LAL	77.8±32.76	93.7±68.13	<0.05
LPL	26±55.26	-34.33±87.74	<0.05
PS	-11.24±38.29	-45.34±26.68	<0.0001
MS	-3.25±35.88	-17.75±35.31	0.09
AS	44.67±15.14	38.33±14.84	0.35
RAL	50.20±19.10	47.40±24.36	0.60
RPL	-15.92±31.10	-35.46±25.32	<0.001

Abbreviations are the same as table 1

Sensitivity, Specificity and PPV of of the algorithm for each AP location were represented in table 6. Specificity and PPV of the algorithm were higher in Mprex than Sprex regarding AP in LAL position (P<0.0001). Sensitivity was higher in Mprex than Sprex for AP in LPL location (P<0.01) meanwhile specificity in Mprex was less than Sprex for the same AP location (P<0.0001).

No significant differences were found in sensitivity, specificity or PPV of the algorithm for other AP locations (PS, MS, AS, RAL and RPL).

Global Sensitivity, Specificity and PPV were higher in Mprex than Sprex (P< 0.05).

Positive predictive value for Sprex, Mprex and concordant pairs of each AP site were represented in table (7) Concordant pairs represents the relevance of locations obtained in sinus rhythm and confirmed by maximal preexcitation. In LAL location 44 pairs were concordant when applying the algorithm on sinus and maximal preexcitation traces. Forty three of the 44 concordant pairs were correctly predicated according to the results of RFCA giving a very high PPV (97.7%).

On the other hand, no significant improvement was observed in PPV of the algorithm for all other sites of AP with concordant pairs. Globally the PPV of the algorithm was significantly high with Mprex or concordant pairs (P-value <0.05 and <0.0001 respectively)

The power of correction of Mprex:

Applying the algorithm on Mprex traces predicted AP sites, these predicted sites were either the same as Sprex (concordant pair) or different from them. The different AP sites were either correctly located (same location as RFCA) or just transposed to another wrong site.

Table 8 shows how much the Mprex help the algorithm in correcting the localization of the AP and how much it transposed wrongly the AP to other location.

Table 6: Represents sensitivity, specificity and PPV for each AP site defined by the algorithm:

Site	Sensitivity		P value	Specificity		P value	PPV		P value
	Sprex	Mprex		Sprex	Mprex		Sprex	Mprex	
LAL	85.2% (46/54)	87% (47/54)	0.780	58.3% (49/84)	96.4% (81/84)	<0.0001	56.8% (46/81)	94% (47/50)	<0.0001
LPL	0% (0/9)	87% (6/9)	<0.01	86.8% (112/129)	71% (88/129)	<0.0001	0% (0/17)	12.8% (6/47)	0.12
PS	14% (7/50)	26% (13/50)	0.133	86.4% (76/88)	97.7% (66/88)	0.056	77% (7/9)	86.7% (13/15)	0.57
MS	0% (0/4)	0% (0/4)	NA	99.3% (133/134)	100% (134/134)	0.316	0% (0/1)	0% (0/0)	NA
AS	0% (0/3)	66.7% (2/3)	0.08	91% (132/135)	96.3% (130/135)	0.472	0% (0/3)	28.6% (2/7)	0.301
RAL	0% (0/5)	20% (1/5)	0.292	94% (125/133)	98.4% (131/133)	0.053	0% (0/8)	33.3% (1/3)	0.09
RPL	61.5% (8/13)	77% (10/13)	0.23	90.4% (113/125)	95.2% (119/125)	0.142	42% (8/19)	62.5% (10/16)	0.23
Global	44.2% (61/138)	57.2% (79/138)	<0.05	89.4% (740/828)	92.9% (769/828)	<0.05	44.2% (61/138)	57.2% (79/138)	<0.05

NA= Chi-square test was not applicable.,Abbreviations are the same as table 1

Table 7: Represents PPV of Sezer'algorithm for Sprex, Mprex and concordant pairs with differences between Sprex and Mprex., and differences between Sprex and concordant pairs for each AP site:

Site	PPV			P-value (Sprex vs Mprex)	P-value (Sprex vs Concordant pairs)
	Sprex	Mprex	Concordant pairs		
LAL	56.8% (46/81)	94% (47/50)	97.7% (43/44)	<0.0001	<0.0001
LPL	0% (0/17)	12.8% (6/47)	0% (0/14)	0.122	NA
PS	77% (7/9)	86.7% (13/15)	66.7% (4/6)	0.572	0.633
MS	0% (0/1)	0% (0/0)	0% (0/0)	NA	NA
AS	0% (0/3)	28.6% (2/7)	0% (0/0)	0.301	NA
RAL	0% (0/8)	33.3% (1/3)	0% (0/0)	0.087	NA
RPL	42% (8/19)	62.5% (10/16)	67% (8/12)	0.229	0.183
Global	44.2% (61/138)	57.2% (79/138)	72% (54/75)	<0.05	<0.0001

NA= Chi-square test not applicable.,Abbreviations were the same as table 1.

Table 8: Represents the correction done to AP location after using Mprex in the algorithm and the number of APs transposed again to another wrong sites:

Site	Corrected by Mprex	Transposed by Mprex
LAL	4	35
LPL	6	3
PS	9	0
MS	0	1
AS	2	3
RAL	1	8
RPL	2	7
Global	24	57

-Abbreviation are the same as in table 1.

In LAL location:

Four APs were wrongly predicted by Sprex (one as LPL and 3 as RAL), corrected to LAL by Mprex, while 35 traces were wrongly named LAL by Sprex (originally were 7 M5M6, 14 M7, 2 T10T1, 3 T12T1, 2T2, 1T3, 3T4T5 and 3T9); thirty four of them removed from being LAL by Mprex to AS, LPL, PS, RA, and RPL and only one trace (M5M6) remained as LAL.

In LPL location:

Six LPL APs wrongly predicted as LAL by Sprex were corrected by applying Mprex. On the other hand, seventeen APs (4M2M4, 5 M7 and 8 T4T5) were named wrongly LPL by Sprex had been transposed wrongly again on applying Mprex, three of them (1M2M4 and 2T4T5) were removed to LAL and PS locations, the remaining 14 remained as LPL.

In PS location:

Nine APs (1AS, 2AL, 2LPL and 4RPL) wrongly predicted by Sprex were corrected to PS by Mprex. On the other hand, two APs (T9) were named wrongly PS by Sprex remained PS by Mprex (non were corrected or transposed by Mprex)

In MS location:

Only an AP (T4T5) that was predicted as being MS by Sprex removed to LPL by Mprex .

In AS location:

Two APs (1LAL and 1RAL) wrongly predicted by Sprex as being AS were corrected by Mprex to AS, while 3 APs (1M2M4 and 2M7) named AS by Sprex were removed from AS to LPL and PS by Mprex.

In RAL location:

One AP that was wrongly predicted as being LAL by Sprex corrected by Mprex to RAL, while 8 APs (3M2M4, 2M5M6, 1T2, 1T3 and 1T4T5) wrongly named RAL by Sprex were removed by Mprex to AS, LAL, LPL, and RPL .

In RPL location:

Two APs that were wrongly predicted as being LAL by Sprex corrected by Mprex. to RPL. On the the other way, eleven APs (2M7, 2T3 and 7T4T5) were wrongly named RPL by Sprex, seven of them removed by Mprex from RPL to LPL and PS; and the rest (four APs) remained as RPL.

The corrective action of the algorithm through the intermediary of polarity modification of QRS by rapid atrial pacing occurs for certain locations. From table 8 the highest correction was done in PS sites as 9 Mprex ECG traces corrected the wrong prediction of the algorithm done by using Sprex. On the other hand, LAL location posses the highest number of wrong AP position removed after using Mprex (35 wrong prediction site transposed to other wrong locations).

Discussion

QRS duration changes:

The average difference of QRS comlpexe duration between sinus rhythm and rapid atrial stimulation was higher in left accessory pathways more than right accessory pathways. This difference is related to the phenomenon of increase of ventricular preexcitation by the left APs due to slowing of conduction in the AV node during rapid atrial pacing (Willens *et al.,* 1990; Teo *et al.,* 1991).

The changes observed in the polarity of QRS complexes:

During maximal preexcitation, obtained during rapid atrial pacing, changes observed in lead I are always in the negative direction and ascertain that the AP is situated in left free wall of left ventricle (M2M6 region). The changes in AVR and V1 are predominantly in the positive direction and advocate to a more wider area (left sided and septal) (M2-M7 and T4-T5). The same for lead II but with a QRS that has the tendency to become more negative.

Cardiac axis:

The changes in cardiac axis depend on changes in QRS polarity. In our study, during Mprex, QRS axis of APs located in M2M4 region were more towards right axis (93.7°±68.13). The QRS Axis of APs at posteroseptal location (M7 and T4T5) were towards left axis (-40.13°±36.42 and -49.78°±13.22 respectively). Right lateral accessory pathways (T7 and T9) had left axis deviation (-42.00°±22.63 and -34.27°±26.61 respectively). Right anteroseptal accessory pathways (T12T1 and T2) had QRS axis of 56.67°±10.41 and 38.33°±14.84 respectively.

Our results were not far from the results of Steurer *et al.* (1994), who utilized atrial pacing to provoke maximal ventricular preexcitation in 118 patients with WPW syndrome having single AP of different locations. In their study they calculated the cardiac axis during maximal preexcitation without compairing with preexcitation during sinus rhythm. They also used different septation other than Sezer *et al*. (1999) for

topographic citation of APs along the mitral and tricuspid annulus. According to Steurer *et al*.(1994) left lateral accessory pathways (32 patients) showed right-axis deviation of the QRS complex (110°±20), posteroseptal accessory pathways (44 patients) had a left axis of the QRS complex (-50° ± 20), right lateral accessory pathways (11 patients) had a left axis of the QRS complex (-40°±20) , left anterolateral accessory pathways (7 patients) had cardiac axis of 50° ± 25 and right anteroseptal accessory pathways (14 patients) had QRS cardiac axis of 45° ± 20.(Steurer *et al.,* 1994).

The contribution of maximal preexcitation in improving the predective power of Sezer's algorithm :

The contribution of maximal preexcitation obtained during rapid atrial pacing did not allow for improvement in the predictive value of the algorithm for almost all sits of APs. Left anterolateral site was the only location that showed improvement in the predictive power of the algorithm with the use of Mprex (PPV= 94%) or concordant pairs (PPV=97.7%) when compared with Sprex (PPV=56.8%) (P-value <0.0001 and <0.0001 respectively) . Lemery *et al.* (1987) tested the algorithm of Gallagher (Gallagher *et al*. 1978; Rosenbaum *et al.,* 1945) and Willems *et al.* (1985) on ECG traces in sinus rhythm. He reported weak results in predictive value of these different algorithm. Lemery speculated that these disappointing results were due to the absence of maximal preexcitation on the ECGs in his study. This hypothesis was not valid in our study as maximal preexcitation obtained during rapid atrial stimulation didn't improve the positive predictive value of the algorithm for most APs locations.

Globally there was improvement in the accuracy of the algorithm but this was only referred to increase in PPV of LAL APs.

New Score based algorithm:

In our study we try to search for a way to improve accuracy of the algorithm of Sezer with the use of maximal preexcitation obtained by applying rapid atrial pacing. Determination of AP location around mitral and tricuspid annulus by the mean of surface ECG is still attracting researchers to find an easy, accurate and efficient method to correctly predict its site. Location of the AP by the use of the traditional tree based algorithm usually builds on pairwise, rather than quantitative distinction. Rantner *et al.* (2012) developed a score based algorithm (locAP) in order to be used within a computer program. According to their point of view, personal computers, laptops, smartphones are widely available in today's clinical routine, thus the usage of a computer program is easily feasable in clinical practice. The locAP (location of accessory pathway) score was computed by summing up the standardized residuals of the given delta wave morphologies; this was done for all locations, the location with the highest score was considered to be the most likely position of the accessory pathway. In Rantner's study, morphology of delta wave was determined in 84 patients with WPW syndrome who were successfully ablated in 10 years period and were used to build the algorithm, then the algorithm was tested on another 50 patients with WPW syndrome who were also successfully ablated in a period of 4 years, and formed the study population for the prospective validation of the developed algorithm. The locAP algorithm's accuracy was 0.54% for 13 locations, with a sensitivity of 0.84%, a specificity of 0.97%. If the second most likely location was included, the accuracy rose to 0.79%. If the third most likely location was also included, the accuracy was 0.82%. Rantner *et al.* (2012) also tested three standard tree based algorithms (Milestein, Fitzpatrick, Arruda), high accuracy could not be observed for these algorithms in his study that do not match their published accuracies. So researchers are still working till current time trying to reach a method for accurately and precisely determine AP location from surface ECG rather than the tree based approach.

Limitations

The small number of patients in our study limit the representation of certain APs, particularly those situated at the free wall of tricuspid annulus

Conclusion

The changes on QRS polarity and cardiac axis during maximal preexcitation, obtained by rapid atrial pacing, improve the positive predictive value of Sezer's algorithm only for left lateral APs and has no value in improving prediction for other locations.

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References

Arruda, M.S., J.H. McClelland, X. Wang, K.J. Beckman, Widman L.E., M.D. Gonzalez, H. Nakagawa, R. Lazzara, W.M. Jackman, 1998. Development and Validation of an ECG Algorithm for Identifying

Accessory Pathway Ablation Site in Wolff-Parkinson-White Syndrome. J Cardiovasc Electrophysiol, 9:2-12.

Basiouny, T., C. de Chillou, S. Fareh, G. Kirkorian, M. Messier, N. Sadoul, P. Chevalier, I. Magnin-Poull , I. Blankoff, J. Chen, P. Touboul, E. Aliot, 1999. Accuracy and limitations of published algorithms using the twelve-lead electrocardiogram to localize overt atrioventricular accessory pathways. J Cardiovasc Electrophysiol, 10 (10):1340-9.

Basiouny, T., 2013. Prospective validation of A Sezer ECG algorithm for localization of accessory pathways in patients with Wolff-Parkinson-White syndrome, AAMJ, 10, 4, 1-27(Suppl-2).

D'Avila, A., J. Brugada, V. Skeberis, E. Andries, E. Sosa, P. Brugada, 1995. A fast and reliable algorithm to localize accessory pathways based on the polarity of the QRS complex on the surface ECG during sinus rhythm. Pacing Clin Electrophysiol, 18(9 Pt 1):1615-27.

Fitzpatrick, A.P., R.P. Gonzales, M.D. Lesh, G.W. Modin, J. L. Randall, M. M.Scheinman, 1994. New Algorithm for the Localization of Accessory Atrioventricular Connections Using a Baseline Electrocardiogram. J Am Coll Cardiol, 23:107-116.

Gallagher, J.J., J. Kasell, W.C. Sealy, et al, 1978. Epicardial mapping in the Wolff-Parkinson-White syndrome, Circulation, 57:854-866.

Lemery, R., S.C. Hammill, D.L.Wood, et al, 1987. Value of the resting 12 lead electrogram and vectrogram for locating the accessory pathway in patients with the Wolff-Parkinson-White syndrome. Br Heart J, 58: 324-332.

Rantner, L.J., M.C. Stühlinger, C.N. Nowak, et al, 2012. Localizing the Accessory Pathway in Ventricular Preexcitation Patients Using a Score Based Algorithm. Methods Inf Med, 51:3-12.

Rosenbaum, F.F., H.H. Hacht, F.N. Wilson, et al, 1945. The potential variation of the thorax and the esophagus in anomalous atrioventricular excitation) Wolff-Parkinson-White syndrome). Am Heart J, 29:281-326.

Sezer, A., K. Adalet, F. Mercanoglu, E.Yilmaz, Z. Bugra, K.Buyukozturk, G. Ertem, 1999. A new electrocardiographic algorithm to localize the accessory pathway in patients with wolf-parkinson-white syndrome and prospective study of three electrocardiographic algorithms proposed for the same purpose. Turk Kardiyol Dern Arş, 27:144-155.

Steurer, G., B. Frey, S. Gürsoy, K. Tsakonas, A. Celiker, E. Andries, K. Kuck, P. Brugada,1994. Cardiac depolarization and repolarization in Wolff-Parkinson-White syndrome, Nov;128(5):908-11.

Teo, W.S., G.J. Klein, R. Yee, et al, 1991. Significance of Minimal preexcitation in Wolff-Parkinson-White Syndrome. Am J Cardiol, 67:205-207.

Willems, J.L., E.O. Robles de Medina, R. Bernard, et al, 1985. Criteria for intraventricular conduction disturbances and pre-excitation. J Am Coll Cardiol, 5: 1261-75.

Willens, H.J.J., J. Atie, O.C. Penn, et al, 1990. Diagnosis and Treatment of Patients with Accessory Pathways. Cardiology Clinics, 8:503-521.