ORIGINAL RESEARCH PAPER

Cardiology

A COMPARISON OF TWELVE ALGORITHMS FOR DIAGNOSING ACCESSORY PATHWAY LOCATION APPLIED IN A CASE SERIES OF PATIENTS WITH WOLFF PARKINSON WHITE SYNDROME

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ABSTRACT

Wolff-Parkinson-White syndrome (WPW), a preexcitation condition characterized by the presence of an accessory pathway (bypass tract) between the atrium and ventricle. Researchers have developed several algorithms for localizing the accessory pathway based on 12 lead surface ECGs to date. We aim to compare twelve ECG algorithms, including two pediatric ones, using a case series of patients with WPW syndrome in this study. The government Chengalpattu Medical College hospital successfully treated five patients in this case series with radiofrequency ablation. We applied and compared twelve different algorithms (Milstein, 1987 [5], Fitzpatrick, 1994 [6], St.George, 1994 [7], Chiang, 1995 [8], D'avila, 1995 [9], Arruda, 1998 [10], Taguchi, 2013 [11], Pambrun, 2018 [12], Li H.Y. [13], Baek, 2020 [14], Easy WPW, 2023 [15], and EPM [16]), including two pediatric algorithms [13, 14]. Among the twelve algorithms, the D'avila, Taguchi, Pambrun, and Li H.Y. algorithms had the maximum diagnostic accuracy of 100%, followed by 80% with the easy WPW, Fitzpatrick, and EPM algorithms (Figure 1). In this case series, the Baek algorithm, which is a pediatric algorithm intended for diagnosing septal pathways, had the lowest accuracy. The other pediatric algorithm, developed by LiH.Y., demonstrated superior accuracy compared to the Baek algorithm. To conclude determining the exact pathway location prior to ablation leads to optimal procedure preparation, maps the pathways that are difficult to locate, and may also reduce catheter-related injury. In this case series, the algorithms designed by Taguchi, D'avila, Pambrun, and Li H.Y. had better predictions. Among the two pediatric algorithms, the algorithm by Li H.Y. had better accuracy than the Baek algorithm.

INTRODUCTION

Wolff-Parkinson-White syndrome (WPW), a preexcitation condition characterized by the presence of an accessory pathway (bypass tract) between the atrium and ventricle. It may be an incidental finding for some patients, but others develop palpitations, atrial fibrillation, syncope, or life-threatening ventricular fibrillation [1, 2]. The condition develops in 0.1-0.3% of the overall population, and 30–60% of these people develop tachyarrythmias in their lifetime [3]. Current treatment guidelines recommend radiofrequency ablation (RFA) as the class I treatment. It is both successful and curative for WPW syndrome patients with tachyarrythmia. Hence, it is clinically important to identify the location of the accessory tract before RFA [4]. To date, researchers have developed several algorithms for localizing the accessory pathway based on 12-lead surface ECGs. In this study, we aim to compare twelve ECG algorithms, including two pediatric ones, based on a case series of patients with WPW syndrome.

Case Series

This is a case series of five patients who were successfully treated with radiofrequency ablation at the Chengalpattu Medical College hospital. Many patients underwent electrophysiological studies (EPS) and RFA. Five patients had WPW syndrome in the form of atrioventricular reentrant tachycardia (AVRT). We discontinued antiarrhythmic drugs at least three half-lives before ablation. We identified the accessory pathways and performed RFA. We applied and compared retrospectively twelve different algorithms (Milstein, 1987 [5], Fitzpatrick, 1994 [6], St.George, 1994 [7], Chiang, 1995 [8], D'avila, 1995 [9], Arruda, 1998 [10], Taguchi, 2013 [11], Pambrun, 2018 [12], Li H.Y.,2019 [13], Baek, 2020 [14], Easy WPW, 2023 [15], and EPM, 2024 [16]), including two pediatric algorithms [13, 14].

Among those patients, four were males and one was female. A 51-year-old male patient presented to us with refractory and recurrent tachycardia. We identified and ablated the right lateral accessory pathway. The second patient, a 38-year-old male referred as a known case of WPW syndrome. We identified the left lateral pathway and performed ablation on it. The third patient, a 55-year-old male with WPW syndrome, underwent RFA four years ago. The patient presented to us with recurrent supraventricular tachycardia and WPW syndrome. The EP study revealed the left lateral pathway. A successful RF ablation is done. The fourth patient is a 35-year-old male with a known case of WPW syndrome. The EP study revealed the presence of the right posterolateral accessory pathway, leading to a successful RFA procedure. The fifth patient was a 47-year-old female with a known case of WPW syndrome. We performed EPS, revealing the left posterolateral accessory pathway. A successful RFA was done. All 5 patients had normal blood counts, renal function tests, and normal LV function. All five procedures were uneventful and successful. Aggressive induction protocols did not induce tachycardia. After the ablation, none of the patients

showed signs of pre-excitation.

In this comparison, an algorithm was considered correct if it predicted more than one site and included the exact accessory pathway (AP) in any of the predicted areas. If the exact location of AP was left lateral, adjacent site predictions, such as left posterolateral and left anterolateral, were also accepted as correct predictions. When the ECG algorithm predicts a septum and the exact location of AP is lateral, it is considered an incorrect prediction. The prediction of the contralateral side (example: predicting a right-sided pathway that was actually left-sided in EPS) was also considered a wrong prediction. We calculated the diagnostic accuracy as a percentage by dividing the number of correct predictions by the total number of predictions. Three left-sided and two right-sided pathways were present (Table 1).

Table 1 : Algorithmic localization and EPS location. of accessory pathway

Algorithms	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Milstein	RAS	LL	LL	RL	PS
Fitzpatrick	RAL	LAL	LAL	RPL	LPS
St.George	RAS	RP	LPL	RPS	LPL
Chiang	MS	LL/LAL	LL/LAL	MS	LP/LPL
d'avila	RL	LL	LL	RL	LP
Arruda	RPS	LL/LAL	LPL	RPS	LPL
Taguchi	RPL/RP	LA/LL	LL/LA	RPL/RP	LPL/LP
Pambrun	RL	LL	LL	RP	LPL
Li.H.Y	RL	LL	LL	RL	LL
Baek	RMS/RAS	LL	LPS	RMS/MS	LPS
Easy WPW	RPL	LPL	LPL	RPL	LPS
EPM	RPL	LAL	LAL	RPL	LPS
EPS study	RL	LL	LL	RPL	LPL

Among the twelve algorithms, the D'avila, Taguchi, Pambrun, and Li H.Y. algorithms had the maximum diagnostic accuracy of 100%, followed by 80% with the easy WPW, Fitzpatrick, and EPM algorithms (Figure 1). In this case series, the Baek algorithm, which is a pediatric algorithm intended for diagnosing septal pathways, had the lowest accuracy. LiH.Y.'s other pediatric algorithm outperformed Baek in terms of accuracy.
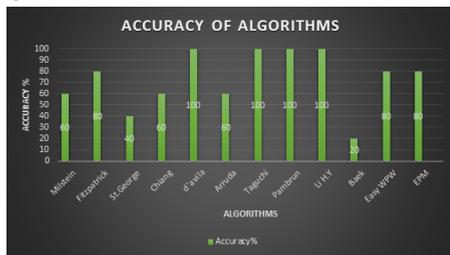

Figure 1 : Accuracy of 12 algorithms according to this case series.

DISCUSSION

We analyzed five patients who underwent electrop hysiological studies at our hospital. We applied twelve k nown algorithms, published between 1987 and 2024. There were three left-sided pathways and two right-sided pathways in the EP study of the patients. Among the twelve algorithms, the D'avila, Taguchi, Pambrun, and Li H.Y. algorithms had the maximum diagnostic accuracy of 100%, followed by 80% with the easy WPW, Fitzpatrick, and EPM algorithms. A study [8] reported a 92% predictive accuracy for the D'avila algorithm. The Taguchi algorithm [11] correctly identified the AP locations in 51 (94%) of the 54 patients, with an accuracy of 94.4% closer to this case series. The 93% accuracy of EASY-WPW [15] was superior compared to the Arruda (75% accuracy) and Pambrun algorithms [15]. D'avila, Taguchi, Pambrun, Arruda, and Chiang had 100% accuracy for the left-sided pathways. Chiang et al. [8] described 13 regions around

the tricuspid and mitral valves, and mentioned an accuracy of 93%, which was better for left-sided pathways, as seen in this study. Arruda et al. [10] mentioned the algorithm's usefulness, particularly in localizing anteroseptal and mid-septal accessory pathways. It is also useful in pathways that require radiofrequency ablation due to issues in the coronary sinus or within the ventricular venous branches. D'avila, Taguchi, Pambrun, Easy WPW, and Fitzpatrick all demonstrated 100% accuracy for right-sided pathways. According to Li H.Y.'s algorithm [13], the R/S ratio of precordial lead V1 and the delta wave polarity in lead I differentiate left and right accessory pathways with 100% accuracy. The algorithm yielded a total accuracy of 92.3%. Despite its development for pediatric patients, this study observed 100% accuracy for the Li H.Y. algorithm. The easy WPW algorithm is better at predicting right-sided than left-sided, as seen in the study by El Hamriti et al. [15]. Baek et al. [14] developed the Baek algorithm for pediatric patients, with a focus on septal pathways. The study by Baek et al. [14] found it superior for localizing septal pathways in pediatric patients. This case series includes adult patients, and none had a septal pathway, resulting in the lowest accuracy of 20% for the Baek algorithm seen in this study. The recently developed EPM algorithm demonstrated a diagnostic accuracy of 51.45% and an adjacent accuracy of 70.67% [16], closely matching the 80% observed in this case series. Algorithms that rely on the polarity of delta waves are Fitzpatrick [6], Chiang [8], and Arruda [10]. QRS morphology is necessary in algorithms like St. George [7], D'Avila [9], and Pambrun [12]. Both delta wave polarity and QRS morphology are necessary in Milstein [5], Baek [14], and easy WPW algorithms [15]. Differentiating between right and left-sided pathways was never a problem, and in this case series, all the algorithms except the St. Georges algorithm differentiated right and left-sided pathways with 100% accuracy. However, determining the exact location of accessory pathways appeared to be more challenging.

CONCLUSION

Prior to ablation, determining the exact pathway location leads to optimal procedure preparation, maps the pathways that are difficult to locate, and may also reduce catheter-related injury. In this case series, the algorithms designed by Taguchi, D'avila, Pambrun, and Li H.Y. had better predictions. Among the two pediatric algorithms, the algorithm by Li H.Y. had better accuracy than the Baek algorithm.

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