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Catheter Ablation of the Accessory Pathway in the Asymptomatic Patient with Wolff-Parkinson-White

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by

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Abstract

Wolff-Parkinson-White (WPW) is a condition in which an accessory conduction pathway exists within the heart. This accessory pathway may or may not cause symptoms, in fact, the first manifestation of the condition may be sudden cardiac death. The management of this condition in asymptomatic individuals is controversial. The purpose of this research and literature review is to analyze the safety and efficacy associated with invasive catheter ablation of the accessory pathway, in comparison to risk of sudden cardiac death and malignant arrythmias in non-ablated, asymptomatic individuals with WPW. In this review, five databases were searched including CINAHL, Clinical Key, PubMed, Cochrane Library, and Dynamed Plus. Both keyword and mesh terms were used to define a set of the literature discussing Wolff-Parkinson-White, ventricular preexcitation, radiofrequency catheter ablation, and sudden cardiac death. Works chosen for review were published from 2009 to 2019, and included surveys, case control studies, and cohort studies. Sources that were excluded included those published prior to 2009, systematic reviews, and meta-analysis, in order to exclusively include original research. Much of the research suggests that electrophysiologists do not currently have an adequate evidence-based recommendation for the management of the asymptomatic patient with WPW. The methodology

and safety of the ablation procedures may have evolved over time, making it difficult with the current data available to conclude the safety and efficacy of modern radiofrequency catheter ablation. Research also appears to be lacking longitudinal studies analyzing the outcomes of the non-ablated individuals. Future research is necessary to develop a guideline to direct decision to ablate the asymptomatic patient according to predetermined criteria and patient factors.

Keywords: Wolff-Parkinson-White, ventricular preexcitation, radiofrequency catheter ablation, accessory pathway, sudden cardiac death

Introduction

Pathophysiology

The heart is a muscular organ that functions to deliver deoxygenated blood to the lungs and distribute oxygenated blood throughout the body. Within the cardiac muscle, or myocardium, exists specialized conducting tissues which electrically activate the myocardium via action potentials resulting in contraction. This review of literature will address the management of a condition that disrupts this physiologic process.

The electrical activity of the heart originates in the sinoatrial (SA) node, also referred to as the pacemaker. After leaving the SA node; the action potential travels through tracts to the atrioventricular (AV) node. The electrical conduction through the AV node is considerably slower, to ensure sufficient time for the ventricles to fill with blood arriving from the atria. From the AV node the action potential continues to activate the ventricles via the Bundle of His, the left and right bundle branches, and the Purkinje system.

The SA node specifically exists as the pacemaker of the heart, as this electrical area has the fastest rate of firing. The AV node, Bundle of His, and Purkinje fibers, considered *latent*

pacemakers have slower firing rates, and therefore are suppressed from controlling the heart rate. This phenomenon is defined as *overdrive suppression*. (Costanzo, 2018) Certain drugs and pathological conditions can affect this process and cause the latent pacers to assume the role of the pacemaker, this results in arrythmias. Additionally, accessory conduction pathways can exist which disrupt the normal conduction through this specific physiologic pathway.

Wolff-Parkinson-White, or WPW, is a syndrome in which an accessory conduction pathway exists between the atria and the ventricles of the heart. This accessory pathway (AP) is typically composed of myocardial tissue, which unlike the AV node, is non-delayed. Consequently, this bypass tract depolarizes and excites an area of the ventricles earlier than the conduction that occurs through the AV node. This is termed *ventricular preexcitation*. The AP is also termed *Bundle of Kent* throughout the literature. This condition is prevalent in 0.1% to 0.3% of the general population, and 40-65% of individuals with WPW remain asymptomatic. Symptoms suggestive of arrythmia include palpitations, syncope, lightheadedness, and cardiac arrest. (Kim & Knight, 2017) Of note, two conditions of WPW are defined: ECG findings of preexcitation with evidence of arrythmia/symptoms is defined as WPW syndrome, while ECG findings of preexcitation without evidence of arrythmia/symptoms is defined as WPW pattern. (Konstantino & Haim, 2020)

The most common tachycardia that exists in the WPW syndrome is AV reentry tachycardia (AVRT). (Watson, 2018) Atrial fibrillation which occurs in the general population, is particularly dangerous in patients with WPW as the AP can elicit a rapid ventricular response, leading to ventricular fibrillation and sudden death. The risk of sudden cardiac death (SCD) in the symptomatic patient is estimated to be between 3% to 4% over a lifetime. (Konstantino & Haim, 2020)

Accessory pathways can be evaluated, through invasive electrophysiologic testing, for high risk properties, or properties that are believed to be associated with malignant arrhythmias and SCD. Additionally, during this invasive assessment, the AP can be eliminated through a procedure termed *radiofrequency catheter ablation*. Management of the symptomatic WPW patient is quite simple, as ablation of the AP is completed for symptom control and the benefit is obvious. (Obeyesekere & Klein, 2014) The approach to managing the asymptomatic WPW patient remains controversial. The purpose of this study is to evaluate the efficacy and safety of catheter ablation in the asymptomatic patient with WPW, in comparison to the efficacy and safety of conservative, non-surgical management.

Statement of the Problem

Management of the asymptomatic patient with WPW remains controversial. Argument promoting invasive catheter ablation of the AP is provided due to the risk of SCD in patients with WPW. Rapid conduction of atrial fibrillation through the AP, resulting in ventricular fibrillation is the assumed mechanism of resultant SCD. (Dreifus, Haiat, Watanabe, Arriage, & Reitman, 1971) The lifetime incidence of SCD in asymptomatic individuals is reported up to 0.1% (Guize et al., 1985), however, SCD may be the first manifestation of the condition in asymptomatic individuals. (Klein et al., 1979) Argument against invasive catheter ablation is provided by early data implying a rate of complications near 5%, and potential risk of mortality. (Hindricks, 1993)

Research Question

In asymptomatic patients with Wolff-Parkinson-White, is there a statistical difference in the safety and potential adverse effects associated with invasive catheter ablation of the

accessory pathway, in comparison to the risk of sudden cardiac death and malignant arrythmias in non-ablated individuals?

Review of Literature

Research Methods

A literature review was performed utilizing electronic search databases: CINAHL, Clinical Key, PubMed, Cochrane Library, and Dynamed Plus. Both keyword and mesh terms were used to define a set of the literature discussing: *Wolff-Parkinson-White* (WPW), *ventricular preexcitation, accessory pathway, radiofrequency catheter ablation* (RFCA), and *sudden cardiac death*. The literature was further searched for risks and efficacy of RFCA in the treatment of WPW, as well as occurrence of malignant arrhythmias and sudden cardiac death in non-ablated individuals with WPW. Only studies published as late as 2009 were included. Meta analyses and systematic reviews were excluded, in order to exclusively include original research.

Current Treatment Options and Guidelines for Management of Asymptomatic WPW.

A survey conducted by Cantu and Goette in 2009 aimed to analyze the current practice approach in evaluating and managing the asymptomatic patient with WPW. The researchers reported a return of questionnaires from 35 facilities in Europe. 16.7% of the respondents reported ablation in all patients with preexcitation, as opposed to 8.3% who reported conservative, non-ablative management in all patients. Additionally, 88.6% of respondents reported that current evidence is insufficient to guide clinical practice. The authors concluded that the majority of electrophysiologists involved in this study elected to risk stratify the asymptomatic patient but extremes and differences in the management of these patients does exist.

Svendsen et al, conducted a survey in 2013 to analyze the current strategies and preferences for treatment of symptomatic and asymptomatic WPW across 20 countries. All 58 responsive facilities were members of the European Heart Rhythm Association EP research network. The countries involved with the survey included Italy, Spain, Belgium, Denmark, France, Greece, Poland, and Germany. The results of this survey revealed a large variation in risk stratification and management of the asymptomatic patient. 30.2% reported they would never perform invasive electrophysiologic study (EPS) as an isolated procedure to risk stratify, while 17% reported always performing this. Additionally, 25% reported that they would never perform exercise stress testing for risk stratification, and 25% reported that they always do. The survey asked the question "How do you anticipate a patient with accidentally diagnosed WPW pattern on ECG, without symptoms and without occupation risk, would be treated at your institution as preferred strategy?" The results revealed that 51.9% would refer for risk stratification in patients age 20-30 years, and 42.9% would refer for risk stratification in patients age over 65. 12.5% would utilize the "wait and see" approach in ages 20-30, and 32.1% would utilize the "wait and see" approach in patients over 65. Additionally, 61 to 69% of respondents reported that their country lacks national guidelines.

The ACC/AHA/HRS provided the following recommendations in their 2015 publication:

> Abrupt loss of conduction over the AP during exercise testing, or intermittent loss of preexcitation during ECG or ambulatory monitoring is useful in identifying the low risk patient with WPW. (LOE B-NR) Invasive EPS is reasonable in the asymptomatic patient with pre-excitation, in order to risk stratify. (LOR B-NR) Catheter ablation of the AP is reasonable in asymptomatic patients with preexcitation, provided the EPS identifies the patient as high risk. (LOE B-NR) Catheter ablation of the AP in asymptomatic patients is reasonable if it precludes

the patient from specific employment (LOE B-NR). Observation, without evaluation or treatment is reasonable in the asymptomatic patient with preexcitation (LOE B-NR). The authors do state that level of evidence designated as B-NR is found from "moderate-quality evidence: from one or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies." (Page et al., 2015)

Risk of Sudden Cardiac Death, Arrhythmias in Asymptomatic Patients With WPW.

It is known that sudden cardiac death may be the first manifestation of the disease in asymptomatic patients with WPW, however early research suggests that this risk is as low as 0.05% to 0.2% per year. (Obeyesekere & Klein, 2014) In the era of radiofrequency catheter ablation, the question arises on how to manage the patient with an incidentally discovered WPW pattern on electrocardiograph. The first query would be: what are the risks if I do nothing, and how great are these risks?

Bunch et al. (2015) conducted a retrospective analysis of two groups of WPW patients; ablated versus non-ablated, to determine a difference in long-term mortality and atrial fibrillation rates between the groups. The researchers identified 872 patients with WPW who underwent ablation and 1461 patients with WPW who did not undergo ablation. These subjects were identified within a system-wide screen of electronic medical records from 1992 to 2014 from all Intermountain Healthcare facilities in Utah and Idaho. Follow-up was approximately 7.9 ± 5.9 years. The researchers reported a success rate of 93% among the WPW patients who underwent ablation. They found that nonablated WPW patients had higher incidence of death, from all-cause mortality, compared to the ablated WPW patients ($p<0.0001$). The non-ablated WPW

patients also had increased incidence of cardiac death ($p<0.0001$). Interestingly; the nonablated WPW patients had a lower incidence of atrial fibrillation than the ablated patients ($p<0.0001$).

This study had several limitations: as a retrospective, system-wide analysis, there were likely many confounding variables that could not be controlled for, such as the various comorbidities of the subjects. Of interest and likely influential to the results: the ablation patients were younger, less likely to have hypertension, diabetes mellitus, renal failure, sleep apnea, and coronary artery disease. This would lend to likelihood of this subgroup having a lower long-term risk of death, despite their ablation history. There was a wide variation in follow-up among patients as well, which could skew the results of long-term outcomes. Additionally, the researchers did not describe the ablation techniques nor the location of the APs in the group that underwent ablation. Over the course of 22 years various techniques and multiple electrophysiologists may have been involved with this cohort. This feature is also recognized as a possible strength of this study, as the results can be generalized to the study population rather than specific to a technique or provider.

Kubus et al. conducted a study in 2014 with a goal to retrospectively identify asymptomatic children with high risk AP properties, according to predetermined criteria, by invasive EPS. The predetermined criteria that indicated high risk properties of the AP included shortest RR interval during atrial fibrillation (SPERRI) of under 250 ms, antegrade effective refractory period of the AP (AP ERP) under 250 ms, or inducible atrioventricular re-entrant tachycardia. The study involved 85 patients under the age of 18 years old with a WPW pattern and persistent preexcitation at maximum exercise during exercise stress testing prior to the EPS, who underwent invasive risk stratification. Single manifest AP (AP that was apparent on ECG) was found in 80 patients, two manifest APs were found in one patient, and a combination of one

manifest and one concealed (AP not apparent on ECG) was found in four patients. High risk AP properties were identified in 32 of 85 patients (37.6%). Among patients with both a SPERRI and an AP ERP measurement obtained: the researchers found that AP ERP designated 7.9% as high risk, while SPERRI designated 22.2% as high risk. Only one patient qualified as high risk according to both measurements. The researchers concluded that SPERRI was a more sensitive measurement for detecting high risk AP. Patients who did not exhibit high risk AP properties at baseline (n = 44) were subjected to isoproterenol challenge, which resulted in an additional 16 patients being designated high risk according to the criteria. RFCA was performed in 41 of the 48 patients considered high risk, and 18 of the remaining 37 non high-risk patients due to patient/parental decision. Ablation was deferred in seven of the 48 high risk patients due to the proximity of the AP to the AV node. In follow-up, six of the seven patients remained asymptomatic at a mean follow-up of 13 months. No adverse effects were reported due to the EPS or ablation.

The researchers concluded that the SPERRI appeared to be a more sensitive measure in determining high risk APs during invasive EPS. They also concluded that invasive testing should be considered to further determine the high-risk vs low risk properties of the AP in the case of persistent antegrade AP conduction throughout maximal exercise during exercise stress testing.

Limitations of this study include the retrospective nature of the study, and relatively small sample size. Additionally, selection bias was not limited; as the researchers specifically utilized cases from two care centers, and selected participants who exhibited persistent preexcitation during exercise stress testing prior to the EPS. Therefore, the results found in this sample can only be applied to this population of asymptomatic WPW patients.

Etheridge et al. (2018) conducted a study to compare demographics and EPS properties of children with WPW who had experienced a life-threatening cardiac event versus children with WPW who had not experienced an event. The researchers conducted a retrospective, multicenter, international study across the United States, Canada, New Zealand, Cuba, Czech Republic, and the United Kingdom. Data was collected on children presenting from 1990 through 2016. The case subjects were limited to children with WPW syndrome, who had experienced a cardiac life-threatening event, such as sudden death, aborted sudden death, or atrial fibrillation, prior to the age of 21 years. The control subjects were limited to children under the age of 21 with WPW, who had not experienced a life-threatening event. 96 cases and 816 control subjects were identified. Demographic data, age, EPS information, and details of the life-threatening event were collected. Results of this study revealed that 60% of the case subjects experienced symptoms prior to the life-threatening event, as opposed to 83.8% of the matched control subjects ($p<0.0005$). 62 of the 96 cases experienced the life-threatening event as their initial presenting symptom. Nine of the cases that experienced a life-threatening event did result in death. EPS data collected on subjects revealed an AP ERP <250 in 41% of the case subjects, and 12% of the control subjects ($p<0.0005$), and SPERRI <250 in 64% of the case subjects, and 18% of the control subjects ($p<0.0005$). More than one AP was found in 18.4% of the case subjects, and in 5.2% of the control subjects ($p<0.0005$).

The researchers discussed that the life-threatening event as the presenting symptom occurred in 65%, and the case subjects were less likely to have experienced previous symptoms. The EPS appeared to significantly predict risk as revealed by the AP ERP and the SPERRI measurements. This study concludes that EPS is more accurate in predicting adverse events than reported symptomology.

The researchers did note that inter-operator variability may have existed during the EP studies, which may have affected the results of the SPERRI measurements. The researchers did utilize a fairly large sample and they attempted to age match the controls.

Pappone et al. (2014) attempted to determine the prognosis of patients with and without symptoms with WPW who underwent RFCA of the AP, opposed to those who underwent conservative management without ablation. The researchers utilized an eight-year prospective, observational approach, analyzing the outcomes of WPW patients who underwent EPS evaluation from May 2005 to May 2010. Both symptomatic and asymptomatic patients were included in the study. The patients were divided into two groups: RFCA group, and no-RFCA group. The researchers conducted a minimum follow-up time of three years, with follow-up visits occurring at six months, 12 months, and every 12 months thereafter. At each follow-up visit; physical examination, 12-lead ECG, and 24-hour Holter monitoring was performed. Among subjects enrolled, 1168 underwent RFCA, and 1001 did not undergo RFCA. This included 206 asymptomatic patients who underwent RFCA, opposed to 962 symptomatic patients who underwent RFCA, and 550 asymptomatic patients in the non-RFCA group, and 451 symptomatic patients in the non-RFCA group. The researchers noted that structural heart disease was more prevalent in the symptomatic subgroup of the non-RFCA group ($p<0.001$). The results also revealed that among the RFCA group, the symptomatic patients had less inducibility of AVRT triggering AF ($p<0.001$), fewer multiple APs ($p<0.001$), and longer AP-ERPs ($p <0.001$). Follow-up results of the non-RFCA group revealed an occurrence of ventricular fibrillation in 13 asymptomatic patients versus two symptomatic patients ($p = 0.01$). 48 asymptomatic patients versus 30 symptomatic patients experienced malignant arrhythmias ($p = 0.22$). All patients with these adverse effects were successfully ablated after the arrhythmia occurrence. The researchers

did conclude that on electrophysiologic testing; the patients who experienced ventricular fibrillation had shorter AP-ERPs than the patients who experienced other malignant arrhythmias ($p<0.001$). This would suggest that electrophysiologic testing is more accurate in predicting adverse outcomes than patient reported symptoms.

The researchers concluded that asymptomatic, untreated individuals are more likely to develop ventricular fibrillation than the untreated symptomatic patients. They additionally concluded that the ERP of the AP, as found during EPS, is likely more determinant of malignant arrhythmias, than the presence or absence of symptoms.

Credit is due for the large sample size as well as length of long-term follow-up utilized in this study. The researchers provided well-defined methodology, and the baseline demographics among the two groups was similar. However, limitations of this study do exist. The study was conducted through a single facility, and without randomization. Also, the study was funded by an Arrhythmology Department, which may have monetary bias in these results.

Santinelli et al. (2009) conducted a study to analyze the natural history and predictors of arrhythmic events in asymptomatic adults with WPW. The researchers prospectively collected EPS data on 293 adults, over the age of 18, who exhibited asymptomatic pre-excitation on ECG, and who underwent EPS testing without ablation of the AP between 1995 and 2005. Subjects were followed for a median duration of 69 months, with visits scheduled every six months for evaluation, 12-lead ECG, and 24-hour Holter monitoring. The researchers reported that 262 of the 293 (90%) patients did not experience any arrhythmic events, 31 patients experienced a first arrhythmic event, and 17 of these experienced potentially life-threatening tachyarrhythmias. One patient did necessitate resuscitation for cardiac arrest. Approximately 30% of participants who remained asymptomatic did experience delta wave disappearance during follow-up. The

researchers reported younger age ($p = 0.004$), inducibility ($p = 0.001$), and AP ERP less than 250 ms ($p = 0.001$) as predictors for these potentially life-threatening arrhythmias. Additionally, with the combined variables of younger age, inducibility, and antegrade AP ERP, the researchers reported 98.91% specificity, with a 95% confidence interval of 96.86 to 99.78 as a predictor for potentially life-threatening arrythmias.

Limitations of this study include potential selection bias, as patients who declined to enter the study were lost to follow-up. The subjects included in this study were not randomized, as patients were specifically referred for participation. Additionally, there was a large variation in follow-up of patients, ranging from eight to 90 months.

Santinelli et al (2009) conducted a study to determine predictors of arrhythmic events and evaluate the natural history of disease in asymptomatic children with WPW. The researchers prospectively collected EPS data on 184 children who exhibited asymptomatic pre-excitation on ECG, and who underwent EPS testing without ablation of the AP between 1995 and 2005. All subjects were followed for a minimum of 24 months after EPS on an outpatient basis scheduled every six months. Follow-up visits consisted of evaluation, 12-lead ECG, and 24-hour Holter monitoring. The researchers report that not a single patient experienced disappearance of the delta wave during follow-up. 133 of the 184 (70%) did not experience arrhythmic events and remained asymptomatic. 51 of the 184 (30%) experienced a first arrhythmic event, and 19 (10%) were considered potentially life-threatening. Additionally, three patients experienced life-threatening tachyarrhythmias which resulted in cardiac arrest. The researchers identified that tachyarrhythmia inducibility ($p<0.001$), AP ERP less than 240 ms ($p<0.001$), and multiple APs ($p<0.001$), as identified during EPS, as risk factors for arrhythmic events in this cohort.

Limitations of this study include potential selection bias, as patients who declined to enter the study were lost to follow-up. The subjects included in this study were not randomized, as physicians across Italy specifically referred patients to be included in this study. Additionally, a relatively small timeframe for follow-up was reported (24 months).

Safety, Adverse Effects, And Efficacy of Radiofrequency Catheter Ablation of The Accessory Pathway.

The alternative management of the asymptomatic patient with WPW is an invasive risk stratification technique, termed "electrophysiologic testing" with subsequent radiofrequency catheter ablation of the identified accessory pathway. As with all invasive procedures, this practice is not without risk of complications. (Obeyesekere & Klein, 2014) The question then arises: what are the risks of invasive RFCA, and how great are these risks?

Glowniak et al. (2019) analyzed incidences of silent cerebral infarcts following ablation of left-sided APs in patients with WPW. The researchers note that silent cerebral infarcts have been well documented in ablation of patients with atrial fibrillation and left-sided APs have similar ablation target areas. The study included 20 WPW patients with left-sided APs, without structural heart disease and no prior history of cerebrovascular incident or transient ischemic attacks. MRI was performed the day prior to the ablation, and the day after the ablation in all patients. RFCA was performed successfully and without intraoperative complication in all patients, and no patients demonstrated neurological symptoms following the procedure. Results of MRI revealed an incidence of two of 20 (10%) patients with new acute silent cerebral infarcts following the ablation procedure. The researchers describe a CHA_2DS_2-VASc score of two in one patient, and one in the other patient. In both cases a non-irrigated catheter was utilized.

This study is limited due to its very small sample size. The researchers note that the sample was too small to even provide statistical power, or to identify risk factors. There is likely a number of uncontrolled variables present in this small cohort, for example: underlying atherosclerosis. Additionally, the researchers were very selective with the inclusion criteria, allowing this information to be very specific to the subset, but less generalizable to the broad population of asymptomatic WPW patients.

Jastrzewbski et al. (2017) attempted to analyze the results of modern AP ablation regarding success and complications. The researchers performed a retrospective cohort study of 610 ablation procedures performed in three facilities by one electrophysiologist between 2002 to 2016. The researchers collected data on AP localization, ablation success versus failure, and periprocedural complications. Results of this study identified 590 of the 610 ablations (96.7%) as successful. The researchers reported a 97% success rate in APs located in the left lateral/anterolateral pathways, and an 88 to 90% success rate in right free wall and septal pathways. One serious periprocedural complication, tamponade, occurred throughout the study, and 14 (2.3%) minor complications occurred. The authors did not describe the minor complications in this article.

Several limitations of this study are noted: A single electrophysiologist's success versus failure was utilized to collect the retrospective data. The researchers note that fewer complications and higher success rates occurred as the electrophysiologist became more experienced, possibly skewing the data. This may be interpreted as a strength of the study as well, as inter-operator variation would not occur with a single electrophysiologist. The authors did elude to a change in ablation technique after the first 210 cases due to two pneumothoraxes.

The authors did not address how complications were determined to be minor versus serious, nor did they describe the 14 minor complications that did occur.

A study described earlier by Pappone et al. (2014) also reported the complications due to EPS in a prospective study of 1168 asymptomatic and symptomatic WPW patients, who underwent RFCA for the AP between 2005 to 2010. The researchers identified complications of EPS: five patients experienced pneumothorax, 25 patients experienced femoral hematomas at the catheter entry site, and two patients experienced fistulas. The researchers identified the following complications of RFCA: right bundle branch block in 10 patients, left bundle-branch block in three patients, an asymptomatic pericardial effusion in two children, and one patient with a third-degree AV block. Efficacy of RFCA was reported as successful ablation in 1150 of the 1168 (98.5%) patients. The authors reported highest reintervention rate in the septal APs (35%), and lowest reintervention rate in the left-sided APs.

Schneider et al. (2009) prospectively analyzed the incidence of coronary artery injury after catheter ablation in children under the age of 21. The researchers conducted selective coronary angiography before and 30 minutes following RFCA, or cryoablation of 212 patients, 117 of which underwent ablation specifically for an AP. Coronary artery narrowing was observed in two of the 117 (0.94%) patients with an AP ablation. Both patients presented with structurally normal hearts and a right posteroseptal localization of the AP. The researchers noted a 40% decrease in luminal diameter of the right coronary artery in one patient and 30% decrease in luminal diameter of the left coronary artery in the other patient. They also reported that ECG changes returned to normal within one week in both patients and neither patient experienced symptoms nor elevation in cardiac enzymes (CK, CK-MB, troponin). Additionally, echocardiography revealed normal function without wall-motion abnormalities at follow-up.

One limitation of this study is that it was conducted as a single-center observation. The authors did not note if blinding of individuals analyzing the coronary angiograms occurred. The authors did not describe the baseline demographics of the subjects. They also failed to describe the follow-up protocol of patients who underwent the procedure.

A study by Stravrakis et al. (2014) examined the risk of coronary artery injury due to ablation associated with the distance between the AP and the coronary artery. They also examined the efficacy and safety of cryoablation, opposed to RFCA, in APs within close proximity to the coronary artery. The researchers recognized 169 patients who underwent ablation of posteroseptal APs between 1989 and 2007. All patients underwent a coronary angiography before ablation, and this was repeated after ablation if the AP was located within 5 mm of a significant coronary artery. The researchers reported coronary artery injury in 11 of 22 (50%) patients when RFCA was performed within 2 mm of a coronary artery. They reported coronary artery injury in one of 17 (17%) patients when RFCA was performed within 3 to 5 mm of a coronary artery. They also reported performing cryoablation opposed to RFCA in 26 patients whose AP was located within 5 mm of a coronary artery. The efficacy of cryoablation was reported at 65%, with the reminder requiring additional RFCA. Additionally, during a follow-up period of three to six months, the researchers reported success rate of 90% for RFCA, and 77% for cryoablation. They concluded that risk of coronary artery injury is correlated to the distance from the ablation site, and cryotherapy may be a safe, and reasonably effective alternative to RFCA when the AP is located in close proximity to a coronary artery.

One limitation of this study is the potential bias, as the authors report CryoCath technologies as a source of funding. Additionally, the researchers described various ablation techniques occurring throughout the study, as ablation techniques evolved throughout the years.

They did, however, describe these techniques in detail within the literature. The results of this study are not generalizable to the broad population of asymptomatic WPW patients, as the researchers limited inclusion specifically to patients with posteroseptal APs.

Discussion

The aim of this research and literature review was to evaluate the safety and efficacy of RFCA in comparison to non-invasive management in the treatment of asymptomatic WPW.

It is apparent that electrophysiologists do not currently have an adequate evidence-based recommendation for the management of the asymptomatic patient with WPW. Surveys conducted by Svendsen et al. (2013), and by Cantu and Goette (2009) reveal a large variation in reported management strategies, including: risk stratification techniques and decision to ablate versus watchful wait.

Patient reported symptoms or lack of symptoms may not provide the most accurate assessment of risk and indication for ablation. The study by Etheridge, et al. (2018) found that invasive electrophysiology testing was a greater predictor of adverse effects in their cohort compared to patient reported symptomology. The authors reported that the initial presenting symptom of WPW was a life-threatening event in 62 of the 96 subjects. (Etheridge et al, 2018) Additionally, the study by Pappone, et al. (2014) found that ventricular fibrillation occurred more frequently in the non-ablated asymptomatic subjects compared to the non-ablated symptomatic subjects. Previous research has attempted to quantify the incidence of malignant arrythmias and sudden cardiac death in non-ablated individuals. Due to the relatively small population (0.1-0.3%) that is affected by this condition, and the feasibility of conducting long duration

longitudinal studies, the results may not be accurately reflective of such outcomes. In past research the duration of follow-up ranged from 13 months to seven years.

Modern RFCA techniques may provide greater efficacy and safety than in the past, and may be the safer and more predictable option, however this is a bold assumption to make as current research has analyzed the outcomes of RFCA over a large, and non-specific span of time. For example, the study described earlier by Stravrakis et al. (2014) which analyzed outcomes of this procedure dating from 1989 to 2007.

Future research is necessary to develop a guideline that directs decision to ablate as well as ablation techniques on the following parameters: accessory pathway location (including distance from the coronary arteries) number of accessory pathways, presence of structural heart disease, patient age, and patient comorbidities. Further research is necessary to evaluate the efficacy and safety specifically of current RFCA techniques. Additionally, a need exists for longitudinal studies evaluating the outcomes of non-ablated asymptomatic individuals with larger sample sizes, and longer duration of follow-up. Ideally, future research would also discover a non-invasive method to accurately predict the location of the accessory pathway, and accurately risk stratify for malignant arrhythmias and sudden cardiac death.

Applicability to Clinical Practice

With the information provided in the literature review, the medical provider will be able to educate the asymptomatic Wolff-Parkinson-White patient and their family regarding the risks and benefits of catheter ablation versus non-surgical management. While future research is necessary to evaluate the safety of modern RFCA techniques, the current review of literature recognizes that sudden cardiac death and malignant arrythmias were reported as outcomes of

non-ablation, while less severe adverse effects have been reported with RFCA. The provider should recognize the need to stay current with evidence-based medicine as techniques and screening tools evolve and further research becomes available.

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