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Safety and Efficacy of Different Approaches for Catheter Ablation of Para-Hisian Accessory Pathway

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ABSTRACT

Background and purpose: Radiofrequency (RF) catheter ablation is recognized as a final treatment for atrioventricular accessory pathways (AP). In experienced centers, the success rate of accessory pathways ablation exceeds ninety-five percent accompanied by a low rate of complications. To investigate the outcomes from various methods for radiofrequency ablation of para-Hisian AP regarding efficacy and safety.

Patients and Methods: This observational analytical study included patients who had RF catheter ablation for a para-hisian AP at Kasr Al-Ainy University hospital and Beni-Suef University hospital EP lab over a period of 24 months from January 2020 to January 2022. Patients were enrolled prospectively and retrospectively through chart review. Forty-five patients had a para-hisian AP that have been successfully ablated thorough different approaches.

Results: Retrograde AVN Wencbach cycle length (AVN WCL) was significantly increased in post ablation compared by pre ablation in the three studied groups with a statistically significant p-values (p-value <0.001).

Conclusion: With accurate and careful mapping, it is relatively safe to ablate para-hisian accessory pathways. if probable, proper extension of ablation duration may diminish the recurrence rate of para-Hisian accessory pathways. The majority of para-Hisian APs may be effectively and safely ablated via iIVC-A, but ablation in the NCC or SVC is neither an early nor a preferred technique. The degree of local ventriculo-atrial fusion in the para-Hisian region throughout retrograde atrioventricular accessory pathways conduction may predict or distinguish the successful ablation location.

Keywords: *Catheter Ablation, Para-Hisian Accessory Pathway.*

1. INTRODUCTION

APs are abnormal muscular bundles that connect atrial and ventricular myocardium, bypassing the His-Purkinje system. (1, 2) Roughly fifty to sixty percent of accessory pathways are located in the left free wall, twenty to thirty percent are posteroseptal (inferoparaseptal), ten to fifteen percent are in the right free wall, five percent are mid septal and two to three percent are anteroseptal (superoparaseptal). (3)

RF catheter ablation has become an effective 1st line curative treatment for symptomatic AP-mediated tachycardias

While great rate of success, exceeding ninety-five percent and reduced recurrence rates varying from two to five percent have been gained in cases had left-sided APs (5), The traditional ablation of right-sided accessory pathways still challenging. The success rate of catheter ablation treatment for these accessory pathways is the lowest between every location, averaging approximately ninety percent, with documented recurrence rates of as much as thirty five percent following successful elimination of accessory pathway conduction (4).

Catheter stability is of great importance, particularly in the ablation of para-hisian accessory pathways. Minimal catheter motion during ablation may results in affection of the conduction system leading to various degress of heart block. (6, 7)

To counteract this complication during ablation of parahisian pathways and the relatively lower long-term success rate and greater recurrence rate of ablating right sided APs in general, several approaches have been tried in addition to the standard inferior IVC approach, namely the superior SVC approach and the transaortic approach from NCC it referred to non-coronary or the right coronary cusp (RCC), (8) leading to varying success rates (9, 10). The present study aims at comparing the success rates and adverse effects of different approaches of ablating parahisian APs from a single center experience.

2. Patients and Methods:

Study population and design:

This prospective observational analytical study included patients who had RF catheter ablation for a para-hisian AP at a tertiary referral center for cardiac rhythm disorders over a period of 2 years. The study investigated outcomes of different approaches of ablating Para-hisian pathways regarding safety and efficacy. This research complied with the declaration of Helsinki (11) and the protocol received acceptance of the local investigation Ethical Committee of the conducting hospital. All patients signed an informed written consent.

Patients:

Including cases had concealed or manifest para-hisian AP, including anteroseptal and midseptal locations, presenting to our EP service who consented for catheter ablation including all age and sex groups.

Para-Hisian AP has been characterized as pathway situated in the anteroseptal or mid septal region that showed a discernible HB potential (either the greatest recordable HB electrogram or an HB potential of above 0.1 mV) at the targeted ablation site which is the earliest atrial activation throughout retrograde AP conduction during orthodromic AVRT or ventricular pacing, or earliest ventricular activation throughout atrial pacing, sinus rhythm, or antidromic tachycardia. (12).

Patients who refused to sign informed consent, when the ablation procedural wasn't conducted because of unacceptable great risk of AV block or cases who had an alternate diagnosis throughout the EP investigation.

Methods

All patients underwent clinical assessment, baseline 12-lead resting Electrocardiogram, Transthoracic Echocardiogram. and Electrophysiology study that carried out following all antiarrhythmic medications have been discontinued for minimum five half-lives.

Electrophysiological study procedure and ablation technique:

Both groins were prepped and draped under standard sterilization techniques. the right groin was infiltrated with lidocaine 1%. Two six French and one seven French venous sheaths have been introduced percutaneously into the right femoral vein. A quadripolar and a decapolar catheter were progressed by a right femoral vein to the RV apex and CS respectively. A quadripolar four millimeters non-irrigated ablation catheter was progressed thorough the femoral vein in inferior vena cava method, thorough subclavian vein in superior vena cava approach or thorough femoral artery in retrograde aortic NCC approach. Intra-cardiac electrograms have been recorded simultaneously with electrographic leads I, V1 in addition to AVF with multichannel recording system (Claris recording system St Jude). Bipolar signals have been filtered at 30 to 500 HZ.

Conduction intervals and refractory periods (all intervals and refractory periods has to be defined here) were measured and defined at the beginning of the study. Induction of tachycardia done via programmed electrical stimulation. After documenting tachycardia, a variety of diagnosis was conducted using ventricular extra-stimulations, ventricular entrainment pacing, or para-Hisian pacing. Diagnosis of variant types of atrioventricular reentrant tachycardias (AVRTs) involving accessory pathways were performed and defined.

The localization and determination of the AP was carried out through careful mapping of the ventricular or atrial activation patterns, or both, utilizing bipolar and unipolar electrograms recorded from regular electrode catheters and a steerable ablation catheter. The insertion sites of APs have been deemed as para-hisian, as previously recognized.

When the existence of the para-hisian APs has been validated, variant ablation methods the method and site of ablation was left to operators' discretion: A) Inferior vena caval approach targeting the right anterior septum B) superior vena caval approach targeting the right anterior septum. C) Retrograde trans aortic approach targeting the NCC.Post ablation study was performed including conduction intervals and refractory periods for comparison with the pre-ablation measurements.

Follow up:

All cases have been monitored at two weeks and twelve weeks post procedure. Follow up was performed either physically or through trans-telephonic interview, collected data included recurrence documented tachycardia, occurrence of procedural related complications with particular emphasis of symptoms suggestive of conduction system disease, 12-lead ECG or Holter monitor if clinically indicated.

Study endpoints:

The study primary endpoint was a safety endpoint namely recurrence of early or intermediate term procedural related

complications. Secondary endpoints included change in the baseline intervals, conduction velocities or refractory periods and efficacy related to recurrence of documented preexcitation or AVRT.

Statistical analysis:

All information has been examined utilizing the Statistical Package for Social Science (SPSS-18). categorical information has been expressed as mean and standard deviation when Kolmogorov and Shapiro-Wilks test conformed to a normal distribution, and as median and interquartile range when a non- normal distribution was conformed. When normal distribution was questionable, histogram and degree of skewness were tested to confirm its pattern.

Comparisons among groups have been conducted with the Chi-Suare or fisher Exact test for categorical parameters and with ANOVA for continuous parameters association analysis has been performed utilizing Person /Spearman correlations.

A probability (p-value) of below 0.05 will be deemed to indicate statistically significant variance for all tests. P: The possibility/significance value. P value above 0.05 (NS) Not significant. P value below 0.05 * Significant at 0.05 level.

3. Results:

Out of 238 patients who underwent an EP study at our lab for supraventricular tachycardia or ventricular pre-excitation, 45 patients had a para- hisian APs that were successfully ablated and thus were enrolled in the investigation and involved in the final analysis investigating outcomes of different approaches regarding safety and efficacy.

Demographic and clinical characteristics of the study population:

Among the included patients in our research, male gender predominates (27 Patients), representing 60 % of patients. Mean age of the research population was 21.4 ±10.6 ranging between 4.5 and 48 years. Forty patients presented with documented supraventricular tachycardia. Twenty-four patients had a concealed para-hisian accessory pathways. Thirty-seven patients were diagnosed to have anteroseptal accessory pathway while 8 patients had a mid-septal accessory pathway.

Procedural outcome and periprocedural complication

Procedural acute Success:

The number of successfully ablated AP in I.V.C approach group were (n=28). in the NCC approach group (n=5) and in the S.V.C approach group were (n=9), as illustrated in Table (6).

Peri-ablation complications:

Peri-ablation complications during follow up period in the studied population according to the ablation method (Table 7).

Mean tachycardia cycle length in the inferior vena cava group was 298.7msc with ±31.9 standard deviation, mean TCL in superior vena cava group was 301.4msc ±26.1 standard deviation while mean TCL in NCC group was 316 msc ±_29.6 standard deviation and mean TCL in all groups was measured 301.2 msc ± 30.6 standard deviation. With a statistically in-significant variances among groups (p value = 0.514) (Table 1).

Mean QRS duration in the IVC approach group was 116.76 msc ±17.82 standard deviation, in SVC approach group mean QRS was equal 116 msc ±25.14 standard deviation, in NCC approach group was equal to 108.2 msc ±13.3 standard deviation and mean QRS in all patients was Successful ablation was achieved at parahisian region through an inferior vena cava approach in 30 patients and superior vena cava approach in 9 patients and through a retrograde trans aortic approach in NCC in 6 patients (Figure 2).

B- Electrophysiological characteristics:

As shown in table (2), Atrial burst pacing and extra-stimulus pacing demonstrates no significant changes in the ante grade AVN wencebach cycle length or the AVN ERP in post-ablation compared to pre-ablation measured values, (p-value >0.05).

Right ventricular burst pacing showed a statistically significant change in the retrograde wencebach cycle length with a significant increase post ablation compared with preablation. (p-value <0.001).

115.6 msc ±18.49 standard deviations with a statistically insignificant variances among groups (p value equal 0.642) (Table 1).

Electrophysiological study and ablation using standard approach (inferior vena cava) approach was done in 66.7 % of patients while 20% of patients undergone AP ablation using superior vena cava approach and 13.3% of patients undergone AP ablation using retrograde aortic NCC approach.

C- Electrographic parameters pre and post ablation:

Table (5) demonstrated the changes in ECG in concealed group in the three studied approaches pre- and post-ablation in the studied population according to ablation method. No significant changes in PR interval pre and post ablation in three studied group with small change in QRS complex pre and post ablation in IVC group due to occurrence of two cases of RBBB but with no statistically significant value in this group or other groups (p value> 0.05).

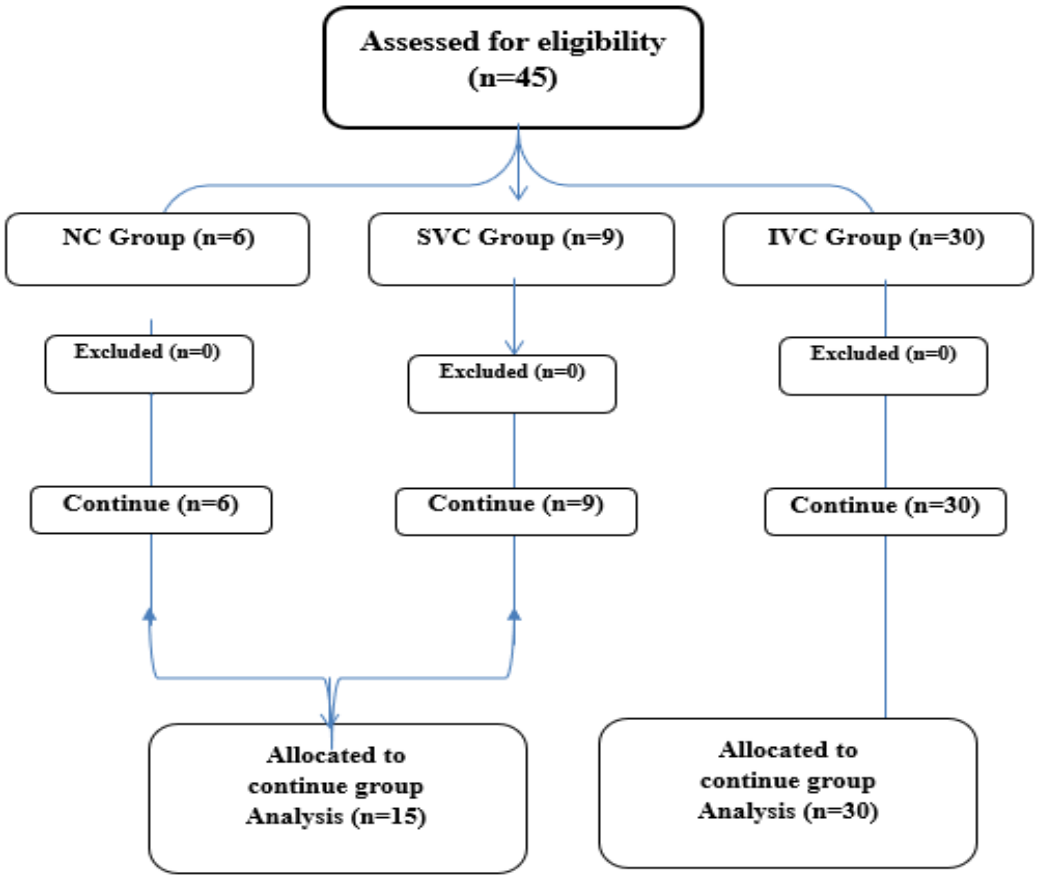

Figure (1): Flow chart of studied patients.

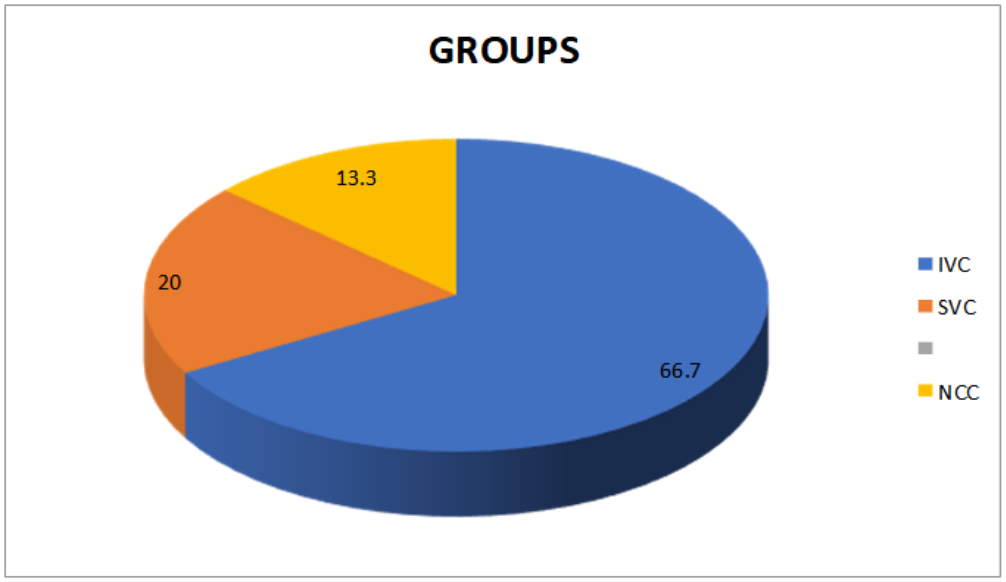

Figure (2): Distribution (percentage) of the studied participants by ablation Approach.

Table (1): Baseline and sociodemographic data; (N= 42)

		Ablation Approach				*p-value*
		I.V.C (N= 30)	**S.V.C (N= 9)**	**NCC (N= 6)**	**Total (N= 45)**	
Age (years)	**Mean ±SD**	23.6 ±10.9	15.9 ±7.9	16.1 ±8.8	21.4 ±10.6	0.110
Gender N (%)	**Male**	21 (70.0%)	4 (57.1%)	3 (50.0%)	28 (62.2%)	0.393
	Female	9 (30.0%)	5 (62.5%)	3 (50.0%)	17 (37.7%)	
Pre Excitation	**Concealed**	15 (50.0%)	5 (55.6%)	4 (66.7%)	24 (51.1%)	0.111
	Manifest	15 (50.0%)	4 (44.4%)	2 (33.3%)	21 (48.9%)	
Documnted tachycardia	**No**	3 (10.0%)	1 (11.1%)	1 (16.7%)	5 (11.1%)	0.797
	Yes	27 (90.0%)	8 (88.9%)	5 (83.3%)	40 (88.8%)	
TCL		298.7±31.9	301.4±26.1	316±29.6	301.2±30.6	0.514
QRS duration		116.76±17.82	116±25.14	108.2±13.3	115.6±18.49	0.642

Table (2): Comparison of Electrophysiological parameters pre- and post-ablation in the studied population according to ablation method

		Approach					
		I.V.C (N= 30)		**S.V.C (N= 9)**		**NCC (N= 6)**	
		Mean ±SD	***p-value***	**Mean ±SD**	***p-value***	**Mean ±SD**	***p-value***
Ante-grade WCL	**Pre-**	302.9 ±63.8	0.873	285.0 ±37.3	0.571	322.0 ±75.0	0.770
	Post-	304.2 ±55.9		271.7 ±17.2		310.0 ±17.3	
Ante-grade AVN ERP	**Pre-**	291.3 ±42.5	0.098	280.0 ±45.2	0.237	266.0 ±38.5	0.693
	Post-	275.8 ±49.6		243.3 ±26.6		274.0 ±32.9	
Retro-grade AVN wcl	**Pre-**	320.0 ±75.8	**<0.001***	283.3 ±32.7	**0.011**	350.0 ±119.0	**0.025**
	Post-	509.2 ±86.7		493.3 ±111.1		548.0 ±116.3	

Table (3): Comparison between IVC group compared to SVC & NC Group according to pre-electrophysiological changes

Pre electrophysiological changes	IVC Group (n=30)	SVC & NC Group (n=15)	t-test value	p-value
Antegrade WCL				
Mean±SD	302.92±63.76	301.82±57.59	0.049	0.961
Antegrade AVN ERP				
Mean±SD	291.25±42.46	273.64±40.81	1.153	0.257
Retrograde AVN WCL	320.00±75.8	313.64±86.05	0.221	0.826

p-value >0.05 is insignificant

Table (4): Comparison between IVC group compared to SVC & NC Group according to post electrophysiological changes

Post electrophysiological changes	IVC Group (n=30)	SVC & NC Group (n=15)	t-test value	p-value
Antegrade WCL				
Mean±SD	304..33±55.9	290.83±25.39	1.104	0.276
Antegrade AVN ERP				
Mean±SD	275.67±49.6	252.50±34.94	1.258	0.216
Retrograde AVN WCL				
Mean±SD	509.2 ±86.7	493.33±102.90	0.441	0.662

Table (5): Comparison ECG (QRS and PR interval) pre- and post-ablation in the studied population according to ablation method

Concealed pre-excitation		Approach					
		I.V.C (N= 15)		S.V.C (N= 5)		NCC (N= 4)	
		Mean ±SD		Mean ±SD		Mean ±SD	*p-value*
PR Interval	**Pre-**	149.4 ±24.88	0.227	152.3 ±16.5	***0.384***	160 ±14.24	0.212
	Post-	160.6 ±24.78		165 ±16.1		185 ±33.16	
QRS Complex	**Pre-**	101.73 ±7.85	0.0729	93 ±13	**0.375**	102.75 ±6.18	0.163
	Post-	108 ±10.4		104.3 ±14.01		112.25 ±10.34	

Table (6): Comparison between success and recurrence rate in different groups

Approach	I.V.C	S.V.C	NCC
Success	28 (93.3%)	9(100%)	5(83.3%)
Recurrence	2 (6.7%)	0(0%)	1(16.7%)

Table (7): Comparison between Peri-ablation complications during follow up period in different groups

		Approach			Total	*p-value*
		I.V.C (N= 30)	S.V.C (N= 9)	NCC (N= 6)	N= 45	
AVB	**No**	28 (93.4%)	9 (100.0%)	5 (83.3%)	42 (93.3%)	0.218
	Yes	2 (6.6%)	0 (0%)	1 (16.7%)	3 (6.7%)	
BBB	**No**	28 (93.3%)	9 (100.0%)	6 (100.0%)	43 (95.5%)	0.657
	Yes	2 (6.7%)	(0.0%)	0 (0.0%)	2 (4.5%)	
Pre-excited AF	**No**	29 (96.7%)	9(100.0%)	6 (100.0%)	44 (97.8%)	0.815
	Yes	1 (3.3%)	0 (0.0%)	0 (0.0%)	1 (2.2%)	
Recurrence	**No**	28 (93.4%)	9(100%)	5 (83.3%)	42 (93.3%)	0.295
	Yes	2 (6.6%)	0 (0%)	1 (16.7%)	3 (6.7%)	
hematoma	**No**	27 (90%)	8 (88.9%)	5 (83.3%)	40 (88.9%)	0.657
	Yes	3 (10%)	1 (11.1%)	1 (16.7%)	5(11.1%)	

4. Discussion

Para-hisian AP ablation is a challenging task because of close anatomical proximity to the conductive system and advert heart block. Also, it might be pumped during mapping. Our study is a cross-section pilot study conducted on 45 patients presented by tachycardia and diagnosed to have a parahisian accessory pathway either manifest or concealed pre-excitation, aiming at exploring the efficacy and safety of radiofrequency ablation of para-hisian AP by variant methods.

Electrophysiological Mapping and Ablation Characteristics

In our research, accessory pathways conduction had been successfully ablated using reduced power (most case thirty W) in the right para-Hisian region among thirty-nine cases. In the electrophysiological research, ventricular and atrial potentials fused throughout retrograde accessory pathway conduction in twenty-seven of the thirty cases in the IVC-A group.

In our investigation, cases in the NCC-A group had poorly fused atrial and ventricular possibilities, that resulted in the elimination of the para-Hisian accessory pathway in the NCC. The initial atrial activation in the NCC occurred prior to that in the HB region, and tiny HB potential has been documented at the location of the earliest near-field atrial activation in 2 out of 6 cases.

In our research, the para- Hisian accessory pathways have been successfully ablated by NCC-A in 6 cases when mapping doesn't illustrate earlier activation period by IVC-A and SVC-A or failure of ablation by these approaches. Our results were matched with Choker et al. (13), XU G etal (14) the aortic method seems to be an effective and safe approach for the ablation of parahisian AP.

Our results were matched with Liang et al. (15) who reported that ventriculo-atrial fusion throughout retrograde accessory pathways conduction in the para-Hisian region might distinguish or predict successful ablation by SVC-A, IVC-A, or NCC-A in most cases had para-Hisian APs.

Different Techniques and Approaches for Ablating Para-Hisian Aps

In our research, the frequency of para-Hisian accessory pathways ablated from the IVC approach was high represents (30/45,

66.7%) however ablation from the NCC was relatively reduced (6/45 cases, 13.3%) and initial ablation of para-Hisian accessory pathways in the NCC failed in 2 consecutive cases and ablation from SVC approach was relatively low (9/45 patients, 20 %) and was based on the operator preference and experience. Our results were matched with Liang et al. (15) who stated fifty-five consecutive cases had PHAPs, most of whom (52/54, 94 percent) had successful radiofrequency ablations via femoral venous (inferior vena cava) or arterial (NCC) approaches

Krishnappa et al. (16) additionally stated that the IVC technique, the catheter may not be stable; consequently, coaxial and contact force may not be good. However, better catheter stability and greater acute success rate may be achieved by a jugular or superior method with some efficacy and safety. Nevertheless, catheter manipulation is complicated and the risk of right bundle branch block and complete atrioventricular block can exist (16).

In our limited number of accessory pathways ablated via SVC approach group, the success rate was 100% with no complications. Our results were matched with Chai C etal (17), which reported high success rate of parahisian accessory pathway ablation through SVC approach (93.3%) with lower incidence of complications.

Electrographic parameters pre and post ablation:

In our study, we measured PR and QRS complex width interval in every patient with concealed group. The changes in ECG among the three studied groups pre- and post-ablation in the studied population according to ablation method showed no change in PR interval and small change in QRS duration but without a statistically significant variance (p-values >0.05).

In our research, the prevalence of atrioventricular delay or block throughout surgery resolved spontaneously without need of pacemaker implantation, indicating that with careful and accurate mapping, it is relatively safe to ablate para-hisian accessory pathways. Our results were matched with Chen et al (18).

Our results were matched with Yang et al. (19) which reported lower risk of AV block or atrioventricular disease when we ablated a parahisian accessory pathways at NCC compared with traditional inferior vena cava approach.

In present study, one patient (2.2%) developed pre-excited atrial fibrillation during pacing which resolved with sedation without need of direct electrical cardio version this patient was in the IVC approach group. Our results were not matched with Chen et al. (18) which reported higher incidence of atrial fibrillation during procedure 8 cases of total 113 patients during study.

The recurrence rate in our study was 6.7%, matching with Chen et al. (18) which reported recurrence rate 11.3% of all case in study and Brugada et al. (20) reported recurrence rate 4.5% in parahisian accessory pathway ablation.

Only three minor hematoma in I.V.C approach and one in NCC and SVC approach matching with ADALET, Ghanma (21) which reported lower incidence of hematoma in parahisian group during procedure only one case of total 36 patients. Our results were matched with Jastrzębski et al. (22) which reported lower incidence of groin hematoma in their study.

In our study, no mortality cases, no reported cases with stroke, tamponade, infection, pulmonary embolism, peripheral artery injury, thrombophlebitis, DVT or pleural effusion. Our results were matched with Chen et al. (18) no mortality cases or stroke. Our results were matched with ADALAT, Ghanma (21) which reported no morbidity or mortality case in parahisan group.

5. Conclusion:

With accurate and careful mapping, it is relatively safe to ablate para-hisian accessory pathways. If possible, proper extension of ablation time could reduce the recurrence rate of para-hisian Aps. Most para-Hisian APs can be safely and effectively ablated by IVC-A, and ablation in the NCC or SVC is not an initial or a preferred approach. The degree of local ventriculoatrial fusion in the para-Hisian region during retrograde AP conduction can differentiate or predict the successful ablation site.

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