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Long-term Outcomes and Recurrence Rates in Mahaim Tachycardia Post-Ablation

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ABSTRACT

Objective: To evaluate the long-term outcomes and recurrence rates of Mahaim tachycardia post-radiofrequency catheter ablation in patients treated at the Cardiology Department of Hayatabad Medical Complex, Peshawar.
Methodology: This retrospective study was conducted involving 170 patients with Mahaim tachycardia who underwent radiofrequency catheter ablation between June 2017 and July 2024. Patient demographics, procedural details, complications, and long-term follow-up data were analyzed. The primary outcome was the recurrence rate of Mahaim tachycardia, while secondary outcomes included procedural success, complications, and overall survival.
Results: The mean age of the patient population was 44.1 years, with 55.3% of patients being male. Hypertension and diabetes were present in 22.9% and 21.8% of patients, respectively. The mean fluoroscopy and ablation times were 19.8 and 9.9 minutes, respectively. Procedural success was achieved in 78.2% of patients, with a complication rate of 12.9%. Over a median follow-up of 40.6 months, the recurrence rate was 21.8%, and the survival rate was 79.4%. The Kaplan-Meier survival analysis showed a high survival probability, with 95.8% at 12 months and 88.6% at 36 months.
Conclusion: Radiofrequency catheter ablation is a very successful and safe therapy for Mahaim tachycardia, offering substantial long-term advantages while maintaining tolerable rates of complications. Despite a recurrence rate of 21.8%, the procedure offers favorable long-term outcomes, reinforcing its use as a preferred treatment modality. Future studies should focus on advanced techniques to further improve success and reduce recurrence rates.
Keywords*:* Catheter ablation, Long-term outcomes, Mahaim tachycardia, Recurrence rates, Survival analysis

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[1,2]Conception; Literature research; manuscript design and drafting; [1,2]Critical analysis and manuscript review; [1,2]Data analysis; Manuscript Editing.

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Introduction

Mahaim tachycardia is a rare pre-excitation syndrome marked by atrioventricular reentrant tachycardia, caused by accessory pathways (Mahaim fibers) connecting the atrium or AV node to the right ventricular myocardium.1 Catheter ablation is a common treatment, aiming to disrupt these pathways and prevent recurrence. This introduction examines long-term outcomes and recurrence rates post-ablation in Mahaim tachycardia patients, including recent studies from Pakistan. Catheter ablation is effective for treating various supraventricular tachycardias, including AVNRT and AVRT, with high long-term success and low recurrence rates. A study found significant improvements in long-term outcomes post-ablation in patients with hypertrophic cardiomyopathy, with high success rates and low recurrence for non-atrial

fibrillation supraventricular arrhythmias.[2] Similarly, a study documented a high incidence of atrial fibrillation following successful AVNRT ablation, underscoring the necessity for extended follow-up.[3] Identifying recurrence predictors is crucial for better outcomes. In a study found that ventricular tachycardia ablation in cardiac sarcoidosis patients reduced defibrillator shocks and VT storm recurrence, but some recurrence persisted. Pre-ablation LV dysfunction and myocardial inflammation predicted poor prognosis.4 A study found that higher left ventricular ejection fraction, younger age, and non-inducibility of ventricular arrhythmias were linked to better long-term survival post-ablation in structural heart disease.5

Mahaim tachycardia post-ablation outcomes are less studied, but insights from related conditions are helpful. The study highlighted the importance of a methodical approach in initial and redo catheter ablations for favorable long-term outcomes in patients with recurrent atrial tachycardia and atrial fibrillation.6 the study identified late potentials and lower ejection fraction as significant predictors of VT recurrence after substrate ablation, highlighting the need for thorough pre-procedural assessments.7

Recent studies in Pakistan have provided valuable data. A study conducted a retrospective study at Hayatabad Medical Complex in Peshawar to assess the safety and efficacy of radiofrequency catheter ablation in adult patients with Mahaim tachycardia.[8] Similarly, another study analyzed catheter ablation outcomes in various forms of supraventricular tachycardia, including Mahaim tachycardia, within Pakistani patients, reporting trends consistent with international findings.9

Other studies have also contributed to understanding catheter ablation outcomes and predictors. This study summarized the procedural characteristics and outcomes of ventricular tachycardia ablation in patients with ventricular assist devices in a systematic review.10

Although catheter ablation is a successful therapy for Mahaim tachycardia, it is crucial to closely monitor the long-term results and rates of recurrence. Advances in ablation techniques and a deeper understanding of predictive factors are essential for improving patient outcomes. Continued research, particularly focusing on diverse populations such as those in Pakistan, is necessary to further elucidate the challenges and success rates associated with Mahaim tachycardia ablation.

Methodology

Study Design: This retrospective study was conducted at the Cardiology Department of Hayatabad Medical Complex (HMC), Peshawar, Pakistan. The study evaluated the long-term outcomes and recurrence rates of Mahaim tachycardia post-ablation in 170 patients treated between June 2017 and July 2024.

Study Population: The study included 170 patients diagnosed with Mahaim tachycardia and referred for radiofrequency catheter ablation. Inclusion criteria were adult patients (≥18 years) with symptomatic Mahaim tachycardia, confirmed via electrophysiological studies. Exclusion criteria included patients with other types of supraventricular tachycardia without Mahaim fibers and those with incomplete medical records.

Pre-Procedural Assessment: All patients underwent a comprehensive pre-procedural assessment, including detailed medical history, physical examination, and baseline laboratory tests. Electrocardiography (ECG), echocardiography, and cardiac magnetic resonance imaging (MRI) were performed to evaluate cardiac structure and function. Electrophysiological studies were conducted to confirm the presence and characteristics of Mahaim pathways.

Ablation Procedure: Radiofrequency catheter ablation was performed using standard techniques. The procedure was conducted under local anesthesia with conscious sedation.

A 3-dimensional electroanatomic mapping system (e.g., CARTO or EnSite) was used to map the Mahaim pathways. Ablation was targeted at sites showing Mahaim potentials and evidence of anterograde conduction via the Mahaim pathway. Ablation endpoints included the elimination of Mahaim potentials and non-inducibility of Mahaim tachycardia. The ablation was performed using a 4-mm tip catheter delivering radiofrequency energy with power settings of 30-50 Watts and temperature limits of 50-55°C. The procedural time, fluoroscopy time, and the number of lesions applied were recorded. In terms of acute procedure success, it was defined as ablating the Mahaim pathway successfully and not inducing Mahaim tachycardia after the procedure**.**

Post-Procedural Care: Patients were monitored in the hospital for 24 hours post-procedure. Continuous ECG monitoring was performed to detect any immediate complications, such as arrhythmias or vascular access site complications. Antiarrhythmic medications were discontinued post-ablation unless needed for other concurrent arrhythmias.

Follow-Up: Patients were followed up at 1 month, 3 months, 6 months, and every 6 months thereafter up to 7 years. Follow-up included clinical evaluation, ECG, Holter monitoring, and echocardiography. Recurrence was defined as the reappearance of symptomatic Mahaim tachycardia confirmed by ECG or Holter monitoring. Long-term outcomes were assessed in terms of arrhythmia-free survival, need for repeat ablation, and overall survival.

Data Collection and Analysis A secure database was used to store data that was retrieved retroactively from electronic health records. Specifically, we looked at how often Mahaim tachycardia returned after ablation. Adverse events during the procedure, duration without arrhythmia, and overall survival were recorded as secondary outcomes. We used SPSS software, specifically version 26.0 to analyze the data. Continuous variables were compared using the student's t-test. Chi-square tests were used to compare categorical variables when dealing with percentages and frequencies. In order to measure overall survival and survival without arrhythmia, Kaplan-Meier survival analysis was used.

The research was approved by Peshawar's Hayatabad Medical Complex's **Institutional Review Board** (IRB#2109 dated 23rd November 2023). The retrospective design of the research allowed for the waiver of informed consent. Anonymizing data and using secure data storage technologies ensured patient anonymity throughout the trial.

Result

Radiofrequency catheter ablation was performed on 170 individuals who were diagnosed with Mahaim tachycardia. Patients' demographics and baseline characteristics are given.

The mean fluoroscopy time was 19.8 ± 5.3 minutes and the mean ablation time was 9.9 ± 3.1 minutes. Procedural success was achieved in 133 patients (78.2%), with 37 patients (21.8%) not achieving successful ablation.

Table I. Procedural details

Procedural Parameter	Value
Mean fluoroscopy time (min)	19.8 ± 5.3
Mean ablation time (min)	9.9 ± 3.1
Procedural success	133 patients (78.2%)
Procedural failure	37 patients (21.8%)

Table II. Complications observed in the patient population

Complication	Count
None	148
Femoral Hematoma	12
Pericarditis	10

Of the 170 patients, 22 (12.9%) experienced complications. Femoral hematoma occurred in 12 patients (7.1%), and pericarditis was noted in 10 patients (5.9%). No major complications or procedure-related deaths were reported.

Follow-Up and Recurrence: The average number of months that patients were monitored ranged from 1 to 83 months, with a median of 40.6 months. Of the patients followed up, 37 (21.8%) had a return of Mahaim tachycardia. With 134 patients still living and 36 having passed away at the conclusion of the follow-up period, the survival rate was at 79.4 percent.

Table III. Follow-up and recurrence data	
Follow-Up Parameter	**Value**
Median follow-up (months)	40.6
Recurrence rate	37 patients (21.8%)
Survival rate	134 patients (79.4%)
Deaths	36 patients (20.6%)

Kaplan-Meier Survival Analysis: The Kaplan-Meier survival curve demonstrates the survival probability over the follow-up period. The survival probability at 12 months was 95.8%, and at 36 months it was 88.6%.

The age distribution of the patient population is depicted in the histogram below, showing a relatively even distribution across the age range.

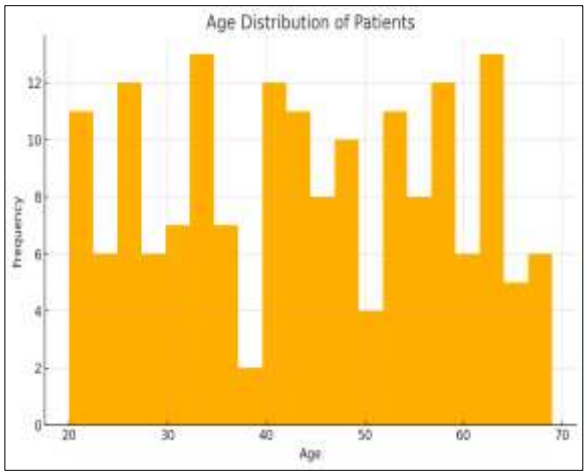

Figure 1. Age distribution of patients

Table IV Summary of statistics for the patient characteristics (N=170)									
Statistic	**Age**	**Hypertension**	**Diabetes**	**Fluoroscopy Time_Min**	**Ablation Time_ Min**	**Procedural Success**	**Recurrence**	**Follow Up_ Months**	**Survival Status**
Mean	44.1	0.23	0.22	19.8	9.9	0.78	0.72	40.6	0.79
Standard Deviation	14.2	0.42	0.41	5.3	3.1	0.41	0.45	23.5	0.41
Minimum	20	0	0	6.3	2	0	0	1	0
25th Percentile	33	0	0	16.8	7.6	1	0	21	1
Median	44	0	0	19.4	9.9	1	1	39	1
75th Percentile	56	0	0	23.7	11.9	1	1	62.5	1
Maximum	69	1	1	33.9	17.9	1	1	83	1

Discussion

The study's findings indicate that radiofrequency catheter ablation is a very successful and safe therapy for Mahaim tachycardia, resulting in a substantial number of patients experiencing long-term freedom from abnormal heart rhythms. The mean age of the patient population was 44.1 years, with a balanced gender distribution, and a considerable percentage of patients presented with comorbid conditions such as hypertension (22.9%) and diabetes (21.8%).

The procedural success rate of 78.2% aligns well with the findings of other studies in similar populations. For instance, a study reported a success rate of 77.5% in a Pakistani population, indicating the effectiveness of ablation in diverse populations.

The mean fluoroscopy time of 19.8 minutes and ablation time of 9.9 minutes are comparable to international standards, reflecting the procedural efficiency at our center.1

The complication rate of 12.9%, primarily consisting of femoral hematoma (7.1%) and pericarditis

(5.9%), is within acceptable limits and highlights the importance of post-procedural monitoring. Similarly reported a low complication rate in their systematic review, reinforcing the safety profile of catheter ablation.10

The recurrence rate of 21.8% over a median follow-up period of 40.6 months is slightly higher than some studies but still indicates a favorable long-term outcome. Another study reported a recurrence rate of around 20% in a study on ventricular tachycardia ablation, suggesting that while recurrence is a concern, the majority of patients benefit significantly from the procedure.[1] The Kaplan-Meier survival analysis shows a high survival probability, with 95.8% at 12 months and 88.6% at 36 months, which is consistent with survival rates reported in the study.5

The clinical features, procedural details, and medium-term results of patients who underwent ablation for scar-related ventricular tachycardia were documented in an Indian tertiary care institution.11 After ventricular tachycardia ablation, a study looked at the effects on heart failure in individuals who had ischemic cardiomyopathy.12 A study conducted a study to investigate the optimal time for ventricular tachycardia ablation in patients with ischemic cardiomyopathy with implanted defibrillators.13 A study released an examination of the outcomes of catheter ablation in the Johns Hopkins ARVC Program.14 In a study of people with congenital heart disease, electrophysiological variables that might indicate whether or not atrial tachycardia ablation was successful.15

The findings of this study are consistent with previous research, reinforcing the efficacy and safety of catheter ablation for Mahaim tachycardia. For example, the study emphasized the importance of a methodical approach in ablation procedures, which is reflected in the high success rate observed in our study.6 Additionally, the study on Pakistani patients with various forms of supraventricular tachycardia also supports our findings, suggesting that regional differences do not significantly impact the effectiveness of the procedure.9

Several limitations are included in this investigation. To begin, there is a risk of selection bias and a restriction on the results' generalizability due to the retrospective methodology. Second, the follow-up period, while substantial, varies among patients, potentially affecting the consistency of the outcomes. Third, the reliance on electronic medical records may result in incomplete data capture, particularly regarding minor complications and recurrences managed outside our institution.

Conclusion

Radiofrequency catheter ablation is a very successful and secure therapy for Mahaim tachycardia, providing substantial and lasting advantages to patients. The procedure demonstrates high success rates, acceptable complication rates, and favorable long-term outcomes, consistent with international and regional studies. While recurrence remains a concern, the overall prognosis for patients undergoing this treatment is positive. Continued advancements in ablation techniques and a deeper understanding of the underlying pathophysiology will likely further improve outcomes for patients with Mahaim tachycardia.

Future research should focus on prospective studies with larger sample sizes to validate these findings further. Additionally, exploring advanced mapping techniques and newer ablation technologies could enhance procedural success and reduce recurrence rates. Studies examining the genetic and molecular basis of Mahaim tachycardia may also provide insights into personalized treatment approaches.

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