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Treatment of Atrioventricular Nodal Reentery Tachycardia by Radiofrequency Ablation of The Slow Pathway at Al-Kadhimyya Teaching Hospital

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Abstract

Background:- AVNRT is the most frequent cause of regular. paroxysmal supraventricular tachycardia, Radiofrequency ablation of the slow pathway has been recommended as first-line therapy for curing AVNRT.
Objective:- This prospective study was conducted at Al-Kadhimiya teaching hospital from January 2004 to July 2006 to report a 2 year experience of RFA of the slow pathway in patients with recurrent attacks of AVNRT that not responded to medical therapy treated in our laboratory and assessed for the success rate and rate of recurrence after ablation , Other parameters like age, sex, symptoms of AVNRT, and complications of Ablation also were assessed. The clinical and electrophysiological feature of patients with AVNRT and their immediate outcomes after undergoing slow pathway ablation were also studied.
Methods and Results:- The study included 15 consecutive patients with AVNRT (mean age 40±11.3 years, 10 women, 5 men) who underwent slow pathway ablation using a combined electrophysiological and anatomical approach. A standard electrophysiological method with three diagnostic and one ablation catheter was used in all patients. All patients had sustained AVNRT induced either spontaneously or by programmable stimulator .the primary endpoint of ablation procedure was non-inducibility of the arrhythmia. The primary endpoint of the study was the recurrence of AVNRT on follow-up. Acute success was achieved in 15 (100%) patients. Complication rate of the ablation procedure was complete heart block (13.3%) and the average fluoroscopy time was 10.5 ±4.5minutes. The patients were followed up for a mean duration of 15±8 months during which there was only one case of recurrence.
Conclusion:- Radiofrequency ablation of slow pathway is highly effective in the treatment of AVNRT. The technique has a high initial success rate and a low complication rate. The recurrence rates are extremely low (6.6%) on long-term follow-up.

Keywords: AVNRT, clinical and electrophysiological feature, symptoms of AVNRT, anatomical approach,

1. Introduction

1.1 Definition:-

Supraventricular tachycardia (SVT) is a generic title for any form of tachycardia whose circuit lies wholly or partly within the atria. [1]

1.2 Classification:-

Supraventricular tachyarrhythmias have been classified into regular and irregular (atrial fibrillation). [2]

Regular SVTs can be subdivided into:

1. Atrioventricular re-entry tachycardias (AVRT), using the ventricle as part of the circuit; these tachycardias are dependent on the presence of an accessory atrioventricular (AV) pathway.

2. Atrioventricular nodal re-entry tachycardia (AVNRT), where the re-entry circuit is within the AV node and the ventricle plays no part in maintaining the arrhythmia.

3.Atrial tachycardia, where the re-entry circuit does not involve any part of the AV junction e.g. atrial flutter,ectopic atrial tachycardia.

Finally, there are rare examples such as junctional tachycardias and incisional re- entry tachycardias seen after surgery for congenital heart disease. [3]

1.3 Clinical feature of SVT:-

The most common presenting symptom of SVT is palpitations, usually described as 'heart racing'. Associated symptoms such as weakness, breathlessness, chest tightness and light-headedness occur frequently also. Syncope is rare and when it does occur it is usually at the onset of the tachycardia.[1] Although AVNRT is not a life-threatening arrhythmia. it can significantly affect the quality of life. Even in patients with infrequent symptomatic episodes, anticipation of arrhythmia recurrence may have considerable psychological impact on their everyday life.[4]

A small number of patients may be unaware of their tachycardia and may present after a variable period ith symptoms and signs of heart failure.

These patients have incessant tachycardias Which are not too fast, usually in the region of 120-140 bpm, and which lead to atachycardia-induced cardiomyopathy. [1]

The ECG most commonly shows a regular narrow complex tachycardia. Sometimes the rhythm is irregular as in atrial flutter with variable conduction or atrial tachycardia with varying AV block. Of course, an SVT may cause a broad complex tachycardia due to bundle branch aberrancy (functional or rate-related) or underlying bundle branch block. There are a number of features which can be used to distinguish this from ventricular tachycardia . [5]

The majority of Supraventricular tachycardias occur in association with the Wolff- Parkinson-White (WPW) syndrome and AV nodal reentry. Most patients with such arrhythmias are symptomatic [5]

1.4 AV nodal re-entrant tachycardia:-

This tachycardia is actually the most common cause of recurrent SVTs. The AVNRT account for up to 85%of SVT (excluding atrial fibrillation) [1]

Atrioventricular nodal reentrant tachycardia is the most common mechanism of paroxysmal supraventricular tachycardia in adults and is relatively uncommon in children [4]

1.4.1 Mechanism of AVNRT:-

The mechanism of AVNRT is classically attributed to dual AV nodal Pathways physiology. including one with relatively fast conduction but long Antegrade refractoriness (fast pathway) and another with slower conduction but shorter antegrade refractoriness (slow pathway) [6] .In most patients with this arrhythmia, posterior atrio-nodal input to the atrioventricular node serves as the anterograde limb, or "slow pathway," of the reentry circuit. and anterior atrionodal inputs serve as the retrograde limb, or "fast pathway".

It has been demonstrated that the fast pathway conduction occurs superiorly in the region of His bundle recording, while conduction over the slow pathway is projected inferiorly over the coronary sinus ostium region, along the tricuspid annulus. [4]

The impulses passes down the slow pathway and back up the fast pathway .Each time it passes through the lower turnaround point, it also passes down to the

Ventricules giving heart rates usually in the region of 180-220bpm.

Curative ablation for these patients is called AV node modification and usually involves interruption of the slow pathway. This leaves just one input into the AV node and so prevents any tachycardia recurrence. [1]

1.4.2 Types or AVNRT:-

Typical AVNRT:

Also called common type; short RP long PR. ln typical atrioventricular nodal reentrant tachycardia. discrete P waves are not visible on the electrocardiogram, because the atria and ventricles are usually depolarized simultaneously or shortly afier R waves [7].ln this type or AVNRT the slow pathway is the antegrade limb and the fast pathway is the retrograde one.

Atypical AVNRT:

Also called uncommon or long RP short PR. In the uncommon. atypical form of atrioventricular nodal reentrant tachycardia,the fast pathway is the anterograde limb, and the slow pathway is the retrograde limb of the reentry circuit, In this type or tachycardia. P waves precede each QRS complex and are inverted in the inferior leads.

1.4.3 Treatment of AVNRT:-

Short term therapy:-

If arrhythmia is poorly tolerated,patient requires immediate cardioversion. Most of SVT and AVNRT in particular depend on atrioventricular node in maintenance of reentry circuit and can be interrupted by:

-Vagal maneuvers (carotid sinus massage valsava maneuver and apply ice pack to race in children). [8]
-lf tachycardia persist. give LV adenosine. [9]
-if tachycardia persist or recur rapidly. l.v verapamil or B-blocker are used. [10]
Next step is I.V procanamide, ibutilide, propafenone or flecanide) [11]
However, sequential trail of different antiarrythmic agent should be undertaken only after careful consideration of their possible negative hypotensive , bradycardic, and proarrythmic effect. [8]

Long term management:-

Patients with recurrent episode, option for long term treatment include medication and ablation therapy. [8]
Patients with AVNRT should primarily receive A-V nodal blocking agent such as verapamil, B-blocker, digoxine. Clinical experience indicates that these agent decrease frequency of episode and severity of symptom in an estimated 30 to 60 percent of patient, but complete remission is uncommon. [13] If treatment with above agent prove unsatisfactory , pharmacological choice include class Ic or class III antiarrythymic drug (propafenone, sotalol or amiodarone).these agent prevent recurrence of tachycardia up to 80 percent of patient over 60 day period of follow up. [14]

Long term therapy with these drugs is generally not advisable because of their potential adverse effect [11] ,catheter ablation is usually preferred if the patient agree to this approach. [8]

Either form of atrioventricular nodal reentrant tachycardia can be eliminated by radiofrequency ablation of either the fast or the slow pathway.[8]

Radiofrequency ablation:-

Catheter ablation can be defined as the use of an electrode catheter to destroy small areas of myocardial tissue or conduction system, or both, that are critical to the initiation or maintenance of cardiac arrhythmias. Arrhythmias most likely to be amenable to cure with catheter ablation are those which have a focal origin or involve a narrow, anatomically defined isthmus.[15]

Complications of radiofrequency ablation:-

Serious complications of ablation are uncommon but include:

l-Development of A-V block required pacemaker therapy both transient and permanent A-V block occur during the procedure. This complication occur less with slow pathway ablation than fast path way ablation.

2-Pulmonary embolism, this occurs in up to 0.2 percent of patients.

3-Tachycardia recurs in 3 to 7 percent of patients. [34]

4-Vascular complications are less common (less than 2-3% of cases), these include bleeding, arteriovenous fistula and venous thrombosis.

5-Myocardial injuries include myocardial perforation, valvular damage and rarely death. [35]

2. Materials and Methods

From January 2004 to July 2006, a total of 15 consecutive patients were admitted to cardiac unit in al-Khadimiya teaching hospital with a provisional diagnosis of AVNRT for RFA. The mean age of patients was 46.8±15 years (range 24-55 years) and 5 were males.

The presence of the symptoms such as palpitations, syncope, and pre-syncope and chest pain was analyzed. Majority of patients were symptomatic with palpitations being the most common symptom occurring in 15 (100%) patients. The indication for RFA was failure of pharmacological therapy either because of lack of efficacy or unacceptable side effects. The second indication for undergoing the ablation was patient's choice to undergo the procedure to avoid life-long drug therapy.

All patients underwent a baseline electrocardiogram and a transthoracic echocardiography (TTE) to detect the presence of any structural heart disease. An analysis of 12-lead electrocardiogram (ECG) taken during the episode of tachycardia was made

Electrophysiology Study:-

The procedures were performed in our cardiac center using the Duo 2.73 N electrophysiology laboratory system (CR Bard Inc., Billerica, MA). Electrical stimulation was performed with a programmable stimulator (Bard electrophysiology.

C.R. Bard IAC. U.S.A) each Patient gave informed written consent for electrophysiological testing and the ablation procedure.

The Procedure was performed after omitting all anti-arrhythmic drugs for a period of at least five half lives.

After sterilizing the skin and 2% lidocaine used to anesthetize the left and right inguinal area. A 3-4 catheters approach was used in those patients who had documented tachycardia suggestive of AVNRT, with aid of fluoroscopic screen, the diagnostic catheters positioned in the high right atrium, the His Bundle and the right ventricle via the femoral vein route. Quadripolar woven diagnostic catheters (CR Bard Inc.,Billerica, MA) were used. One catheter may be added to be positioned in the coronary sinus if needed.

The basal electrophysiological intervals on normal sinus rhythm were recorded for all the patients. The induction of tachycardia was attempted using programmed electrical stimulation from the high right atrial site and then the right ventricular apex at two driving cycle lengths and up to two extra stimuli, at 10 msec decrements until the arrhythmia was induced or atrial or ventricular refractoriness was reached.

In many times spontaneous inductions occur during manipulation of catheters. Simultaneous 12-lead surface ECG and bipolar intracardiac electro grams were continuously recorded and saved on optical disc. The standard criteria for diagnosis of dual AV physiology and AVNRT were used.

(1) The presence of an AH jump of 50 msec and above and AV nodal reentrant (echo) beats were ascertained. (2)VA interval at His position is less than 60 msec.

The tachycardia was induced on at least one occasion, usually by programmed atrial or ventricular extra stimulation. Various electrophysiological intervals during the tachycardia along with the mode of initiation and termination were also recorded.

Radiofrequency Ablation:-

Radiofrequency ablation catheter (EPT catheter, Diag, sr.Jude medical, USA) was positioned in the posteroinferior aspect of the tricuspid annulus using fluoroscopic guidance for ablating the slow pathway. We used the anatomic approach described by Jazayeri *et al*,. in which a step-wise positioning of the ablation catheter from low in the triangle of Koch to more superior areas was used. After placing the catheter, the mapping electrode was examined for good ablation signals, i.e. a large ventricular signal and a small atrial signal. Radiofrequency (RF) energy was delivered.

When an AV ratio of 0.1:0.5 was observed using Radionics RF generator (Freiburg, Germany).Appearance of junctional rhythm during delivery 0f RF is an indication of Successful RF delivery. When junctional rhythm did not appear during ablation within the first 30 seconds of the current delivery, the application was stopped and

repeated. This occurred in 15% of the patients. After ablation patients were checked for evidence of persistence of dual AV nodal physiology and inducibility of tachycardia. If there was no evidence of dual AV nodal physiology or tachycardia induction after the 30 seconds burn, another pulse of RF energy was delivered for 60 seconds at the same site. However, in patients who had junctional rhythm during the initial 30 seconds, the RF energy was delivered for a total time of 120 seconds. The catheter tip temperature was always maintained from 50°C to 60°C with power of 30-40 watts. Patients in whom tachycardia was inducible even after two pulses, the catheter was positioned in a more mid septal position under fluoroscopic guidance and the above steps were repeated.The ablation was carried out in sinus rhythm in 4 patients and during the tachycardia in 11 patients. The endpoint for success was non inducibility of AVNRT and not more than a single AV nodal echo beat which was checked for immediately and at 30 minutes of last RF energy application.

The slow pathway was said to be 'modified 'when AVNRT was no longer inducible but an AH jump of at least 50 msec with or without echo beat may persist at the end of the procedure. The slow pathway was said to be 'ablated' when AVNRT was no longer inducible in the absence of AH jump. The basal intervals along with the antegrade and retrograde Wenckebach intervals were recorded at the end of the study. Post-procedure, the patients were observed in the recovery ward for 4 hours on rest after which they were mobilize. They were discharged from the hospital after at least 24 hours.

The patients were followed up on outpatient basis every one month after the procedure. They were asked about the recurrence of palpitations/tachycardia or any hospitalizations for episodes of tachycardia. A basal 12-lead ECG was recorded in all the patients. Anti-arrhythmic drugs like beta-blockers and calcium channel blockers were intentionally avoided in all the patients while treating them for their coexistent illnesses like hypertension continues.

3. Results

All the cases were studied prospectively from January 2004 to July 2006.

Total number of patient included in this study was 15 patients.

Age range was 25-55, mean 40±11.3.

Regarding sex, female patients were more than males in this study (67% vs. 33%) (See figure 1).

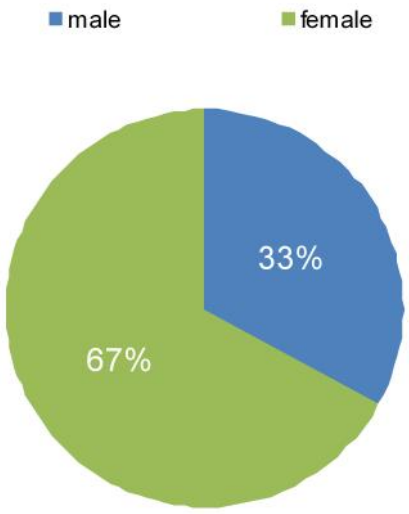

Figure (1) - sex ratio patients

Common symptoms in descending order of frequency were palpation (100%),dizziness (60%), syncope (20%) and chest pain (20%) (see figure2).

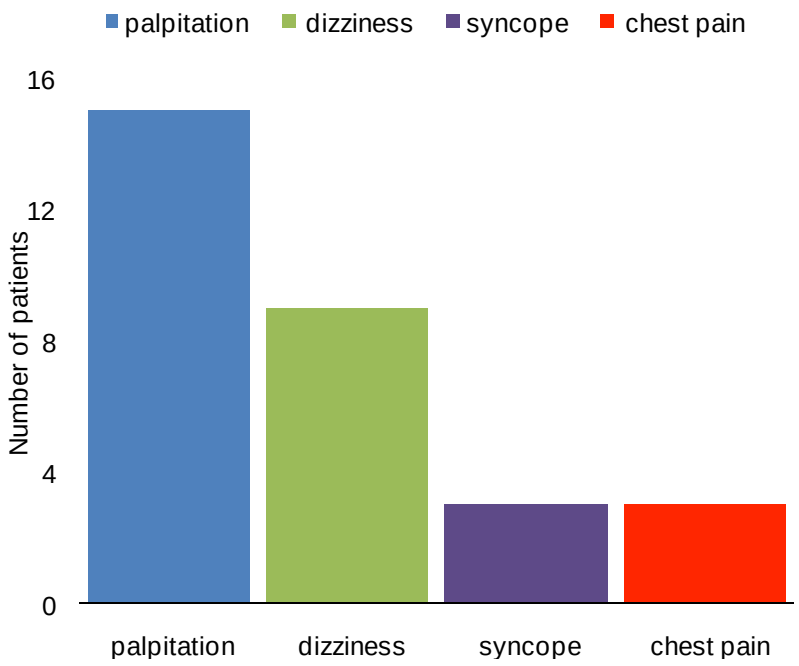

Figure (2) -clinical parameters of patients

Associated heart diseases were found in 2 patients (13%), one patient with cardiomyopathy and other with sick sinus disease (as shown in table 1).

Table 1 clinical characteristics of patients.

	Number of patients	Percent
Total number Female	15 10	67%
Reasons for ablation Failure of drug Side effect of drug Patient choice	 13 1 1	 86.6% 6.6% 6.6%
Associated heart disease Cardiomyopathy Sick sinus syndrome	 1 1	 6.6% 6.6%

The indication for RFA was ineffective pharmacological therapy in 13 patients (86.6%), side effect of drugs in 1 patient (6.6%) and patients choice in 1 patient (6.6%).(as shown in table 1) .

The basal resting ECG was normal 14 patients (93.3%) and RBBB in 1 patient (6.6%). (As shown in table 2).

Table 2 electrocardiographic characteristics of patients

Basal ECG features	Number of patients	Percent
Normal	14	93.3%
RBBB	1	6.6%
ECG during tachycardia Ventricular rate -150-179 -180-200 ->200 Short PR-long PR	 9 4 2 14	 60% 26.6% 13.3% 100%

Table 3 ablation procedure parameters

Parameter	Number of patients	Percent (%)
Access Right femoral vein Left femoral vein Superior vena cava	 15 15 1	 100% 100% 6.6%
Electrode catheters used High right atrium His Right ventricular apex Coronary sinus	 15 15 15 1	 100% 100% 100% 6.6%
RFA done	15	100%
Success rate Slow pathway ablation Junctional rhythm	 15 12	 100%
Average number of burns	5.5+-4.1min	
Procedure time	72.2+- 21.1 min	
Fluoroscopy	10+-5.4 min	

ECG during tachycardia show common AVNRT (short RP long PR).Ventricular response was:

< 180 beats per minutes in 9 patients (60%).

180- 200 beats per minutes in 4 patients (26.6%).
>200 beats per minutes in 2 patients (13.3%). (As shown in table 2).

AVNRT could be induced in 15(100%) with programmed electrical stimulation. In 9(60%) patients AVNRT induced spontaneously during catheters positioning.

Typical AVNRT (slow-fast type) was induced in 15 patients (100%).

RFA was done in 15 patient, all were successfully ablated (success rate was 100%).

Average procedure time was 72.2±21.1 minutes. (See figure 3).

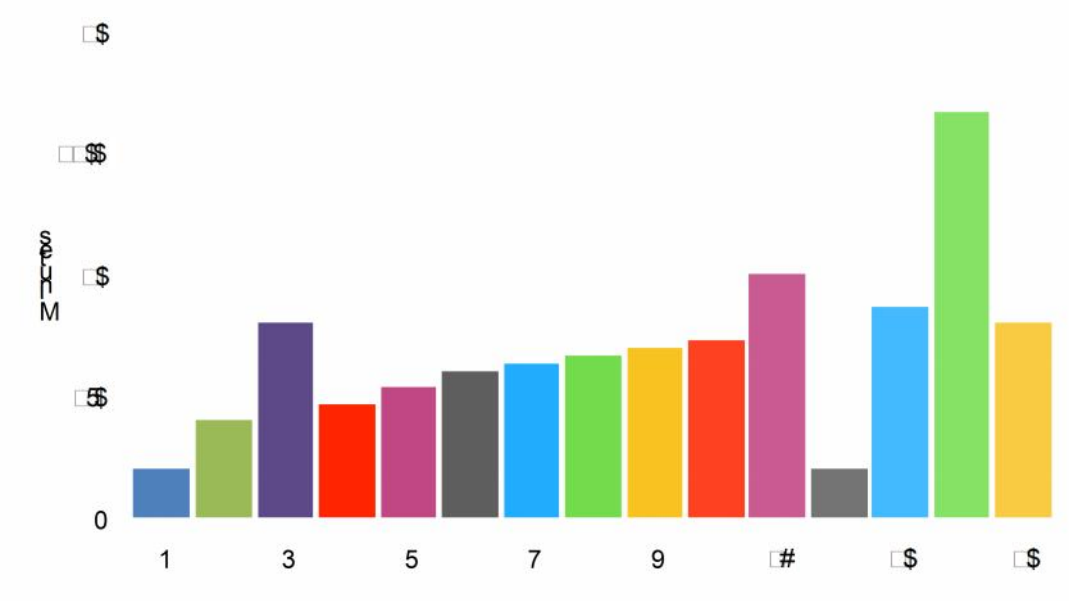

Figure (3) total procedure time in the patients

Average fluoroscopy time was 10±5.4 minutes. (See figure 4).

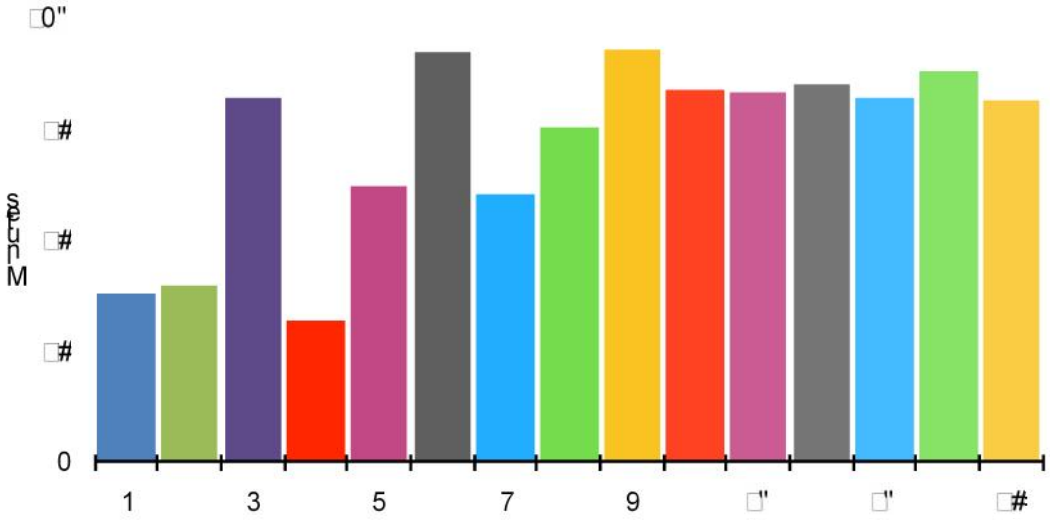

Figure (4) fluoroscopy time

Average number of RF pulses delivered was 5.5±4.1 (See figure 5).

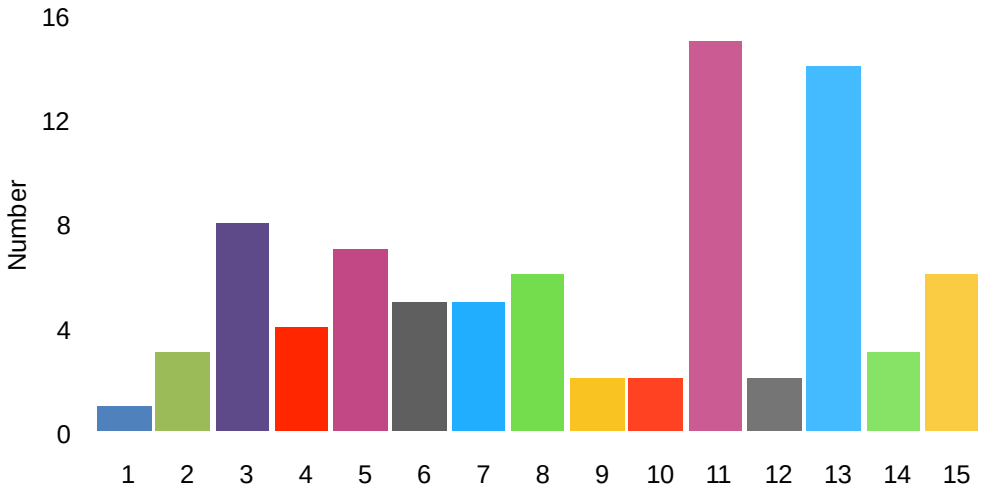

Figure (5) number of lesions

Complication rate.

Complete heart block requiring pacing in 2 patients (13.3%) and Severe vasovagal episode in 1 patient (6.6%).

73.3% of patients were followed up for 2 year period clinically for recurrence of tachycardia episodes. The patients were asked for episodes of palpitation and tachycardia or hospital admission for the same. There was only one recurrence of AVNRT after 1 year after ablation.

4. Discussion

RFA is the most effective therapy of many SVT and Al-Kadhimiya teaching hospital is only center for ablation in Iraq.The total number of patients in this study was small because it is a complex and new procedure in Iraq and it required a team of experienced cardiologist and good and advanced EP lab and well trained staff, it also necessitates a well prepared patient, staff and equipment. Only one case a week could be done at present

Clinical features and AVNRT parameters:-

AVNRT is the most form of SVT, accounting for approximately 85% of the cases[36] SVT is more common in women [36] and usually occurs in the age of 42-55 years [38] in our study, 67% of patients were women and the average age of onset was 40$±1.3 years.

Wood *et al*,. described the common symptoms of AVNRT in descending order of frequency as palpitation (96%), dizziness (75%), dyspnea (47%) and syncope (0.5%) [41]. in our study, palpitations was (100%) the most common symptom followed by pre-syncope (dizziness) (90%), syncope (20%) and chest pain (20%).

Structural heart disease may be present in few percent of patients with AVNRT ,the prevalence of structural heart disease in patients with AVNRT was found to be 6-19.5% in different studies [37,41]. In our study, 13.3%0f patients had associated heart disease.

Slow-fast (typical) type of AVNRT is much more common in patients than fast-slow (atypical) type [36]. In our study, the slow-fast type was found in all patients (100%).

Success rate:-

RFA of slow pathway is highly successful and safe [36]. Our success rate was 100%.The higher success rate of our study is due to careful selection of patients, being typical AVNRT and a careful dedicated work.

Junctional rhythm:-

The presence of junctional rhythm during ablation was seen in 80% of patients. junctional rhythm is considered as marker for successful slow pathway ablation by some authors[36-37]. However, some studies suggest that absence of junctional rhythm is not related with any increased risk of recurrences [45-46]

The first site of RF energy delivery in our study was selected by using fluoroscopic guidance and good ablation signals. if the first site of RF energy delivery did not produce junctional rhythm ,the ablation was stopped after 30 seconds and evidence of persistence of dual AV nodal physiology and inducibility of tachycardia were checked. In our study(20%) patients did not develop junctional rhythm, which higher compared to the reported in publish literature. We believe this approach is safe and at the same time, as effective as the approach when ablation attempts are made to get junctional rhythm during ablation. in fact, nearer the ablation site is to the compact AV node , more is the frequency of junctional rhythm during ablation, thereby increasing the risk of AV nodal injury [38,47]

RFA as first-line therapy:-

RFA improves health-related quality of life to a greater extent than do medications [50] and was the least expensive therapy as compared to drug therapy options among patients who have monthly episodes of PSVT. AVNRT is readily amenable to definitive therapy by catheter-based RF energy delivery at the Slow Pathway area Results from the present and other series have shown this strategy to be both Safe and effective, supporting ablation therapy as first-line therapy for the majority of patients, especially young patients.

AV block:-

The incidence of AV block was seen in 2(13.3%) patients and both required pacemaker implantation. This, complication occurred during early experience (first and forth patients) and not seen in the latter eleven successive patients.

Determinants of AVNRT recurrence:-

Unfortunately, we lost follow up of 4 patients .In the remaining 11 patients was only one case of recurrence on follow up .he had junctional rhythm during the first RF energy application .Post ablation, he did not manifest any slow pathway conduction or any inducible tachycardia.

The recurrence rate of AVNRT after successful are very low and may vary from 3- 6% (36,38), In our study the recurrence rate was 6.6%.Various authors found that majority of recurrence Occurred in the first months following ablation procedures [40]

It observed that recurrence does not occur afier three years of successful ablation [48] Our patient recurrence occurred after six months of ablation. Histological studies showed that acute ablation lesions are composed of central coagulation necrosis, surrounded by hemorrhage and interstitial edema. Conduction may resume following settling of edema and inflammation after thermal injury, predisposing for AVNRT recurrence within few days to months after ablation [37].

Conclusion

This study demonstrated in a series of patients that slow pathway ablation is highly efficacious in treatment of AVNRT, and now consider as first line of therapy and is associated with low risk of complications. The recurrence rate during follow up is low.

Recommendations:-

1.More wide application of radio frequency in treatment of AVNRT with no response to medications.
2. Usage of recent and more advance electrophysiology lab in proper diagnosis of different type of SVT.
3. Increasing the training of physicians for EPS and RFA.
4. Arrange more conferences and lectures for general and junior doctors to clarify the idea of RFA their efficacy, so as more patients will be referred to specialized RF centers.
5. Establishment of new cardiac centers for RFA.

Limitationsof the study:-

The number of our patients that involved in the study was small (15) patients, in comparison to other studies.

The recurrence rate was based only on outpatient evaluation of patient’s symptoms and their ECG. No electrophysiology studies were done on follow-up.
Out of 15 patients 4 patients were lost to follow—up. Thus , the true recurrence of AVNRT might have been underestimated .

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