

The First Three Years of Ablation Therapy in Cardiac Arrhythmias: Single Centre Experience

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ABSTRACT

Improvements in both evaluation of intracardiac signals and molecular data yielded an easy understanding of complex cardiac arrhythmias and channelopathies in last years. However, the mentioned techniques are not applicable by all health providers because of high costs, requirement of well-educated team members, and the most importantly the presence of long learning curve for cardiologists. In this article, the catheter ablation of arrhythmias in the Van Yuzuncu Yil University Department of Cardiology in last three years will be reviewed.

Intracardiac signals were filtered at 20-500 Hz, amplification gains were 10-80 mm/mV. All signals displayed and acquired on an electrophysiological recording system (EP-TRACER 2 system, Schwarzer Cardiotek, Germany). All types of arrhythmias such as atrioventricular nodal reentry tachycardia, atrioventricular reentry tachycardia, atrial flutter, atrial tachycardias, atrial fibrillation, premature ventricular contractions, and ventricular tachycardias were ablated according to the latest guidelines and techniques.

A total of 430 patients were screened in this trial. The success rate in the ablation of atrioventricular nodal reentry tachycardia, atrioventricular reentry tachycardia, atrial flutter, atrial tachycardias, atrial fibrillation, premature ventricular contractions, and ventricular tachycardias was 100%, 88.2%, 88.8%, 72.2%, 100%, 73.9%, and 87.5% respectively.

There was only one death among 430 ablation procedures in our centre and the reason of death was not clear because of patient's other co-morbidities. Otherwise, our success and complication rates were similar with the results of most advanced centres in all around of the world.

Key Words: Cardiac arrhythmias, ablation, radiofrequency, cryoballoon

Introduction

There was no enough information about cardiac arrhythmias in the earlier than 2000 years but more comprehensive data about them has come after an advanced technology in this area. Improvements in both evaluation of intracardiac signals and molecular data yielded an easy understanding of complex cardiac arrhythmias and channelopathies (1). More recently, intracardiac signals were integrated with magnetic or impedance based three-dimensional mapping systems (2,3). Obviously, the mentioned systems helped to determine and treat an almost all of cardiac arrhythmias in last years. In addition, one of the most recent technology supplies to get 3-D map of heart only by ultrasound signals (CARTOSound image integration module, Biosense Webster, J&J company, USA) (4).

Numerous energy sources were used to ablate cardiac arrhythmias in past but radiofrequency (RF) and cryothermal ablations are most preferred methods today. As a result of successful ablations by mentioned techniques, management of cardiac

arrhythmias with medication was substituted by ablation in recent years. On the other hand, pharmacologic treatment of arrhythmias is restricted by excessive failure degrees, impending for proarrhythmia, and medicine related toxicity. All of these factors referred the physicians from medication therapy to ablation therapy in the presence of almost of all cardiac arrhythmias [5,6]. However, the mentioned techniques are not applicable by all health providers because of high costs, requirement of well-educated team members, and the most importantly the presence of long learning curve for cardiologists (7,8).

In this article, the catheter ablation of arrhythmias in the Yuzuncu Yil University, Faculty of Medicine Department of Cardiology in last three years will be reviewed. An explanation of invasive cardiac electrophysiological studies and 3-D mapping, and catheter ablation of different arrhythmias is presented separately.

Materials and Methods

Present trial is a retrospective observational study.

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Patients who undertook RF or cryoenergy ablations among July 2016 and August 2019 in a university hospital in the eastern part of Turkey were registered in our study. All data was obtained by hospital's electronic files and cardiac device recordings. All of our patients had clinically documented electrocardiography (ECG) records before the procedure. Diagnostic electrophysiological procedures were not included in the current trial.

Informed consent form of patients was obtained as a result of routine approach in our centre. All antiarrhythmic medications were discontinued at least 2 days before the procedure and none of anxiolytic medication was administered just before or during an operation in awake patients. General anaesthesia was chosen in the presence of haemodynamically instable patients or according to the patient's preference because of severe anxiety. Propofol, fentanyl and midazolam were used in all patients under GA and noradrenalin was administered in case of necessity particularly in patients with diagnosed ventricular tachycardia (VT) and during activation mapping of VT.

Electrophysiological Stimulation and Ablation

Procedure: Mono and biplane X-ray fluoroscopy systems (Siemens™) were used with conventional and 3-Dimensional mapping systems respectively. Right femoral vein was selected for placement of introducers. Two 6 French (F) and one 7F introducers were placed in conventionally ablated patients. After initial measurements, tachycardias were induced by variable programmed electrical stimulations. Intravenous isoproterenol was administered when needed in order to stimulate clinical tachycardia. Two long 8F (Fast-Cath™) and one short 6F introducers were placed in the ablation of complex arrhythmias such as atrial tachycardias, atrial fibrillation, atypical flutter and ventricular arrhythmias. One-puncture, double transseptal catheterization manoeuvre was applied to perform ablation of left sided complex arrhythmias. 5000 IU of unfractionated heparin was administered just before the puncture and completed with an additional dose after puncture according to 100 IU/kg protocol. Targeted activated clotting time was between 350 and 400 seconds in the ablation of left sided arrhythmias.

Intracardiac signals were filtered at 20-500 Hz, amplification gains were 10-80 mm/mV. All signals displayed and acquired on an electrophysiological recording system (EP-TRACER 2 system, Schwarzer Cardiotek, Germany).

Atrioventricular Nodal Reentry Tachycardia

(AVNRT): The presence of ST depression in inferior leads and pseudo ST segment elevation in V1, shortness of RP duration than 70 ms (millisecond) hidden P wave in QRS and initiation of tachycardia by jump on surface ECG were accepted as favourite features for AVNRT. Occurrence of accelerated nodal rhythm during ablation and disappearance of jump beat or non-inducibility of clinical tachycardia after ablation were accepted as sufficient criteria for an effective ablation of AVNRT. Focal cryoablation was conducted in very young and old patients and totally other criteria were followed to decide a successful ablation.

Atrioventricular Reentry Tachycardia (AVRT):

Presence of AVRT was confirmed according to surface ECG in case of overt pre-excitation. An activation pattern on CS (coronary sinus), initiation of tachycardia during EPS (electrophysiology study) existence of shorter V-A (V:ventricul, A:atrium) A-V duration on ablation catheter than CS were evaluated to detect concealed AVRT. Preliminary and optimal ablation sites were found according to the closest A-V signals on the CS and ablation catheters respectively. Most of APs (accessory pathway) by non-irrigated ablation catheter at 50W and maximally 60°C in shorter than 30 seconds but several of them came back just after cessation of ablation procedure. Disappearance of closest V-A or A-V signals or sudden prolongation of mentioned signals on ablation catheter recordings were accepted as favourite criteria for sufficient ablation. In addition, narrowing of QRS duration or vanishing of delta wave on surface ECG were preferred to decide an adequate amount of delivered RF energy.

Cavotricuspid Isthmus Ablation: which is the cornerstone for successful treatment of typical atrial flutter (AFL). Point by point ablation technique was preferred and each point ablated at least 30 seconds. Impedance drop (5-10 ohm) and diminishing of atrial voltage (more than 50%) were accepted as desired criteria for effective ablation of CTI (Cavotricuspid Isthmus). In the termination of procedure, ablation catheter placed precise over the CTI line and CS pacing was started to confirm CT block. During CS pacing, the duration >140 milliseconds between atrial signals on CS and ablation catheter, presence of double potential (A-A) on ablation catheter, attendance of proximal to distal activation pattern and sudden prolongation of atrial signal on ablation catheter were accepted as sufficient criteria for successful ablation of CTI.

Ablation of Atrial Tachycardia and Atrial Fibrillation:

The ablation of these complex arrhythmias was carried out by the help of 3-D mapping systems and inflation of cryoballoon. Only CARTO® System was used to get an electro-anatomical 3-D view of heart. In the beginning of ablation therapy in our centre we had to prefer conventional techniques to treat the atrial tachycardias (AT) because of inadequate experience about 3-D mapping but in last one year our first approach to AT was absolutely ablation by contact force catheter and 3-D mapping system. Local activation time (LAT), entrainment criteria, tachycardia cycle lengths and variability between beats were assessed to distinguish focal AT than re-entrant AT. The origins which have at least 20 msec earlier signals than CS proximal were much-loved areas to ablate or terminate the arrhythmia in focal AT. Ablation index of 380 to 420 and 500 to 550 were accepted as sufficient for posterior and anterior wall originated atrial tachycardias correspondingly. Roof, cavotricuspid and mitral lines were evaluated according to activation pattern both on CS and ablation catheters in the suspicion of macro re-entrant tachycardia. Local or micro re-entrant tachycardias were detected by the help of propagation mapping on CARTO system. Standard and aggressive pacing protocols were performed just after and 20-30 minutes after the ablation to decide for successful procedure.

Ablation of atrial fibrillation (AF) or isolation of pulmonary veins (PV) were carried out mainly by cryoballoon. RF energy was preferred in patients with large atriums or persistent AF. Cryoballoon cooled up to -60°C at least 240 seconds in each pulmonary vein and repeated in case of necessity. During isolation of right pulmonary veins, diaphragm muscle stimulation was done by pacing catheter in superior vena cava to avoid phrenic nerve paralysis. Successful isolation of pulmonary veins was confirmed by the occurrence of entrance and exit block. The signals on ablation catheter both in PV and LA (left atrium), jump movement of ablation catheter throughout leaving the PV to LA and impedance dissimilarity of LA and PV were assessed in the creation of optimal ablation line. In addition, X-ray finding such as vertebra image and catheter positions were evaluated to prevent the complications of RF ablation. Substrate or voltage mapping of LA was generated in all patients with persistent AF.

Ablation of Premature Ventricular Beat Origins and Ventricular Tachycardia: In the beginning of our ablation therapy period, we have

performed the ablations of premature ventricular complexes (PVC) only by conventional techniques, without 3-D mapping and so therefore, we could not manage any ventricular tachycardia. Fluoroscopy view, local activation time and pace mapping criteria were assessed to find the best point in order to ablate the source of PVC. Since last 14 months we have used the 3-D mapping system in the ablation of both PVC and VT. Documented ventricular arrhythmia or 12-lead surface ECG recording is extremely crucial for us to guess a precise origin of tachycardia and in the selection of appropriate catheters in the beginning of procedure. Uninterrupted, high watt, single shot energy delivered until to reach 2000 of ablation index in order to abolish the PVC which originates from LV (left ventricle) summit. The lower limit was 1.5 mV in the detection of low voltage or ischemic areas in ventricle and a main approach was to ablate or homogenise low voltage areas. In addition, mid diastolic potentials have been marked during sinus rhythm and ablation of related regions were achieved. Entrainment criteria were considered and activation mapping was obtained in hemodynamically stable ventricular tachycardias. Pace mapping was done several times to get the best pace-match ratio. All ablations were performed by contact force catheter and targeted ablation index was at least 600 to 1000 for each point. Non-inducibility of clinical tachycardia at the end of procedure was the goal of our ablation strategy. On the other hand, we have not carried out any epicardial approach in the ablation of ventricular arrhythmias due to the absence of appropriate materials in our laboratory.

Statistical Analysis: We have presented the categorical data as counts and percentages.

Results

A total of 430 patients were screened in this trial. The electrophysiological diagnosis, success rate and complications of procedures were presented in table 1.

AVNRT managed with 100 % of success rate. Focal cryo catheter (Freezor™, Medtronic Inc, Minneapolis, MN, USA) was utilized in only three patients whose ages were 14, 77 and 78 years. We have mainly used RF energy to create a lesion in slow pathway. Unfortunately, third-degree conduction block in AV (atrioventricular) node appeared in two patients during RF ablation of slow pathway and have not restored in the following time.

Table 1. The electrophysiological diagnosis, success rate and complications of procedures

| Diagnosis | Numbers | Success rate | Major. Complications |
|-------------------------|---------|--------------|----------------------|
| AVNRT | 220 | 100 % | 0,91 % |
| AVRT | 68 | 88,2 % | 1,47 % |
| AV node ablation | 14 | 100 % | 0 % |
| Atrial tachycardia | 18 | 72,2 % | 0 % |
| Atrial flutter | 18 | 88.8 % | 5,55 % |
| Atrial fibrillation | 71 | 100 % | 4,22 % |
| PVC | 23 | 73,9 % | 0 % |
| Ventricular tachycardia | 8 | 87,5 % | 12,5 % |

AVNRT: Atrioventricular nodal re-entrant tachycardia, AVRT: Atrioventricular re-entrant tachycardia and PVC: Premature ventricular contractions

We have improved our success rate up to 96,7% in last 30 patients by antegrade transseptal approach and the use of irrigated tip ablation catheters in the ablation of APs. The only complication was rupture in right femoral introducer and separated part of introducer remained in right femoral artery.

Atrial tachycardias originated from crista terminalis, posteroseptal & coronary sinus ostium, anteroseptal and tricuspid annulus in ten, three, three and two patients respectively. Ablation of AT which originates out of crista terminalis was very difficult without 3-D mapping system. So, therefore initial success rate of our team was low in the beginning and overall success rate increased up to 72,2 % in the latter days by the help of 3-D mapping system.

We have not detected any inscribed complication which related to the ablation of AT.

Pericarditis was only complication after a creation of cavotricuspid line in the treatment of AFL. The patient stayed at hospital for two days, creatinine kinase MB, troponin I and C-reactive protein values elevated after ablation. In the following two days, he became as almost asymptomatic and we have discharged him with painkiller medication. On the other hand, we could not get CTI block in two patients probably because of pouch on CTI line, formation of excessive oedema and absence of long sheath in some patients.

We have totally isolated all pulmonary veins in all patients and experienced with severe complications in three patients. In the very early period of our transseptal puncture we have perforated right atrial appendage during the application of one puncture double catheterization

technique. The patient referred to an operation room and right atrial appendage was found as perforated and it was repaired under open heart surgery. The patient discharged after 1 week of operation without any sequelae. Second complication was an extraordinary result of transseptal puncture which we have punctured descendant aorta. The patient was on dabigatran medication and so therefore, we have administered 2,5+2,5 mg of idarucizumab intravenously. The complication was managed without any adverse outcome and the patient was discharged after visualization of normal structure of descending aorta by thorax CT (computer tomography). Last of our complication was phrenic nerve paralysis during cryoballoon isolation of right inferior pulmonary vein. Unfortunately, she died at the third day of operation probably because of phrenic nerve paralysis or pulmonary oedema.

Ablation success rate of PVCs from outflow tract was 68% in the beginning of our ablation era and it increased up to 95% by the help 3-D mapping system. Most significant increase in success rate was detected in the ablation of non-outflow tract PVCs from 23% to 80% as a result of 3-D mapping system for sure.

Clinical ventricular tachycardia was remained as inducible although all ablations of suspected areas in the ventricle but the good effect of ablation was the tachycardia cycle length increased to about 390 msec from 340 msec in one patient. Otherwise, we have effectively managed 7 of 8 patients with VT. The only complication was occurrence of LBBB (left bundle branch block) in one patient during ablation of ischemic VT and he was discharged

with same condition day after of procedure but we saw disappearance of LBBB on surface ECG during outpatient clinic examination of patient after one month of ablation.

Discussion

The variety of ablated arrhythmias was different than arrhythmias in developed countries in our centre [9]. AVNRT is most encountered regular supraventricular tachycardia and many centres in the world prefer RF energy in the ablation of slow pathway while others use cryoenergy [10-13]. We have had only 2 (0,91%) permanent AV conduction block and it looks a little better than the results in the world [14,15]. We believe that, this proportion shows an adequate experience of our team in the management of AVNRT. On the other hand, there was no reported permanent AV conduction block in large series by cryoenergy [16] but rigidity, difficulty in the management, and higher costs are disadvantages of cryoenergy catheter. In addition, criteria in the decision of successful ablation of slow pathway by cryoenergy are totally different than by the use of RF energy and it requires the familiarity, experience and long-term learning curve of operator. Because of all these reasons, we have used RF energy in the ablation of slow pathway except three patients and they have also managed successfully by cryoenergy without major complications.

We have not considered the effective refractory period (ERP) of APs as essential criteria in their ablation. We have ablated all overt APs regardless of presence of symptom and $ERP < 250$ msn and patients became happier after the ablation of AP in the subsequent time. In addition, earlier trials stated that patients with APs had a greater leaning to progress AF than that in general population (17-18) and it was another reason for us to ablate all APs regardless of clinical situation. So therefore, our first approach was ablation of all manifest APs instead of medication but if the location of APs was close to AV node then we had to follow-up the patients until occurrence of clinical tachycardia because of high damage risk in AV node during ablation. Conduction over AP came back just after cessation of RF energy in some patients and we have referred irrigated tip ablation catheter in these patients because of its proven superiority (19).

Our success rate was lower in the ablation of ATs in the beginning but we have effectively managed all ATs after the utilization of 3-D mapping system. To finding an origin of AT was took

longer time in some patients possibly because of the absence of advanced mapping catheters such as pentaray® and others and we had to create the activation mapping of tachycardia by ablation catheter (SmartTouch®).

The most site for gap was an area between right pulmonary veins in patients with recurrent AF and most of them have had ablation by cryoballoon catheter before. It was an expected area in other words, due to the difficulty of insertion of cryoballoon catheter into the right inferior pulmonary vein. Martin RP et al. were also encountered with the same challenge in their patients and they have developed a new strategy in order to effectively intubate the right inferior pulmonary veins (20).

The reason of higher complication rate in our patients during ablation of VTs was probably depends on a lower number of patients. However, the mentioned complication had totally recovered after one month of operation and there was not any VT episode in the ICD (implantable cardioverter defibrillator) of patient. Presence of extended scar area reduces the success of ablation in patients with VT and unfortunately, one of our patient have had extremely large scar area which we could not manage the VT successfully in that patient and it was remained as inducible despite to all of our aggressive ablation approaches.

There was only one death among 430 ablation procedures in our centre and the reason of death was not clear because of patient's other comorbidities. Otherwise, our success and complication rates were similar with the results of most advanced centres in all around of the world.

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