Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/crvasa

Review article

Current status and future catheter ablation strategies in atrial fibrillation

*Lukas Fiedler**, *Charlotte Eitel*, *Sascha Rolf*, *Phillip Sommer*, *Thomas Gaspar*, *Emmanuel Koutalas*, *Arash Arya*, *Gerhard Hindricks*, *Christopher Piorkowski*

Department of Electrophysiology, University of Leipzig, Heart Center, Strümpellstrasse 39, 04289 Leipzig, Germany

ARTICLE INFO

Article history:
Received 3 December 2012
Received in revised form
4 August 2013
Accepted 11 September 2013
Available online 25 September 2013

Keywords:
Atrial fibrillation
Ablation
3D mapping
Individualized ablation strategies

ABSTRACT

Catheter ablation of atrial fibrillation (AF) is a highly effective therapy to achieve freedom of recurrent arrhythmia and relief from symptomatic AF. Transmural ablation of atrial tissue is crucial for success. Thus steerable sheaths and catheter design with contact measurement as an additional feature have been developed to increase success rates. New 3 dimentional (3D) mapping technologies engage clinical routine to reduce fluoroscopy time and radiation dose for patients and medical staff to a minimum. To unmask dormant pulmonary vein reconduction and to avoid early pulmonary vein reconduction administration of adenosine is useful. Future approaches aim at individualized ablation strategies taking clinical and electrophysiologic characteristics of the individual patient into account.

Contents

Abbreviations: AF, atrial fibrillation; CF, contact force; PVI, pulmonary vein isolation; TSP, transeptal puncture; CFAE, complex fractionated atrial electrogram; 3D, three dimentional

*Corresponding author. Tel.: +49 341 865 1413; fax: +49 341 865 1460.
E-mail address: flukas@me.com (L. Fiedler).

0010-8650/$ - see front matter
http://dx.doi.org/10.1016/j.crvasa.2013.09.001

Introduction

Atrial fibrillation (AF) is associated with an increased risk for thromboembolic events, hospitalization and mortality. The number of patients suffering from AF steadily increases, as patients get older and present with more comorbidities and structural heart diseases [1]. Treatment for AF has constantly evolved over the last decade. Catheter ablation has become a routine procedure, with excellent success rates accompanied by acceptable complication rates. Still careful patient selection is important for clinical success. Since superiority of catheter ablation against medical, antiarrhythmic treatment, avoiding recurrence of AF, is shown, ESC guidelines admit, that catheter ablation could be performed as a first line therapy for patients suffering from AF [2,3], which was consolidated by the MANTRA-PAF trial published in October 2012. This randomized comparison of first line catheter ablation in paroxysmal AF to antiarrhythmic drug therapy showed significantly more patients free from AF and symptomatic AF and better quality of life in the ablation group at the 24 month of follow up. AF burden though did not differ [4]. Therefore the 2012 expert consensus statement from the Heart Rhythm Society, European Heart Rhythm Association and European Cardiac Arrhythmia Society on catheter and surgical ablation of atrial fibrillation includes ablation, if performed by an electrophysiologist, who has received appropriate training in an experienced center, as a reasonable first-line therapy for preselected patients suffering from paroxysmal AF [5].

Mechanisms of AF

Mechanisms causing paroxysmal AF appear to be different from those causing persistent AF. Paroxysmal AF is defined by spontaneous termination and episodes shorter than 7 days. Persistent AF does not self-terminate and episodes last longer than 7 days. Haissaguerre first described focal triggers within the atrial muscular extensions of pulmonary veins [6]. High frequency electrical activity of these focal sources is crucial for initiating paroxysmal AF in 85–95% of patients. Knowing that has led to the development of effective ablation strategies to isolate pulmonary veins electrically. Circumferential, antral pulmonary vein isolation became a therapy of choice in patients suffering from paroxysmal AF [7]. Cumulative success rates, between 80% and 90%, after more than one procedure, are reported in the literature [3]. Main cause of recurrent arrhythmias in these cases is attributed to electrical reconnection of former isolated pulmonary veins [8]. In persistent AF mechanisms are multiple and therefore ablation strategies to ablate suffer from imperfection. Structural and electrical alterations in the atrial myocardium are accused of perpetuating AF. Coexisting hypertension, valvular disease and heart failure lead to abnormal atrial pressure, causing wall stress and regional fibrosis, which provides substrate for persistent AF [9]. Atrial rotors, focal driver and wandering wave fronts seem to play a decisive role in perpetuation of AF [10]. Patients with persistent AF have distinctively reduced success-rates. Up to 30% of this population develops recurrent AF over time [11]. During the long-term follow-up (5 years) only 29% of patients stayed free of any arrhythmia after a single procedure. Most recurrences occurred within the first 6 months after initial procedure. Additional procedures can raise long-term success to 63% at 5 years [12]. Another significant mechanism for recurrence, as a result of post-ablation modulation, is macro-reentry tachycardia, which accounts for about a third of recurrences after atrial defragmentation [13]. Creation of trans mural scars therefore represents a crucial endpoint in ablation of atrial fibrillation and bears a challenge for operator and technical equipment. Thus there is a constant development of procedure strategies and technical support to reach these endpoints.

Catheter tissue contact

Catheter tissue contact is crucial for radiofrequency lesion size and depth. Contact force (CF) >20 g applied to the atrial endocardium during AF ablation, correlates with better clinical outcome at the 12 month in AF ablation compared to less than 10 g [14]. Recently published data confirmed that there is significant difference in CF at different anatomical sites during pulmonary vein isolation (PVI) [15]. It could be shown, that the lowest contact force at the left pulmonary veins was applied to the carina anteriorly. At the right pulmonary veins lowest CF was to the carina. These segments correlate with usual regions of early electrical reconduction [16]. Knowledge about this may improve clinical outcomes during PVI. A notable improvement of stability and catheter contact to the atrium is provided by the use of steerable sheaths. Several clinical studies have proven the concept of better tissue contact achieved by steerable sheaths, that results in higher success rates without increasing complication rates. There is a significant reduction in fluoroscopy time, while procedure time is not prolonged due to the use of steerable sheaths [17–19]. As mentioned above, on the one hand sufficient catheter–tissue contact is crucial for pulmonary vein isolation, on the other hand data about amount and vector of force delivered to the tissue is important information in order to avoid thromboembolic events and perforation through the atrial wall. In general, it is difficult for operators to exclusively define a sufficient catheter–tissue contact by tactile feedback; up to now fluoroscopy and signal-quality have been additionally used to confirm proper touch to atrial surface, both of which are implicit variables defining adequate tissue contact. To generate reliable information about delivered pressure to atrial wall, ablation-catheters with different features of contact measurement or feedback have been developed and investigated in the past. Currently there are two different technologies to measure contact force via an ablation catheter. Specially designed catheters, with integrated force sensors in the tip have been developed. The Tacti-Cath® (Endosense, Switzerland) System contains a pressure measurement based on a fiber-optic sensor technology with a sensitivity of less than 1 g. Another, quite similar system is represented by the SMART Touch™ Technology (Biosense Webster), which uses a mechanical catheter tip to provide valid data of pressure to the atrial endocardium, expressed in grams. Published data support the thesis that complications due to excessive