Prague Workshop on Catheter Ablation: **20 years of progress 1998–2017**

Prague Ablation Workshop

IKEM
INSTITUTE FOR CLINICAL AND EXPERIMENTAL MEDICINE
DEPARTMENT OF CARDIOLOGY

NEMOCNICE NA HOMOLCE

rytmus srdce

CCL

In 1998, the first edition of the Prague workshop on catheter ablation with live demonstrations took place at the Institute for Clinical and Experimental Medicine in Prague. To commemorate past 20 years of the workshop, we have decided to prepare this brochure. It summarizes history, brings interesting statistics about faculty members, patients and participants. It adds photographs, parts of programs, quotations from the Guest book and interesting case reports.

Besides materials related to the workshop, the brochure provides also information about the history of electrophysiology in the Czech Republic and about the Czech Registry of catheter ablations that was launched in 1994.

Josef Kautzner

Contents

The historical roots of catheter ablation therapy of arrhythmias in the Czech Republic

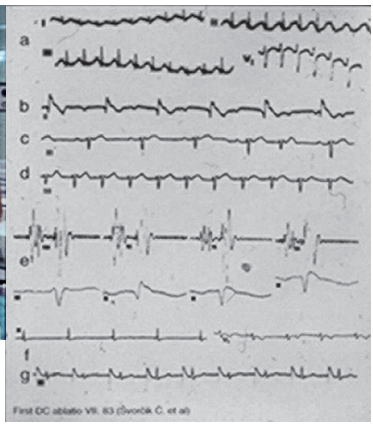
This article attempts to summarize briefly the history of non-pharmacological therapy of cardiac arrhythmias in the Czech Republic (or former Czechoslovakia). It is important to emphasize that even in the communist period, this country was one of the leaders in arrhythmia therapy in the Soviet Block. IKEM (Institute of Clinical and Experimental Medicine) in Prague and its predecessor – ÚKECH (Institute of Clinical and Experimental Surgery) have played a dominant role in this history. The close and creative cooperation between the medical and technical staff in this institution resulted in concrete achievments in experimental and clinical cardiac electrophysiology. Below, I would like to point out just a few of the significant innovations in this field of medicine in our state between 1950 and 2000:

- Development of external non-synchronized defibrillator (Peleška B. et al.), which was awarded the Grand Prix in the World Exhibition EXPO 58 (Brussels) in 1958,
- The first cardiac pacemaker implantation in 1962,
- Development and commercial production of original implantable pacemaker (1965),
- The first DC (direct current) ablation of a-v junction („His bundle ablation") in 1983,
- The first ICD (implantable cardioverter-defibrillator) implantation in 1984,
- The first DC ablation of accessory a-v pathway in 1986,
- The first selective surgical ablation of ventricular tachycardia substrate guided byendocardial and epicardial mapping in 1987,
- The first RF (radiofrequency) ablation of accessory pathway in an adult with WPW syndrome in 1992,
- The first RF ablation of the arrhythmogenic substrate in a patient with ventricular tachycardia in 1993,
- The first selective catheter ablation of atrial fibrillation in 1999,
- The first implantation of ICD with resynchronization pacing in 2000,
- The first 3D electroanatomical mapping-guided ablation in 2000.

It would be possible to continue with more examples. However, I suggest to focus on IKEM's milestone, dated 1983 (Fig 1). The first „His bundle ablation" in IKEM was performed in 1983 (Švorčík, Č. et al.), it means one year after the first procedure in the world (Gallagher J.J, et al., NEJM 1982, Scheinman MM at al., JAMA 1982). In IKEM we used our own modification of this procedure -„double cathode" catheter ablation. Two bipolar USCI 6F bipolar catheters were introduced transvenously. First one was introduced into the right ventricle for the subsequent pacing. The second bipolar catheter was localized in the His bundle area to record clear H signal. After the achievement of the stabile position, the both electrodes of this bipolar catheter were connected using a special switch-box to the cathode of a conventional defibrillator unit. It means that we delivered the discharge simultaneously by both electodes of bipolar catheter (with 1 cm interelectrode distance) against the anode of external paddle which was positioned to the left lateral thoracic wall. After switching from His bundle registration to the ablation mode, a short intravenous general anaesthesia was used and nonsynchronized shock therapy with energy of 200-400 Wsec. Immediately after the discharge, the system was switched to registration of intracardial signals and the patient was stimulated from the right ventricle. In 1984, we used this method also in one patient with hemodynamically significant permanent sinus tachycardia. We applied several discharges in the anatomical region of sinus node to achieve modification of the sinus node function. It was successfull even more than we wanted and therefore, a pacemaker had to be implanted. Our results from the first two years were published in the monography Cardiac Pacing (ed. Gomez F.P., Mount Kisco New York, 1985). Over the next 3 years, the procedure was used in almost 100 patients with the main diagnosis of symptomatic persistent atrial fibrillation resistant to other conventional therapeutic options. This procedure, which is today perceived as rather primitive, ushered the era of catheter ablation of tachyarrhythmias in our country.

Fig 1

Dr. Švorčík preparing temporary pacemaker for the first DC ablation procedure of AV junction in 1983 and recordings documenting inerruption of conduction between atria and ventricles



However, until the regime change in 1989, the opportunities for implementation of novel technologies such as radiofrequency current generator were very limited. After 1989, the Working group on Arrhythmias (part of the Czech Society of Cardiology) was founded by Professor Jan Lukl (son of one of the former presidents of ESC)and by other colleagues. Thanks to continuing efforts of this body that comprised negotiations with newly formed insurance companies, the Ministry of Health and hospital authorities, more economical resources were allocated for this programme.

After the Czechoslovakia split in 1993, there were only 4 centers in the Czech Republic equipped with simple simultaneous multichannel ink-recorders and performing selective radiofrequency ablation (Fig 2 A, B and Fig 3). After the promising reports of the leading cardiac centers worldwide and thanks to the activities of the Working group on Arrhythmias, our country witnessed a significant increase in the number of new centers starting the systematic programme of catheter ablation therapy of cardiac arrhythmias. By the end of 1990s, several Czech cardiology centers obtained modern multichannel systems for mapping of intracardiac electrical activitity and generators for radiofrequency ablation. In 1994 we initiated the National registry of catheter ablations of arrhythmias. This registry is now web-based and collects data on catheter ablation procedures over 2 decades. It remains under the gestion of the Working group on Arrhythmias and Cardiac Pacing that has been recently transformed into the Czech Heart Rhythm Association.

In 1998, we decided in IKEM to organize the first Prague Workshop on Catheter Ablation with live demonstrations. The first edition commemorated the 15th anniversary of the first DC ablation of a-v junction, performed in IKEM in 1983. The opportunity to watch strategies of the procedures and novel technologie sproved to be a good concept and we decided to organize the meeting on annular basis. Since 2000, the first systems for nonfluoroscopic, computer-based catheter mappin, so called electroanatomical mapping (CARTO system), were available in several Czech centres. The number of procedures as well as the spectrum of indications for catheter ablation continued to increase. We believe that this developmend was sparked off predominantly by the above annual meeting. At present, some Czech centres are able to perform any type of ablation procedure and have experience with any novel technology available.

Fig 2 A

Dr Cynthia Tracy in the lab, performing the first radiofrequency ablation in an adult patient in 1992.

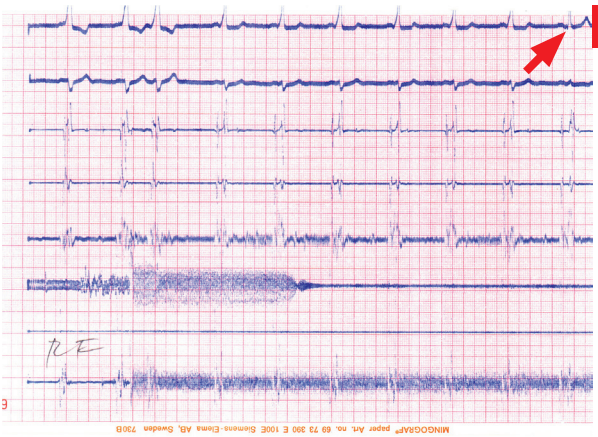


Fig 2 B

ECG recording on ink-jet recorder showing disappearance of preexcitation during catheter ablation (arrow)

Registr RFA v ČR – první souhrn 1992 - 1994:

• IKEM Praha	99
• FN Olomouc	51
• Dětské KC, Praha-Motol	12
• Odd.dětské kard., Brno	8
	170 pacientů

Fig 3

Original slide from the first summary of the Czech Registry of Catheter ablation 1992-1994 (in Czech). A total of 170 procedures were performed in 4 centres.

20th anniversary of the Prague workshop on catheter ablation with live demonstrations: a short trip into history

This year, already 20 years have passed since organisation of the first edition of the symposium which we named the Prague Workshop on catheter ablation with live demonstrations. The first meeting took place in a congress centre of the Institute for Clinical and Experimental Medicine on April 6-7, 1998 (Fig 1 and 2). Live cases were transmitted from the electrophysiology laboratory of the Department of cardiology which was housed in the old building of the neighbouring Thomayer hospital. The transmission was organized by the Medicacenter company. The following pages intend to summarize 20 years of the history.

To understand the mission of the Prague Workshop, we have to return back to a year 1997. This year could be called a landmark in the development of cardiac electrophysiology in the Czech Republic, since few pioneer centres with some experience with catheter ablations had purchased novel digitized recording systems. In 1997, the numbers of catheter ablations in the Czech Republic almost doubled from 275 to 501. However, there was a need to open new centres and to train more electrophysiologists. We discussed with Jan Bytesnik, who did first adult radiofrequency catheter ablation in the Czech Republic in 1992, how to support education in this field and how to increase public awareness about catheter ablations.

I had some personal experience from my previous study stay in London, UK about seminars with live cases. The idea of this format is simple – first lecture about the topic followed by a life demonstration of the technique or strategy of ablation. Since it is well know that the best way of learning of any craft is practical demonstration, we decided with Jan Bytesnik to try such a format in our institution. In the same time, we wanted to raise awareness about catheter ablation in the Czech Republic. For this reason, the workshop was accompanied by a press conference on the topic. Finally, even though the primary intention was to educate Czech physicians, I invited friends from other countries to join. Therefore, the intention was from the beginning to promote also networking and international friendship and cooperation.

We invited for the first workshop my mentor from London, Edward Rowland (Fig 3) and Cordis company recommended Paolo Della Bella from Milan in Italy (Fig 4). The workshop was organised in an amateur way and supported by the foundation „Modern treatment of arrhythmias". There was no registration fee. The total number of audience

20th anniversary of the Prague workshop on catheter ablation with live demonstrations: a short trip into history

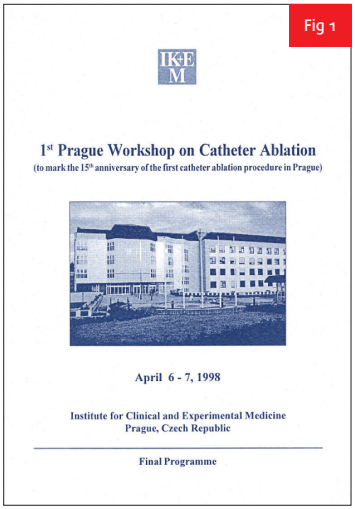


Fig 1

Facsimile of the programme of the first edition of the Workshop.

Fig 2

Chairmen of the first edition of the Workshop in 1998 (from left: K Filip, director of IKEM, V Staněk, head of cardiology department, J Bytešník, head of arrhythmia unit).

Fig 3

Operators of the first ablation case (J Kautzner, left, E Rowland, right).

Fig 4

Operators of the third clinical case (J Bytešník, left and P Della Bella, right).

reached 93 and 31 of them were from abroad (Fig 5 and 6). This unexpected number of participants formed from the beginning international character of the Workshop.

We had few lectures and 3 live cases. The very first case of a young woman with WPW syndrome illustrated how treacherous could accessory pathways be. Despite meticulous mapping of the right posterlolateral accessory pathway and many ablation attempts, we failed to ablate the pathway. The view was that this is due to epicardial location of the substrate. The patient underwent subsequently other two ablation attempts with temporary block of the pathway. Finaly, the pathway was successuflly ablated 12 years after the workshop from endocardial access. The case report of this first patient is published below. However, the second case of a woman with long-standing history of incessant atrial tachycardia was great enjoyment for everybody (at the end also for the patient). Edward performed transseptal puncture, mapped activation sequence and ablated with bravura the focus. The patient was implanted in other center unnecessarily with pacemaker for false diagnosis of AV block. Later, we explanted the device. The third case was excellent demonstration of catheter ablation of ventricular tachycardia after myocardial infarction (Fig 4). At that time obviously without any electroanatomical mapping system.A 58-year-old patient had successful ablation of clinical tachycardia but inducible other fast ventricular tachycardias. He was subsequently implanted with an ICD. The device was reimplanted for infection and exchanged for exhausted battery. The patient received only one shock in 2003 and few in 2006. He died 8 years later due to progression of heart failure. Altogether, the first workshop met our expectations above average and this supported our feeling that we are on the right track (Fig 5 and 6). Our feelings were expressed by our colleague Martin Fiala who wrote a report on workshop to Cor et Vasa (Czech cardiology journal – Cor Vasa 1998;4:K156): "Arrhythmology in our country deserve promotion of this kind. It is not anymore abstract and marginal appendage of cardiology of a seventieth and beginning of eighties. It is clear as a day that the results of non-pharmacological treatment of arrhythmias achieved in the last decade demonstrate what revolutionary changes and what position have been achieved. Together with colleagues who are addicted to catheter ablation we enjoy repeatedly with our patients exciting feeling at the moment of accessory pathway disappearance and/or tachycardia termination. We have also a feeling of moderate satisfaction watching the limits of drug treatment of arrhythmias. We feel like this also due to the fact that catheter ablation enabled us to better understand mechanisms of arrhythmias and move to higher level that is inaccessible to surface ECG interpretation. Moments when successful catheter ablation confirms mental analysis and synthesis and spatial imagination of complex electrical processes in the heart, changed forever clinical electrophysiology from infertile witch-doctor craft into one of the most efficacious and measurable therapeutic methods in medicine ever". Besides the workshop, we managed to organize a press conference and the topic of catheter ablation was introduced to the public.

Fig 5

The auditorium during the first Workshop.

Fig 6

The next co-director of the Workshop, Professor Petr Neužil (middle left) and the future president of the Czech Society of Cardiology, professor Miloš Táborský (middle right) as participants of the first Workshop.

Fig 7

Operators of the second edition of the Workshop (R Čihák, left and D Shah, right).

For the second edition of the workshop we managed to bring 5 guest operators and speakers who demonstrated different approaches to ablation of atrial or ventricular tachyarrhythmias (Fig 7, 8). The audience watched for the first time catheter ablation of focally triggered atrial fibrillation performed by Pierre Jais from Bordeaux (Fig 9). The attendance reached 113 participants (52 from abroad). The third edition witnessed the first case of electroanatomic mapping, performed by Anders Kirstein Pedersen from Denmark (Fig 10). We still organized the meeting enthusiastically, using members of our staff. The nurses worked at registration or as hostesses, physicians were transporting guests in their own cars. There was no registration fee and the sponsor of the workshop was foundation Modern treatment of arrhythmia. Obviously, the industry support was important from the beginning and the main contributors were companies as Cordis-Biosense Webster, Cardion (trade company for St Jude Medical) and Biotronik.

The organization of the Workhop became professional in 2001 when a company CCL took over and handled all logistics (Fig 11). Especially executive manager, Mrs Hana Hudecova, contributed to the seamless organization ofthe subsequent symposia (Fig 12). We continued to use TV company Medicacenter to handle live transmissions. Since the meeting grew larger and larger and we invited more and more faculty members, we had to impose a fee for participants to be able to cover all costs. Also the number of sponsors increased. All subsequent editions built gradually reputation of the workshop as the acknowledged international education meeting.

In 2001, William G Stevenson accepted an invitation for demonstration of mapping during sustained stable ventricular tachycardias in postinfarction aneurysm (Fig 13). We selected a patient with recurrent well-tolerated ventricular tachycardia that was believed to be nicely mappable to demonstrate entrainment mapping and other strategies. However, the case turned to be nightmare with spontaneous occurrence of 2 unmappable arhhythmias that necessitated many electrical cardioversions and rapid electroanatomical mapping with substrate modification. The case finished late in the evening and and dcoumented nicely that in patients with structural heart disease, any scenario is possible and ablation of such arrhythmias requires expertise. The patient had later another re-ablation and was without recurrences until 2014 when we performed combined endo-apicardial procedure. He is still alive without recurrences of arrhythmia.

The highlight of the year 2002 was the procedure of ablation of atrial fibrillation performed by Carlo Pappone and his team (Fig 14). Despite some controversies (e.g. whether to check for isolation of pulmonary veins or not), he provided a simplified concept of circumferential ablation around pulmonary veins. This demonstration proved crucial for wide acceptance of atrial fibrillation ablation in many centres, including ours.

In 2003 we demonstrated for the first time intracardiac echocardiography. Year 2004 was important since Andrea Natale and Nassir Marrouche showed their intracardiac echocardiography-guided ablation of atrial fibrillation using 8 mm tip

Fig 8

R Čihák together with P Della Bella watching live cases.

Fig 9

P Jais dressing for the procedure.

Fig 10

AK Pedersen (right) joking with J Kautzner (left) after successful ablation.

Fig 11

Facsimile of the flyer for the first workshop organized by CCL.

Fig 12

Mrs Hana Hudecova (left) with one of the guests D Callans (right)

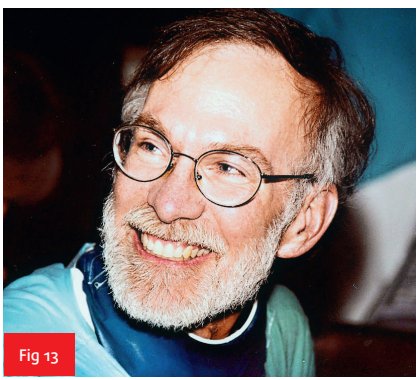


Fig 13

Bill Stevenson in the lab.

Fig 14

Carlo Pappone first time in IKEM.

Fig 15

A Natale (left) and N Marrouche (right) during ICE-guided procedure.

Fig 16

D Callans during his lecture on ablation of outlow tract arrhythmias.

Fig 17

Late Prof J Lukl, one of the pioneers of catheter ablation in Czech Republic, watching live case (in the middle)

catheter and monitoring of tissue overheating (Fig 15). This strategy influenced our practice significantly, mainly due to the use of intracardiac echocardiography. In 2005, David J Callans demonstrated excellent case of intracardiac echocardiography-guided mapping of aortic cusps and ablated idiopathic ventricular tachycardia from the left cusp (Fig 16). Later he admitted that this was his first case performed outside of his institution.

With improving infrastructure, we were able not only to show different strategies of ablation but also novel technologies. A new era of the workshop began in 2006 when we moved to a newly constructed building of the institute and opened 2 modern EP labs (Fig 17). This made possible to transmit cases from both labs in parallel. In addition, we were able to introduce also newly installed technologies. Another milestone was the year 2008 when we decided to organize a meeting together with other large-volume Prague centre, called Homolka Hospital (Fig 18). The head of cardiology, Professor Petr Neuzil is well known international expert and together with Vivek Reddy from New York contributed significantly to development of the meeting (Fig 19 and 20). Since then, we do have 4 state of the art EP labs available for parallel transmissions.

Over two decades of the history, altogether 106 faculty members attended the meeting and contributed with a lecture and/or with live cases (See name list below) (Fig 22-37). Many of them enjoyed their roles as one could judge from their entries in the guest book (Fig 38-44).The number of participants reached more than 200 and many of them attend the meeting regularly. Some participants attended almost all meetings. They came from different countries, mostly from the central, northern and Eastern Europe. However, we had participant even from Australia. Based on feedback we received after each edition of the workshop, most participants appreciated friendly and informal atmosphere and interesting live cases.

The workshop was organized continuously by the CCL company.In 2014, we reached maximum capacity of the Congress centre in IKEM (Fig 44). In 2015, we decided to move to a new congress centre of the neighbouring Academy of Sciences with a capacity of 300 seats (Fig 45). Last year, the auditorium was full for the first two days of the meeting. The organization of the workshop was managed by the Heart Rhythm patient organization.

We managed to show not only different strategies and techniques of ablation but also many novel technologies. This story is covered by Petr Peichl below.

Last but not least, the Workshop contributed significantly to networking of electrophysiology community, not only in Central and Eastern Europe but also on both sides of the Atlantic. Many friendships were developed during these meetings.

All the above activities contributed significantly to promotion of electrophysiology and education of many physicians. The history of Czech registry of catheter ablation is described in another chapter. One of the achievements of the Czech arrhythmology was co-organisa-

tion of the first official EHRA congress Europace 2005 in Prague. Our golden city welcomed around 3500 participants from different countries of the world. I was honoured to be President-Host of the congress and other colleagues were chairing some sessions and/or presented lectures. We organized 2 live cases on implantation of CRT from EP labs in IKEM and in Homolka hospital. In 2007, Prague hosted for the first time international meeting AF symposium organized by Biosense Webster.

This is in summary brief history of the Prague Workshop on Catheter Ablation. The fact that it attracts every year many participants and that the field of catheter ablation is developing rapidly in central and Eastern Europe suggest that all the effort behind was worth of it.

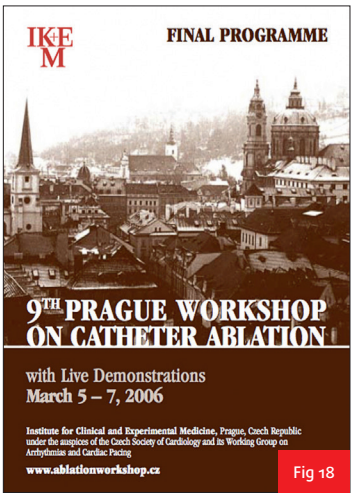


Fig 18

Fig 19

Fascimile of the program when Homolka Hospital joined the Workshop.

Fig 20

P Neužil (left) and V Reddy (right) chairing the session.

Fig 21

P Neužil providing refreshment to V Reddy during a long ablation case.

Fig 22

The legend of electrophysiology, Prof Wellens (right) with P Loh (left).

Fig 23

Team of colleagus at IKEM watching an interesting case.

Fig 24

D Callans (right) and P Peichl (left) are happy after successful ablation.

Fig 25

P Peichl (middle) in a discussion with S Stec (right).

Fig 26

Team of colleagues at Homolka hospital watching the live case from control room.

Fig 27

P. Peichl (left) and C Piorkowski (right) during ablation using MediGuide technology.

Fig 28

Faculty members at registration (from left - M Antz, H Nakagawa, R Cappato, A Skanes).

Fig 29

Discussion in the control room - P Peichl (left), D Wichterle (middle) and M Valderrabano (right).

Fig 30

Good mood in the control room at Homolka (P Neužil, J Petrů and V Reddy).

Fig 31

D Packer during his presentation.

Fig 32

F Marchlinski (right), chairing the session with J Bytešník (left).

Fig 33

S Ernst after ablation in a control room with P Neužil.

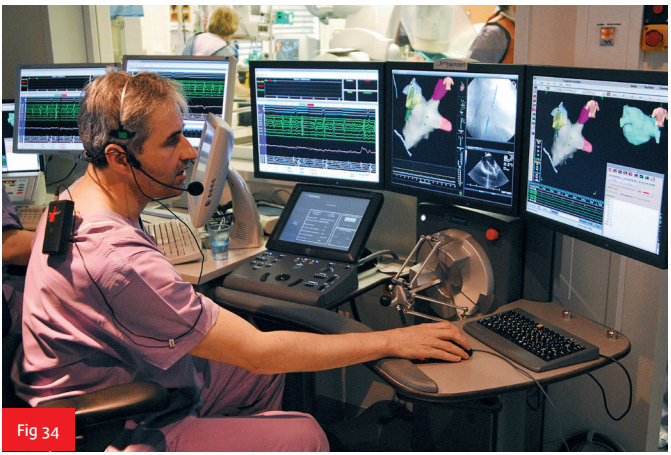


Fig 34

J Kautzner during ablation using robotic navigation.

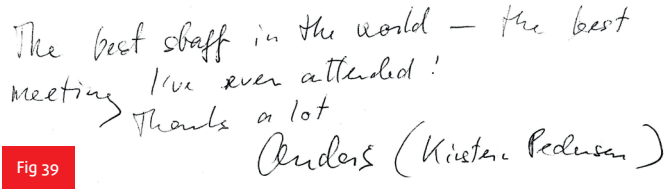
Fig 35

Distinguished faculty members watching live case (from left H Nakagawa, R Hatala, F Marchlinski).

Fig 36 Y Yao during his presentation.

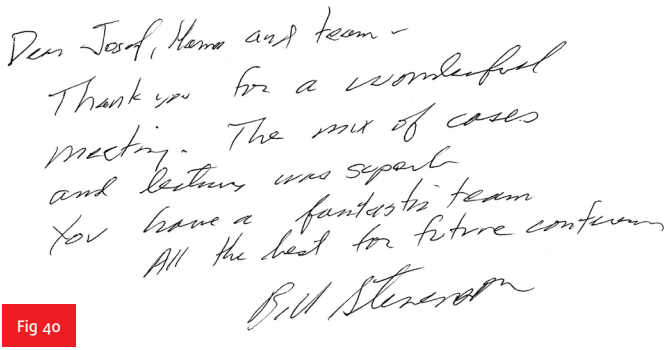
Fig 37 M Mangrum in the lab with J Skoda.

Fig 38 Greetings from S Ernst with her kiss.



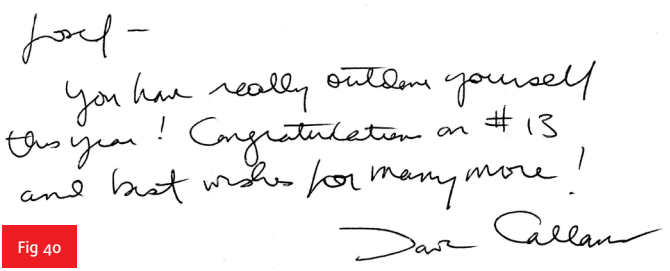
Anders Pedersen worked with us many times and we all enjoyed it.

Fig 39



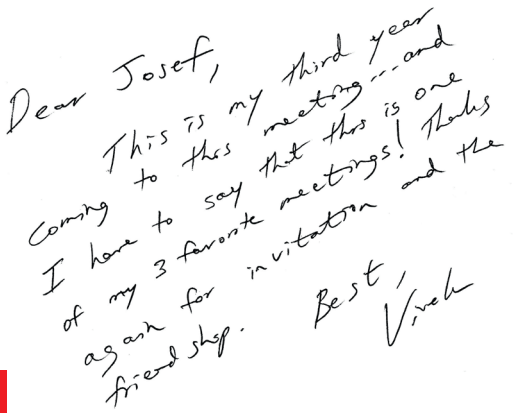
Nice words from Bill Stevenson.

Fig 40



Greeting from D Cllans.

Fig 40



Vivek Reddy's confession.

Fig 41

I am honored to have had the opportunity to perform a procedure with such a wonderful team with outstanding leadership and spirit. I will remember it fondly.

Frances Marchlinski

Fig 42 Frank Marchlinski enjoyed wotking with us.

Dear Josef,

Wonderful meeting!
Terrific discussion. Lovely city and people.

Sonny Jackman

Fig 43 Message from the living legend electrophysiology - Sonny Jackman.

Fig 44 Maximum capacity of IKEM congress centre has been reached.

Fig 45 Auditorium of the Academy of Science - new venue.

Patients of the Workshop

During the preceding 19 years, the total number patients who underwent catheter ablation at IKEM during ablation workshops reached 139 and 1 patient had implantation of the appendage closure device. The spectrum of ablation procedures according to arrhythmia substrates is listed in Table 1.

Table 1. Spectrum and number of ablation procedures at IKEM

Diagnosis	Number of procedures
Atrial fibrillation	53
Ventricular tachycardia (structural heart disease)	28
Idiopathic ventricular ectopy	16
Atrial flutter	16
WPW/AVRT	14
Atrial tachycardia	7
AVNRT	3
GP ablation for syncope	2
Appendage closure (Amplatzer)	1
Total number	**140**

It is important to mention that the vast majority of these procedures were acutely successful with few exemptions. Interestingly, most of them occured in the early years (from 1998-2006). One was the very first case of WPW which is discussed in detail in this brochure. The other case was another WPW patient with midseptal pathway that stopped to conduct after bumping with mapping catheter and the procedure had to be interrupted. Pathway conduction reappeared after 2 days and and continued to be intermittent and patient remained without major complaints. The third case was focal ectopy in the RVOT that was not ablated due to its probable epicardial location. The fourth case was a patient with left sided superior vena cava and 2 accessory pathways – one left sided and the other right sided. Live case had to be inter-

rupted for futility, nevertheless the next day both pathways were ablated with the help of electroanatomical mapping system. An unfortunate case was 71-year-old patient with postinfarction dysfunction and multivessel disease who was admitted acutely for very frequent runs on monomorphic ventricular tachycardia despite amiodarone therapy. The plan was perform ablation before coronary revascularisation procedure. Quickly after introduction of the sheaths in the groin and one transseptal puncture, the patient developed hypotension that could not be managed by application of atropine. There was no tamponade and no signs of air embolism. Despite prolonged cardiopulmonary resuscitation, electromechanical dissociation developed and the patient died. Another patient presented with atrial tachycardia after correction of Tetralogy of Fallot. Noncontact mapping was not able to assess the mechanism and the case was terminated. The second day, electroanatomical mapping-guided procedure revealed typical atrial flutter which was ablated successfully. SInce 2007, all cases were temporarily successful.

We were able to demonstrate either novel technologies or different strategies of catheter ablation, mainly for atrial fibrillation and/or ventricular tachycardias or ectopy. We employed all different mapping and navigation systems, including MediGuide (St Jude Medical). One of our highlights was electromechanical robotic technology (Hansen Medical) that we used with a great success for almost 10 years for ablation of both atrial fibrillation and ventricular tachycardias.

Complications that occurred during workshop were few. The most severe was the above case of patient with postinfacrtion VT who died of electromechanical dissociation before any mapping or ablation could be performed. There was one case of transient AV block after ablation of the slow pathway for AVNRT. Finally, we had one case of hemopericardium after catheter ablation of atrial fibrillation which was drained and evacuated preventively.

To assess prognosis of all patients after ablation, we received information from the Czech Institute for Health Information and Statistics. Altogether, 10 patients died during the follow up. In 8 cases, the underlying substrate was ischemic cardiomyopathy and patients underwent ablation for recurrent ventricular tachycardia and in one case for focally triggered ventricular fibrillation. Two other patients died longer period after ablation of atrial flutter. The mean time period from ablation to death was 35 months (from 1 to 122 months).

Since 2008, we started to organize live cases also from other large cardiovascular centre in Prague – from Homolka hospital. Over almost one decade, Professor Neuzil and his team together with Vivek Y Reddy have demonstrated a great number of novel technologies and approaches. They showed cases performed with magnetic navigation, different balloon technologies, ventricular tachycardia ablation on mechanical support, exclusion of left appendage using either occluder or external ligation (Lariat system), renal denervation, implantation of leadless pacemakers, etc. The spectrum of di-

agnoses and number of procedures is listed in Table 2. Again, the vast majority of cases were finished with a great success and minimum complications. The cases from previous edition of the workshop will be demonstrated in detail at the beginning of the workshop this year.

Table 2. Spectrum and number of ablation procedures at Homolka

Diagnosis	Number of procedures
Atrial fibrillation	15
Ventricular tachycardia (structural heart disease)	8
Idiopathic ventricular ectopy	1
Atrial flutter	1
WPW/AVRT	3
Atrial tachycardia	6
AVNRT	1
Appendage closure	3
Renal denervation	3
Leadless pacemaker	3
Implantation of LV transducer (CRT)	1
Total number	**45**

Looking at the numbers, we can summarize that during 19 years history of the Workshop, altogether 185 procedures have been performed. The number and spectrum of these procedures make this symposium unique worldwide. This simple analysis also documents that catheter ablation is very successful strategy of management of cardiac arrhythmias. It also shows that with the advent of novel technologies and with growing experience, success improved and complications decreased. These are also arguments to support the mission of demonstrating live cases during the workshop. We all agree that practical demonstration of strategy or technology is the best way to share the knowledge and educate each other.

A case report of the first patient treated during the Prague workshop (1998)

The first case for live demonstration was a young sporty woman (24-years-old in 1998) with a history of frequent palpitations with of sudden onset and termination and documented AV reentry tachycardia. She had preexcitation on her resting 12 lead ECG (Fig 1) and underwent one unsuccessful ablation procedure in 1997. Mapping during AVRT and during sinus rhythm confirmed presumed location of the accessory pathway in the right posterolateral region. Using all tips and tricks, Edward Rowland was not able to interrupt the conduction via pathway. We all concluded that the pathway is located predominantly epicardially.

In 1999, we tried to ablate the pathway from above. Using subclavian access and mapping and ablating during AVRT, we were able to block pathway only for few seconds and catheter was dislocated during termination of arrhythmia. The patient was on antiarrhythmic medication and decided to undergo another ablation with the use of electroanatomical mapping system in 2005 for worsening symptoms. Using CARTO XP system, we mapped both atrial and ventricular insertion of the pathway during pacing from ventricle and/or from atrium. With a support of non-steerable sheath and intracardiac echocardiography, we were

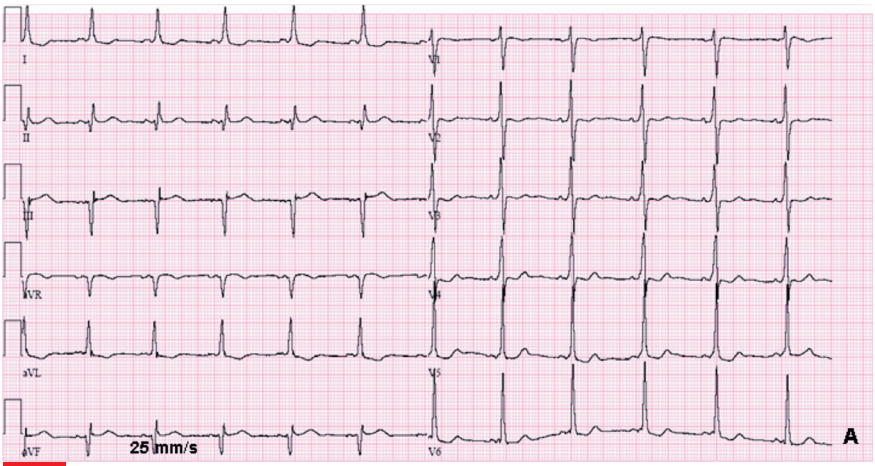


Fig 1 Standard ECG documenting preexcitation due right PL pathway.

able to block the pathway in the right ventricle below the lateral leaflet of the tricuspid valve (Fig 2 A, B, Fig 3). However, reconduction was observed overnight and the patient continued to have paroxysms of palpitations, even more frequently.

In 2010, the patient finally agreed to undergo epicardial mapping. We performed subxiphoideal puncture and introduced mapping catheter around tricuspid annulus. Mapping during AVRT showed late local activation (Fig 4 A, B). Therefore, we moved back to endocardial mapping. With the use of the Agilis steerable sheath and intracardiac echocardiography we were able to localize a small area neighbouring the annulus where the earliest atrial activation could be measured (Fig 5 A, B). Within a second, the arrhythmia and

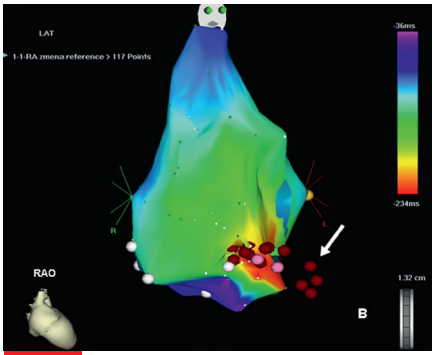


Fig 2 A

A. Electroanatomic map of the right atrium with early atrial activation in low lateral region. Red dots show ablation points both on atrial and ventricular insertion,

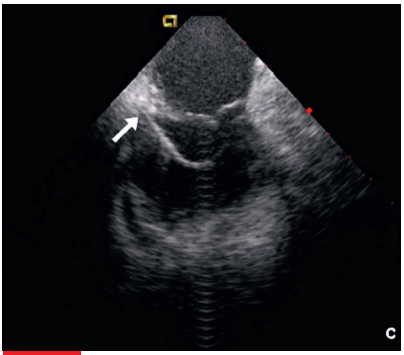


Fig 2 B

B. Intracardiac echokardiogram depicting ablation catheter below the lateral leaflet of the tricuspid valve.

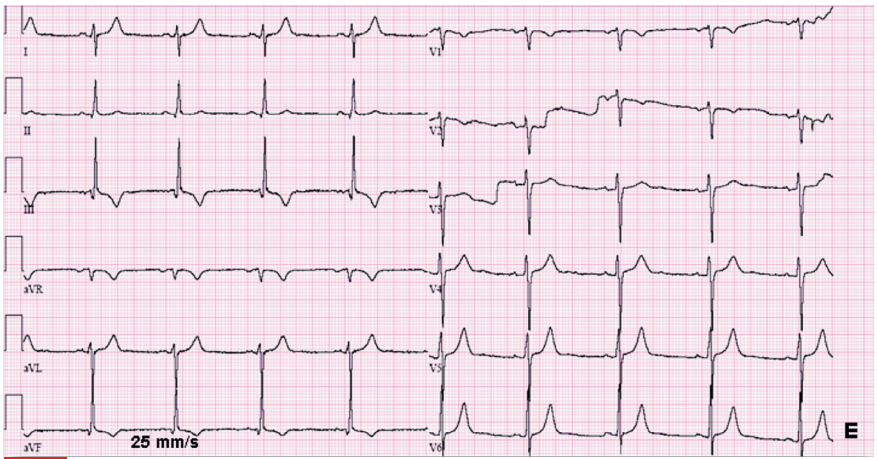


Fig 3 Standard ECG showing the absence of preexcitation after ablation.

accessory pathway conduction were interrupted. The patient has been without recurrence of arrhythmias since 2010. This case illustrates how important could be to display the site of ablation in order to understand anatomy and contact of the catheter, and also how important is to use steerable sheath for some indications.

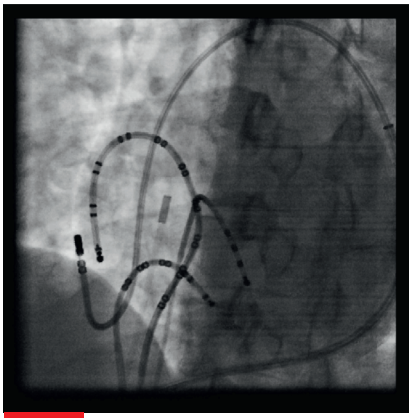


Fig 4 A

A. X ray in LAO that illustrates placement of the catheters, including ablation catheter in epicardial space close to tricuspid annulus.

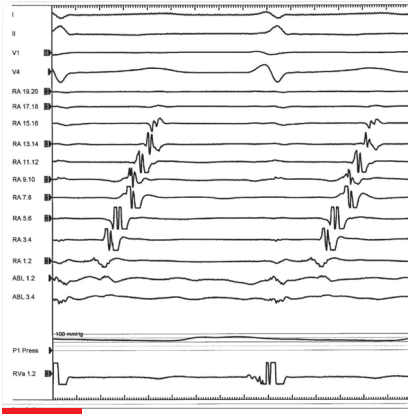


Fig 4 B

B. Intracardiac electrograms from the right atrial duodecapolar catheter RA 1,2-RA 18,20, ablation catheter located at the annulus epicardially and right ventricular catheter during AV reentry tachycardia. Note significant delay between V and A signal.

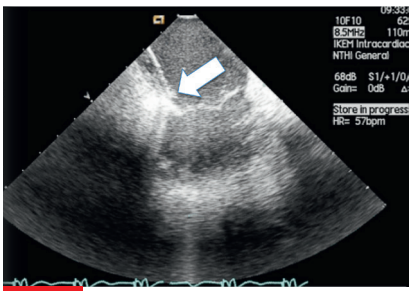


Fig 5 A

A. Intracardiac echocardiogram showing location of the tip of ablation catheter at a small area next to the valve and its good contact with the tissue
B. Intracardiac electrograms from the right atrial duodecapolar catheter RA 1,2-RA 18,20, ablation catheter located at the annulus endocardially and right ventricular catheter during AV reentry tachycardia. Note early atrial activation in a small area at the tricuspid annulus.

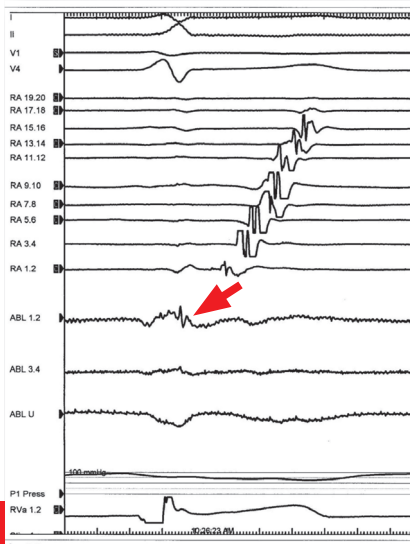


Fig 5 B

Faculty Members

During last 19 years of the history of the Prague Workshop on Catheter Ablations, an incredible amount of experts accepted our invitation and became faculty members. Altogether, 106 individuals helped us to create scientific programme of the Workshop. Many of them repeatedly. Vivek Y Reddy has participated since 2007 in almost every meeting, other „frequent-flyers" are Gerhard Hindricks (6x), Hans Kottkamp (6x), Hiroshi Nakagawa (5x), Thorsten Lewalter (5x) and Anders Kirstein Pedersen (5x). We would like to thank all these faculty members for their valuable contribution that built the reputation of the Prague Workshop.

List of Faculty members

1998
Edward Rowland, London, UK
Paolo Della Bella, Milan, Italy

1999
Pierre Jais, Pessac-Bordeaux, France
Francesco Cosio, Madrid, Spain
Gerhardt Hindricks, Leipzig, Germany
Hans Kottkamp, Leipzig, Germany
Dipen Shah, Pessac-Bordeaux, France

2000
Edward Rowland, London, UK
Ali Massumi, Houston, USA ✚
Anders Kirstein Pedersen, Aarhus, Denmark
Dipen Shah, Pessac-Bordeaux, France

2001
Peter Sten Hansen, Aarhus, Denmark
Pierre Jais, Pessac-Bordeaux, France
Anders Kirstein Pedersen, Aarhus, Denmark
William G Stevenson, Boston, USA
Cynthia Tracy, Washington DC, USA

2002
Richard Hauer, Utrecht, The Netherlands
Gerhardt Hindricks, Leipzig, Germany
Hans Kottkamp, Leipzig, Germany
Carlo Pappone, Milan, Italy
Dipen Shah, Pessac-Bordeaux, France

2003
Paolo Della Bella, Milan, Italy
Richard Hauer, Utrecht, The Netherlands
Gerhardt Hindricks, Leipzig, Germany
Hans Kottkamp, Leipzig, Germany
Peter Loh, Utrecht, The Netherlands

2004
Johannes Brachmann, Coburg, Germany
Alessandro Capucci, Piacenza, Italy
Yen Ho, London, UK
Meleze Hocini, Pessac-Bordeaux, France
Gregory Lip, Birmingham, UK
Laurent Macle, Montreal, Canada
Nassir Marrouche, Cleveland, USA
Andrea Natale, Cleveland, USA
Antonio Raviele, Mestre, Italy
Amiran Revishvili, Moscow, Russian Federation
Jurgen Vogt, Bad Oeynhausen, Germany

2005
Paolo Della Bella, Milan, Italy
David J Callans, Philadelphia, USA
Eduard R Holmann, Leiden, The Netherlands
Thorsten Lewalter, Paderborn, Germany
Thomas Paul, Göttingen, Germany
Anders Kirstein Pedersen, Aarhus, Denmark
Stephan Willems, Hamburg, Germany

2006
Michael M Alshibaya, Moscow, Russian Federation
Jacques MT de Bakker, Utrecht, The Netherlands
Martin Borggrefe, Mannheim, Germany
Andrea Natale, Cleveand, USA
Mauricio Scanavacca, Sao Paulo, Brasil
Richard J Schilling, London, UK
Hein JJ Wellens, Maastricht, The Netherlands
David J Wilber, Maywood, USA

2007

Alessandro Capucci, Piacenza, Italy
Gerhardt Hindricks, Leipzig, Germany
Thorsten Lewalter, Paderborn, Germany
Gregory Y Lip, Birmingham, UK
Andrea Natale, Cleveland, USA
Anders Kirstein Pedersen, Varde, Denmark
Eugeny A Pokushalov, Novosibirsk, Russian Federation
Vivek Y Reddy, Boston, USA
Walid Saliba, Cleveland, USA

2008

David J Callans, Philadelphia, USA
Sabine Ernst, London, UK
Yen Ho, London, UK
Peter Loh, Utrecht, The Netherlands
Vivek Y Reddy, Boston, USA
Amiran S Revishvili, Moscow, Russian Federation
Edward Rowland, London, UK
Christoph Scharf, Zurich, Switzerland
Claus Schmitt, Karlsruhe, Germany
Hein JJ Wellens, Maastricht, The Netherlands

2009

Mathias Antz, Oldenburg, Germany
Aldo Bonso, Mestre, Italy
Riccardo Cappato, Milan, Italy
Maxim Didenko, St Petersburg, Russian Federation
Thorsten Lewalter, Paderborn, Germany
Rob Mac Leod, Salt Lake City, USA
Hiroshi Nakagawa, Oklahoma City, USA
Christopher Piorkowski, Leipzig, Germany
Vivek Y Reddy, Miami, USA
Burghard Schumacher, Bad Neustadt, Germany
Anil-Martin Sinha, Coburg, Germany
Alan Skanes, London, Ontario, Canada
Kyoko Soejima, Miami, USA
Sakis Themistoclakis, Mestre, Italy
Katja Zeppenfeld, Leiden, The Netherlands

2010

Martin Borggrefe, Mannheim, Germany
David J Callans, Philadelphia, USA
Martin Fiala, Třinec, Czech Republic
Gerhardt Hindricks, Leipzig, Germany
Hans Kottkamp, Zurich, Switzerland
Hiroshi Nakagawa, Oklahoma City, USA
Eugeny A Pokushalov, Novosibirsk, Russian Federation
Tom de Potter, Aalst, Belgium
Vivek Y Reddy, New York, USA
Christoph Scharf, Zurich, Switzerland
William G Stevenson, Boston, USA
Bernard Zrenner, Landshut, Germany

2011

Annalisa Angelini, Padua, Italy
Roberto de Ponti, Varese, Italy
Warren Jackman, Oklahoma City, USA
Dominique Lacroix, Lille, France
Thorsten Lewalter, Munich, Germany
Carlo Pappone, Cotignola, Italy
Sanjay Prasad, London, UK
Christopher Piorkowski, Leipzig, Germany
Helmut Pürerfellner, Linz, Austria
Vivek Y Reddy, New York, USA
Amiran S Revishvili, Russian Federation
Boris Schmidt, Frankfurt, Germany
Gabriele Vicedomini, Cotignola, Italy

2012

MAttias Duytschaever, Bruges, Belgium
Natasja MS de Groot, Rotterdam, The Netherlands
Robert Hatala, Bratislava, Slovakia
Mark La Meir, Brussels, Belgium
Francis E Marchlinski, Philadelphia, USA
Hiroshi Nakagawa, Oklahoma City, USA
Douglas L Packer, Rochester, USA

Anders Kirstein Pedersen, Copenhagen, Denmark
Christopher Piorkowski, Dresden, Germany
Helmut Pürerfellner, Linz, Austria
Vivek Y Reddy, New York, USA
Boris Schmidt, Frankfurt, Germany
Rene Tavernier, Bruges, Belgium
Yan Yao, Beijing, The Peoples Republic of China

2013

Stavros Apostolakis, Birmingham, UK
Krzysztof Bartus, Krakow, Poland
Wolfgang Bauer, Wurzburg, Germany
Jose Angel Cabrera, Madrid, Spain
Alessandro Capucci, Ancona, Italy
Mattias Duytschaever, Bruges, Belgium
Christian de Chillou, Nancy, France
J Michael Mangrum, Charlottesville, USA
Hiroshi Nakagawa, Oklahoma City, USA
Akihiko Nogami, Yokohama, Japan
Christopher Piorkowski, Dresden, GErmany
Vivek Y Reddy, New York, USA
Damian Sanchez-Quintana, Badajoz, Spain
Roland Tilz, Hamburg, Germany
Miguel Valderrabano, Houston, USA
Katja Zeppenfeld, Leiden, The Netherlands

2014

Dietmar Bänsch, Rostock, Germany
Leif-Hendrik Boldt, Berlin, Germany
David J Callans, Philadelphia, USA
Carsten Israel, Bielefeld, Germany
Thorsten Lewalter, Munich, Germany
Han Sung Lim, Pessac-Bordeaux, France
J Michael Mangrum, Charlottesville, USA
Hiroshi Nakagawa, Oklahoma City, USA
Mark O Neil, London, UK
Tom de Potter, Aalst, Belgium
Vivek Y Reddy, New York, USA
Sebastian Stec, Warsaw, Poland
Miguel Valderrabano, Houston, USA

2015

Simona Ben-Heim, London, UK
Antonio Berruezo, Barcelona, Spain
Christian de Chillou, Nancy, France
Paolo Della Bella, Milan, Italy
Joris Ector, Leuven, Belgium
Sabine Ernst, London, UK
Fermin Garcia, Philadelphia, USA
Gerhardt Hindricks, Leipzig, GErmany
Warren Jackman, Oklahoma City, USA
Hans Kottkamp. Zurich, Switzerland
Jose Merino. Madrid, Spain
Jose C Pachon Mateos, Sao Paulo, Brasil
Reza Wakili, Munich, Germany

2016

Elad Anter, Boston, USA
Arash Arya, Leipzig, Germany
Isabel Deisenhofer, Munich, Germany
Mattias Duytschaever, Bruges, Belgium
Mariana Gardasdottir, REykjavik, Island
Jose Guerra, Barcelona, Spain
Gregory F Michaud, Boston, USA
Kars Neven, Essen, Germany
Boris Schmidt, Frankfurt, Germany
Vivek Y Reddy, New York, USA
Yan Yao, Beijing, The Peoples Republic of China

We are very sad to announce that one of our Faculty members from the early years of the Workshop history, Dr Ali Massumi, died due to chronic diseaase on 13 March 2015. May he rest in peace.

Participants of the Workshop

Since 1998, we have enjoyed participation of a vast number of colleagues from different countries. The table shows participation list between 2001-2016. Statistics shows that average number of participants until 2015 reaches 200 and approximately 2/3 are from abroad. Last few years, the audicence exceeded number 200 and therefore we moved the venue.

Historically, Poland is the country number one in terms of number of participants (Average 50). Other countries with higher number of attendees are listed in the table. Altogether, we have welcomed colleagues from 47 countries.

PRAGUE WORKSHOP ON CATHETER ABLATION – PARTICIPATION STATISTICS

YEAR	TOTAL	CZECH REPUBLIC	OTHER COUNTRIES	Finland	Israel	Italy	Lithuania	Latvia	Hungary	Germany	Poland	Austria	Russia	Slovakia	Slovenia	USA
2001	188	63	125	5	1	3	4	4	19	2	46	4	1	8	2	3
2002	226	72	154	12	0	6	8	3	11	11	43	9	7	9	1	4
2003	188	67	121	7	0	1	10	2	11	9	40	4	10	7	2	1
2004	193	56	138	8	0	4	7	0	15	7	40	10	18	6	1	6
2005	202	67	135	9	0	3	4	1	19	16	41	7	0	3	7	1
2006	144	51	93	4	0	0	4	5	20	7	31	0	3	2	0	4
2007	165	58	107	5	0	4	2	2	15	11	41	0	3	3	5	6
2008	191	51	140	7	0	2	6	4	18	9	49	2	2	3	7	6
2009	180	65	115	3	0	3	4	4	11	10	46	3	2	3	8	5
2010	181	76	105	4	0	0	3	3	3	19	37	1	3	5	3	5
2011	205	86	119	2	0	5	6	3	5	12	53	2	2	5	6	5
2012	197	63	134	4	0	2	6	1	2	3	59	2	2	15	6	4
2013	224	59	165	2	0	12	6	2	7	10	69	1	2	5	7	9
2014	232	48	184	2	11	0	7	2	8	7	75	2	8	9	6	10
2015	255	58	197	1	18	0	7	2	6	9	69	2	7	10	8	19
2016	230	53	177	1	14	18	6	3	14	8	54	5	10	12	9	17
average attendance	200	62	138	5	3	4	6	3	12	9	50	3	5	7	5	7

History of electroanatomical mapping and imaging in IKEM

Catheter ablation as a technique for selective treatment of arrhythmias has been introduced in the late eighties. Within few years, it has become a curative method of choice for majority cardiac rhythm disorders.

Progress in the field of catheter ablation over the past decade has lead to a paradigm shift in interventional electrophysiology. While in conventional ablation procedures such as ablation of accessory pathways or AV nodal reentry the definition of the target site was determined primarily by electrograms, and fluoroscopy was sufficient for navigation of ablation catheters, the situation is different in catheter ablation of complex arrhythmias (e.g. atrial fibrillation, arrhythmias after previous correction for congenital heart disease, ventricular tachycardias in structural heart disease, etc). Such cases require new definition of ablation targets. These are not anymore defined by electrophysiological recordings only (like zone of slow conduction or earliest activation), but by a complex interplay between electrograms and anatomical structures. In order to provide precise description and visualization of both anatomical and electrophysiologic data, three-dimensional electro-anatomical mapping systems that can map the geometry and physiology of the cardiac chambers were developed in the mid-1990s, enabling the user to localize catheters and identify ablation targets. Additional on-line visual information could be obtained from intracardiac echocardiography.

The first ablation procedure guided by three-dimensional mapping system (CARTO, Biosense Webster) was performed in IKEM in early 2000. Subsequently, in March 2000, the full potential of the CARTO system was demonstrated by A.K. Pedersen from Aarhus in a case of inicisional atrial tachycardia in a patient after surgical correction of congenital heart disease (Fig 1). At that time, the system ran on Silicon graphics workstation, but had already all basic features that are available in 3D mapping systems today – i.e. visualization and re-navigation of ablation catheter in a space, tagging of points of interest and creation of activation and/or voltage maps. These new features created a lot of enthusiasm and opened new era of ablation in patients with complex arrhythmias, e.g. ventricular tachycardias in structural heart disease, atrial fibrillation and incisional arrhythmias. We started to use CARTO for identification of a substrate of ventricular tachycardias in structural heart disease already in 2000 (at that time, the seminal paper by Marchlinski et al on substrate mapping and modification was published). In this pioneering era, we gained substantial a substantial experience with mapping of various substrates for ventricular tachycardias (Fig 2). Apart from ablation, the

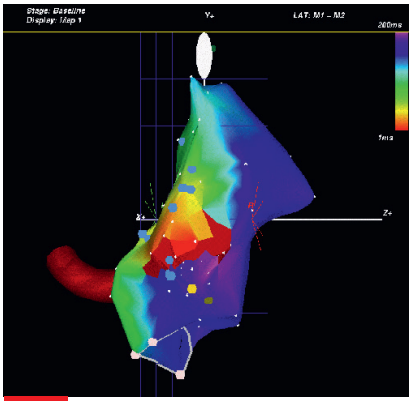


Fig 1

The first electroanatomical activation map of the right atrium in a patient with postincisional tachycardia after previous correction of atrial septal defect. It shows reentry circuit with an isthmus in lower part of the atrium (qbove 2 blue dots).

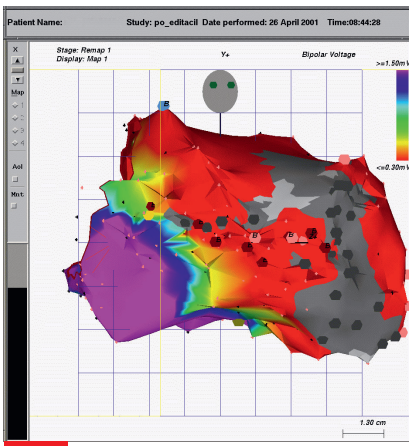


Fig 2

Electroanatomical voltage map of the left ventricle of a patient with recurrent ventricular tachycardias after myocardial infarction (right anterior oblique view). Reg colour indicates low voltage area, grey color non-capture regions.

CARTO system was used at that period in IKEM as a research tool for mapping of ventricular activation patterns during ventricular conduction disturbances and different pacing modes and those data provided novel inside into benefit underlying resynchronization therapy.

Selective ablation of atrial fibrillation was first performed in IKEM in 1999. In that particular case, atrial fibrillation was triggered from frequent triggering ectopy located and ablated within pulmonary vein using a conventional activation sequence mapping. Such approach was consequently abandoned for the risk of pulmonary vein stenosis and the first pulmonary vein isolation was performed in late 2000. The initial cases aimed for segmental pulmonary vein isolation guided by fluoroscopy and lasso catheter as introduced by Michel Haissaguerre. This approach was later substituted by circumferential pulmonary ablation guided by 3D mapping as proposed by Carlo Pappone. Both approaches were demonstrated during live cases at Prague's ablation workshop in 2002. Interestingly, Carlo's approach raised significant interest and many attendees changed their practice and started to use CARTO-based approach. Most of us merged both approaches together and used three-dimensional mapping together with circular catheter to check for pulmonary venous isolation. Since then, wide circumferential ablation and isolation of pulmonary vein has become the corner stone of interventional treatment of atrial fibrillation.

From the beginning, our group emphasized the role of imaging of individual

pulmonary vein anatomy. Initially, the anatomical three-dimensional reconstruction of pulmonary veins was obtained by magnetic resonance imaging using a purpose-built software (based on subtraction of individual phase of contrast enhancement) (Fig 3 A, B). At that time, we used these images side-by-side with three-dimensional electroanatomical map. Later, the image integration became integral part of the mapping system. Of interest, the CARTO Merge module was used for the first time world-wideduring Prague's ablation workshop in 2005 by P. Della Bella. These options allowed us to learn even more about the anatomy of the left atrium and the pulmonary veins. However, it was still virtual reality. We were keen to have some opportunity to display all important structures on-line.

Intracardiac echocardiography (ICE) was first introduced in IKEM in 2003 also during the ablation workshop (Fig 4). Initially, ICE by EP Med Systems was used, but subsequently, it was replacedby Acuson by Siemens Medical Solutions (Fig 5). In the beginning, ICE was used mainly only to guide transseptal puncture. However, with more experiences gained, its importance slowly mounted. Besides visualization of individual anatomy, ICE enables real time imaging of catheter-tissue contact and stability, early detection of tissue overheating during radiofrequency energy delivery and complications in general. We developed a strategy to guide entire procedure using ICE. The integration of ICE into CARTO system in the CARTO Sound module was demonstrated during workshop in 2009 by S. Themistoclakis. However, we still prefer to

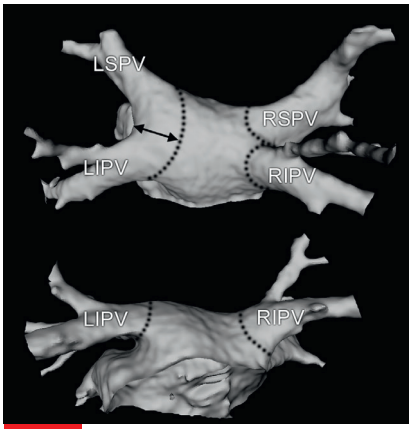


Fig 3 A

A. 3D reconstruction of the left atrium and pulmonary veins obtained by purpose-built signal subtraction software using gadolinium in a patient planned for ablation of atrial fibrillation.
B. Virtual endoscopic view looking into ostia of the left veins and appendage.

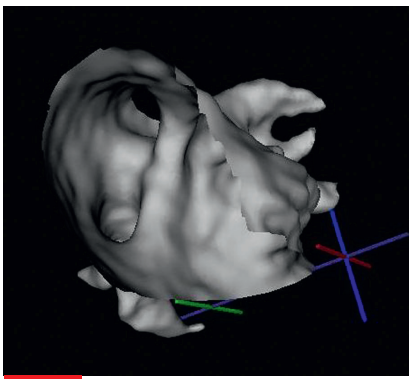
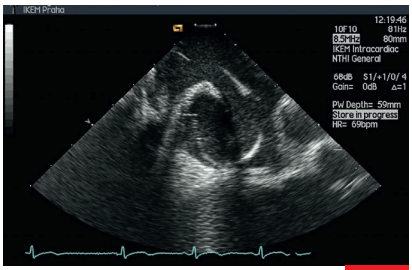


Fig 3 B

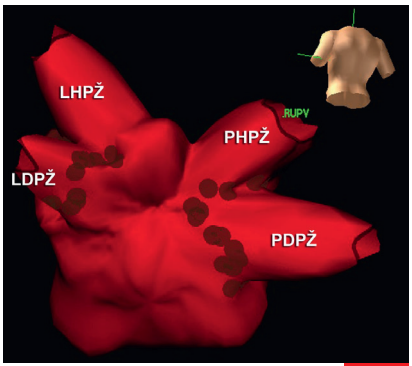
The first use of intracardiac echocardiography in Central Europe in 2003 (J Kautzner)

Fig 4



Intracardiac echocardiogram depicting the cavotricuspid isthmus with ablation catheter.

Fig 5



Electroanatomical map of the left atrium and pulmonary veins obtained by NAVx system (PA view). Brown points show ablation lesions.

Fig 6

use simpler AcuNav catheter to assess anatomy, the level of tissue heating and detect possible complications. Currently, ICE is used in IKEM for the majority of complex ablation cases.

Parallel with CARTO platform, which relays on magnetic sensor within the catheter tip, other mapping systems have been introduced. Many are primarily based on impedance mapping. The predecestor was LocaLisa (Medtronic) – a simple location system without mapping capabilities. It was demonstrated during the workshop by P. Loh in 2003 in a case of atrial flutter. Impedance mapping was then further developed and used in Ensite NAVx system (St. Jude Medical). The first case of ablation of the pulmonary veins guided by NAVx was performed during ablation workshop in 2004 by L. Macle (Fig 6). Apart from other features, the NAVx system enabled full integration with robotic navigation system (Hansen Medical), which was first used in IKEM in 2006. Robotic system together with NAVx and a software called Co-Hesion allowed remote and intuitive navigation of the ablation catheter within the heart. We demonstrated the advantages of the system several times during the workshop. Yet, the system was not further developed to enable fully robotic ablation and its use declined during last few years, As the precision of impedance-based visualization in Ensite NAVx system has inherited limitations, St Jude company introduced in 2012 novel Mediguide system that used magnetic sensor enabled tip for NAVX system and later become integral part of NAVX system in the form of EnSite Precision platform. Pulmonary vein iso-

lation guided by the Mediguide system was demonstrated by C. Piorkowski during ablation workshop in 2012.

The potential of remote navigation systems to ablate complex arrhythmias together with electroanatomical mapping system was demonstrated by Carlo Pappone during the Workshop in 2011. He performed true long-distance ablation of atrial tachycardia using magnetic navigation (system Niobe, Stereotaxis). The patient was at Homolka hospital at the other side of the river Vltava and Carlo was handling catheter sitting behind the table at IKEM.

The concept of multipolar mapping was initially introduced by EnSite Array (St Jude Medical) in the form of the so-called non-contact mapping. This system was showed during the Workshop by T Paul in 2005 for mapping of complex substrate of atrial tachycardia after correction of tetralogy of Fallot. The case demonstrated one of the weaknesses of the non-contact mapping – inability to analyse properly activation sequence in a large chamber of interest. The system was few year later used by Y Yao who successfully determined origin of the ventricular ectopic beats in the pulmonary artery. The idea of multipolar mapping was further expanded in the Rhythmia mapping system (initially Rhythmia company, later acquired by Boston Scientific). The Rhythmia system uses a small basket microelectrode catheter that enables rapid acquisition of ultra-high density activation maps with fully automated annotation of local electrograms. From 2010, a team at IKEM was involved in development of the system and its first clinical testing. Nowadays, the Rhythmia system is used in IKEM in an attempt for more precise characterization of arrhythmogenic substrate in patients with ventricular tachycardias and structural heart disease.

More recently, the so-called panoramic mapping has been introduced by CardioInsight company that was acquired by Medtronic. The system merges detailed body surface mapping with a special vest with CT imaging of the heart. A special software attempts to identify local sources and/or rotors that are important for the maintenance of atrial fibrillation. Recently, we have tested the system in a series of cases. Its clinical demonstration will be presented by Michel Haissaguerre during this year edition of the workshop. The other approach to map during atrial fibrillation has been developed by S Narayan using basket catheter in both atria and a special software that should be able to differentiate rotor activity (FIRM mapping). The system has been commercialized by the Abbott company. We could watch demonstration of this technology during 2016 edition of the Workshop during live case from Leipzig. In next weeks we are about to perform a series of cases to learn more about this technique.

This short summary documents rapid development of technology of 3D mapping and imaging in electrophysiology. The Prague Workshop on Catheter Ablation introduced many of these technologies to electrophysiology public and contributed to their adoption in everyday life.

Catheter ablation Registry in the Czech Republic

Introduction of radiofrequency energy in the late eighties replaced DC current shock ablations and resulted in safer and more efficacious procedures. The first radiofrequency ablation in an adult patient was performed in May 1992 in IKEM in a cooperation with Pediatric Heart Centre in Motol. The guest operator was Cynthia Tracy from USA, together with doctors Jan Bytešník and Jan Janoušek from Prague. Intracardiac signals were recorded on paper by inkjet Mingograf Siemens Elema.

Catheter ablation registry

At the beginning, catheter ablations of arrhythmias were performed only in two centers for adult patients (IKEM in Prague and University Hospital in Olomouc) and in two pediatric hospitals (Heart Centres in Prague-Motol and in Brno). Till the end of the year 1994, only 170 radiofrequency catheter ablations were performed in these centers altogether (20 ablations were performed in children). The first symposium of the newly founded Working group on arrhythmias and pacing (WG ACP) of the Czech Society of Cardiology was organized the same year in Olomouc. This symposium witnessed the foundation of the National registry of catheter ablations of arrhythmias. Initially, it was based on paper reports from individual centres. The existence of the registry allowed annual presentation of the results during meetings of the working group since 1995. In 2003, based on mutual agreement with Slovak colleagues, the first Czech and Slovak joint symposium was organized. Since then, we present annually data from both countries during the meeting. We also invited representatives from other surrounding countries to present their registries. In the year 2011, the Czech registry was transformed into the on-line, web-based registry. This is administered by the Institute of Biomedical Analysis in Brno. Financial support comes from the WG ACP.

During two decades of organisation of the Prague ablation workshops (1998-2015), the number of ablations in Czech Reublic increased almost nine times (Fig 1). The spectrum of procedures has changed significantly. While AV nodal reentry, AV reentry and atrial flutter were the most frequent arrhythmias between 1997-2005 (Fig 2), today the most frequent ablation procedure is for atrial fibrillation (Fig 3). Also the number of ablations for ventricular tachycardias is increasing as well as AV nodal ablations (mainly in patients with cardiac resynchronization therapy).

Czech Republic in 2015

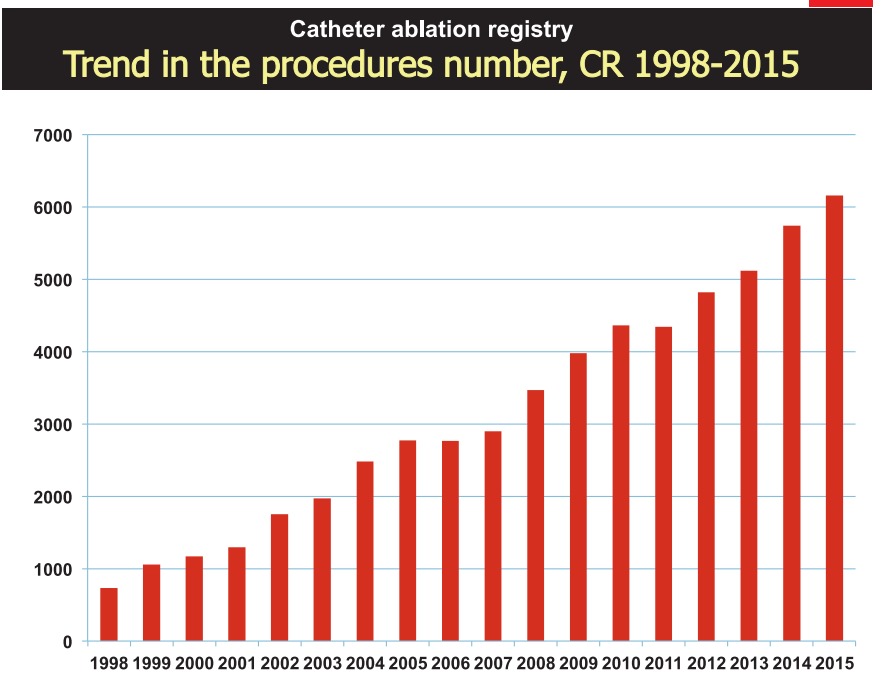
In the year 2015, there were 23 electrophysiology centres performing catheter ablations in the Czech Republic (approx. 10 million population). These centres are regionally distributed with some exceptions (Fig 4). A total of 6158 ablation procedures were entered in the registry. The

two largest electrophysiology centres, IKEM and Homolka Hospital, performed approximately one third of all ablations (Fig 5). Atrial fibrillation is far most frequent arrhythmia that is ablated (Fig 6). Ventricular arrhythmias (tachycardia and ventricular premature beats) form 10% of indications. Except of radiofrequency energy, cryoenergy and laser are used in a small proportion of procedures. Baloon and circular catheters were used in less than 3% of ablations. A 3-D navigation system was helpful in almost 50% of cases. Exceptional high number of ablations – in comparison to other countries – were intracardiac ultrasound-guided.

Comparison of catheter ablations in Czech Republic and in other countries in Europe

European Heart Rhythm Association (EHRA) has developed a project called The White Book which summarized numbers of procedures for each segment of electrophysiology. These data are provided by the national societies and cross checked against offcial and/or industry driven databases. The data are published in the so-called EHRA White Book. According the 2016 edition, comparing the total expenditure on healthcare as percentage of GPD (gross domestic product) per million inhabitants, Czech Republic is ranking bellow the European average (Fig 7). However, the efficacy seems to be dissociated from the resources allocated into healthcare. Specifically, the number of catheter ablations per million places the Czech Republic in the fourth quartile of all countries, on the seventh place in Europe (Fig 8).

Fig 1



Catheter ablation registry

Indications for ablation, CR 1997-2005

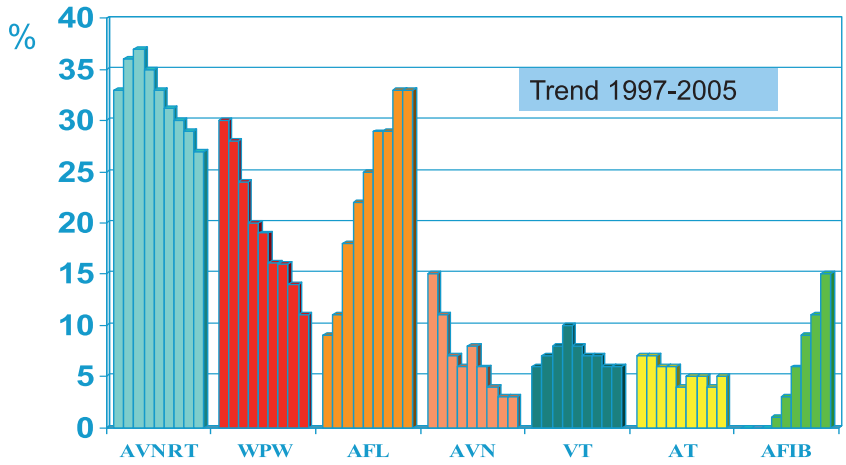
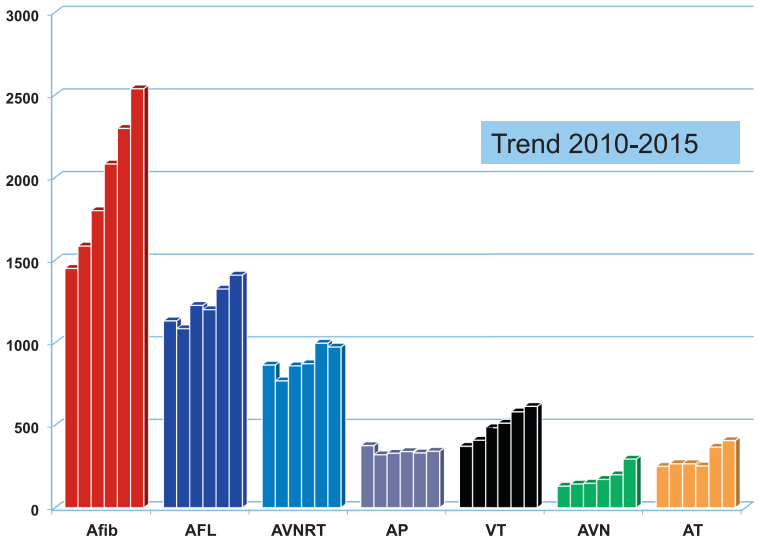


Fig 2

Fig 3

Catheter ablation registry

Indications for ablation, CR 2010-2015



Catheter ablation registry, CR 2015
EP centers, CR

1. Nemocnice Na Homolce – Kardiologické odd.
2. IKEM Praha – Kardiologická klinika
3. Nemocnice České Budějovice – Kardiocentrum
4. Třinec - Podlesí – Kardiocentrum
5. FNUSA Brno – Kardiologická klinika
6. VFN Praha – II.IK - Kardiologická klinika
7. FNHK – 1. IK
8. FN Brno – Kardiologická klinika
9. FN Olomouc – I. interní klinika – Kardiologická
10. Kardiologické centrum AGEL a.s.
11. FNKV Praha – III.interní - Kardiologická klinika
12. FN Plzeň – Kardiologické odd.
13. Liberec – Kardiocentrum
14. ÚnL – Kardiologické odd.
15. FN Ostrava – Kardiovaskulární odd.
16. FN Motol – Kardiologické odd.
17. FN Motol – Dětské kardiocentrum
18. Kardiologie na Bulovce, s.r.o.
19. Karlovy Vary – Kardiocentrum
20. FN Brno – Pediatrická klinika
21. Městská nemocnice Ostrava – Kardiologie
22. Zlín – Interní klinika
23. ÚVN – Kardiologické odd.

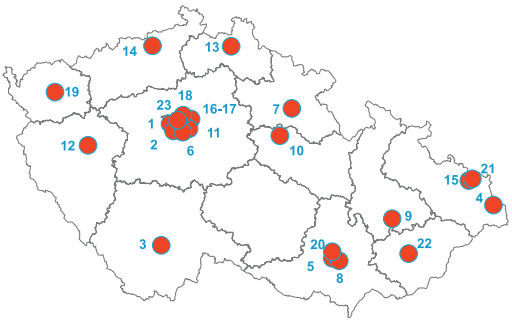
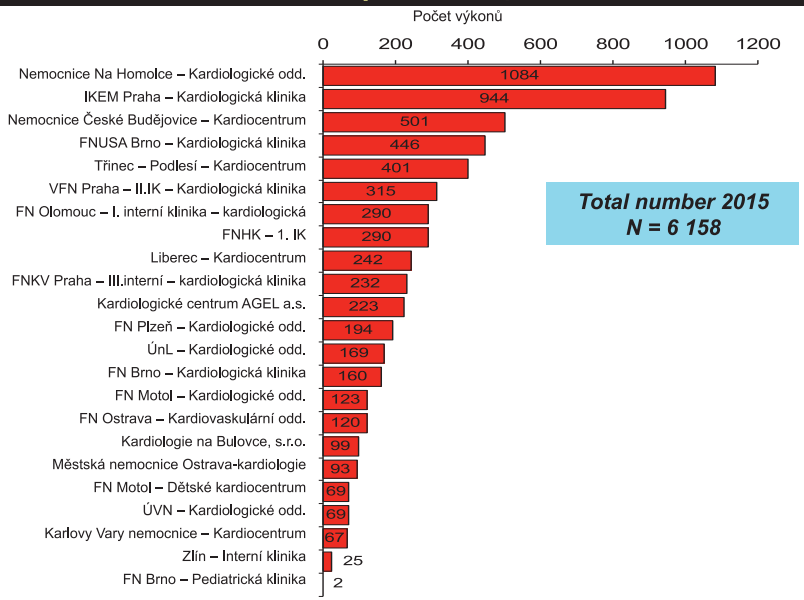


Fig 4

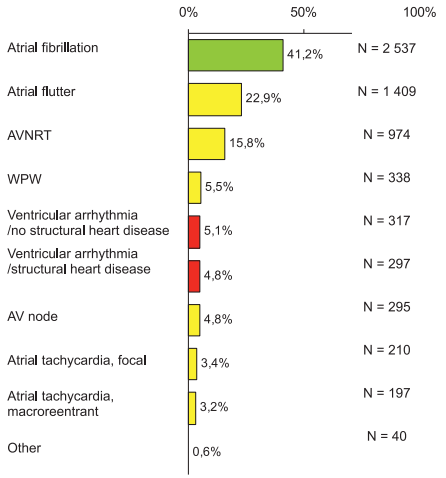
Fig 5

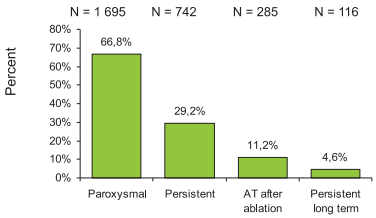
Catheter ablation registry
Procedures number per center, CR 2015



Total number 2015
N = 6 158

Catheter ablation registry
Indications for ablation, CR 2015





A Fib (N = 2 537)

Total ablation number 2015 (N = 6 158)

Fig 6

Fig 7

EHRA White Book, 2016
Catheter ablation number per milion inhabitants

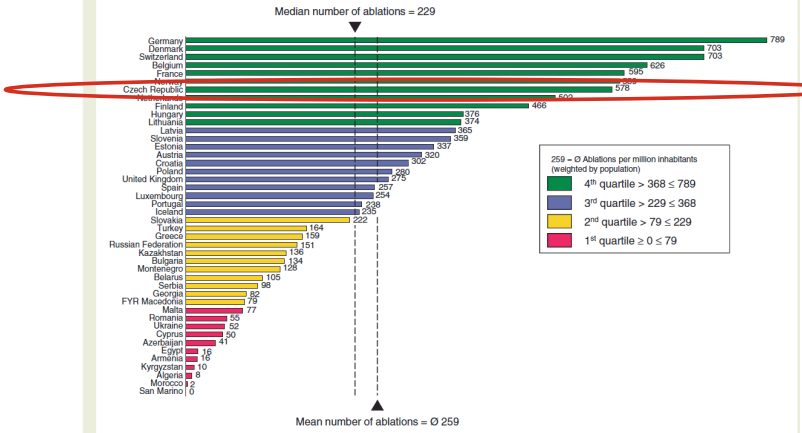


Figure 59 Catheter ablations per million inhabitants in 2015. The mean number of ablations is weighted by population.

EHRA White Book, 2016

Total expenditure on healthcare as % of GPD

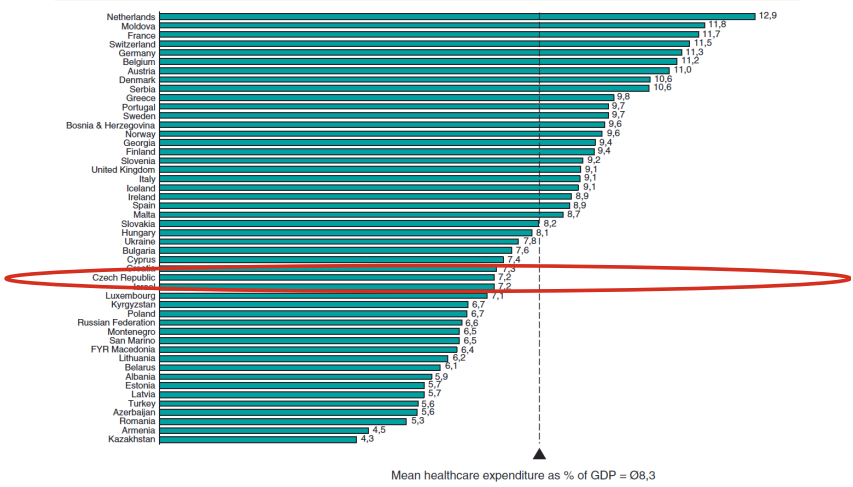


Fig 8

Institute for Clinical and Experimental Medicine

Institute for Clinical and Experimental Medicine (IKEM) in Prague is the largest superspecialized clinical and medical research facility in the Czech Republic. For more than 40 years, it has been focused on management of cardiovascular diseases, diabetology and metabolic disorders. In the same time, it is the largest national centre for transplantation of solid organs with catchment area covering entire country.

IKEM, as it is today, was founded in 1971 by integration of 6 previously independent research departments – Institution for clinical and experimental surgery, Institution of circulatory diseases, Institution for people's nutrition, Research institution for experimental therapy, Research institution for utilization of radioisotopes in medicine and Research Institution for medical electronics and modeling.

IKEM consists of 4 specialized centres, 8 departments and 15 specialized units and laboratories. Out of a total number of 1700 employees, there are more than 300 physicians and 600 nurses. Bed capacity is 315 beds and 111 out of this number are designated as intensive care beds.

IKEM performs per year almost 1300 cardiac surgeries, 900 coronary angioplasties, more than 900 catheter ablations of various cardiac arrhythmias, and 800 implants of pacemakers and implantable cardioverters/defibrillators. Almost 60 % of all solid transplant organs in the Czech Republic are performed here. IKEM performs 100 % of all transplants of insulin-producing tissues and is the only centre that transplants uterus and intestine. Unique programme consists of paired exchange of kidneys, live-saving split liver transplants (including pediatric cases). Another exclusive programme deals with development of mechanical support devices and/or management of patients with diabetic foot.

The aim of all specialists at IKEM is the continuous improvement of patient care, refinement of therapeutic approaches and use of the latest scientific discoveries in clinical practice.

IKEM consists of 4 centres:

- Heart Centre of IKEM is the largest, most complex and historically oldest among cardiac centres in the Czech Republic. It covers all range of contemporary cardiovascular medicine.
- Transplant Centre is the largest centre for transplantation of solid organs in the Czech Republic. It performs also multivisceral transplants.
- Diabetology centre is focused on diabetes and metabolism disorders and has a unique programme of management of complications of diabetes..
- Centre of experimental medicine interconnects basic research in molecular biology and genetics with clinical research in the free main fields of interest of the institute.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