

Spanish Registry on Catheter Ablation. Second Official Report of the Working Group on Electrophysiology and Arrhythmias of the Spanish Society of Cardiology (2002).

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Introduction and objectives. We present the results (success rates and complication rates) for the second consecutive year of the 2002-Spanish Catheter Ablation Registry, developed by the Spanish Society of Cardiology.

Material and method. Data were collected retrospectively by questionnaires sent to all interventional cardiology laboratories in Spain. The outcomes and complications of ablation procedures performed during 2002 were classified according to the substrate or mechanism of arrhythmia treated.

Results. Forty-three centers voluntarily submitted completed questionnaires. The number of procedures analyzed was 4970, performed at 42 centers, for a mean of 118 ± 78 procedures per center. Global outcome rates were success in 93%, major complications in 1.2%, and death in 0.04% of the patients. The three main substrates treated were AV nodal reentry (29%), accessory pathways (28%) and common atrial flutter (24%).

Conclusions. The 2002 Spanish National Catheter Ablation Registry reports the activity of the majority (90%) of interventional cardiology laboratories in Spain. The efficacy of catheter ablation procedures in Spain is high, and the complication and mortality rates are low.

Key words: *Catheter ablation. Electrophysiology. Statistics. Registry.*

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*A list is presented at the end of the article with the physicians responsible for data management at each center participating in the Spanish Registry of Catheter Ablation for 2002.

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Registro Español de Ablación con Catéter. II Informe Oficial de la Sección de Electrofisiología y Arritmias de la Sociedad Española de Cardiología (2002)*

Introducción y objetivos. Se detallan los resultados (éxito y complicaciones) del Registro Nacional de Ablación del año 2002, elaborado por la Sección de Electrofisiología y Arritmias, por segundo año consecutivo.

Material y método. La recogida de datos se realizó, como en el registro anterior del año 2001, de forma retrospectiva cumplimentando un cuestionario que fue enviado, desde la Sección de Electrofisiología y Arritmias, a los laboratorios de electrofisiología. Se recogían los procedimientos de ablación realizados durante el año 2002, detallando los resultados y las complicaciones en función del sustrato o mecanismo arritmico tratado.

Resultados. Un total de 43 centros contestaron el cuestionario. El número de procedimientos de ablación analizados fue de 4.970 (42 centros), con una media de 118 ± 78 procedimientos por centro. Los 3 sustratos más frecuentemente abordados fueron la taquicardia intranodal (29%), las vías accesorias (28%) y la ablación del istmo cavotricuspidé (24%), y el porcentaje de éxito fue del 99, 93 y 94%, respectivamente. El porcentaje global de éxito, analizado por paciente, fue del 93%, el de complicaciones mayores del 1,2% y el de mortalidad del 0,04%.

Conclusiones. El Registro Nacional de Ablación con Catéter del año 2002 se consolida como una de las mayores series publicadas hasta el momento de procedimientos de ablación, y recoge la actividad de la mayoría de los laboratorios de electrofisiología de nuestro país (90%). La eficacia de este procedimiento en nuestro medio sigue siendo elevada, con un escaso porcentaje de complicaciones mayores y de mortalidad.

Palabras clave: *Ablación con catéter. Electrofisiología. Estadísticas. Registro.*

INTRODUCTION

Last year the Section of Electrophysiology and Arrhythmias (SEA) of the Spanish Society of Cardiology published its first Official Report on the state of catheter ablation (corresponding to 2001).¹ This article presents the Second Spanish Registry of

ABBREVIATIONS

CVA: cerebrovascular accident.
NASPE: North American Society of Pacing and Electrophysiology.
SEA: Section of Electrophysiology and Arrhythmias.

Catheter Ablation, which was compiled with data from ablation procedures performed during 2002. Participation was voluntary and the study included most of the electrophysiology laboratories in Spain.

MATERIALS AND METHODS

The method was the same as for the previous registry.¹ A questionnaire was sent (either as hardcopy or in electronic format) for retrospective completion to all laboratories where ablation was known to be performed. The structure of the questionnaire (Annex 1) was similar to the previous one, but with some changes to correct the main causes of error.

The first part of the questionnaire gathered information on the hospital and the human and material resources available to the electrophysiology laboratory. The second part asked about the number of procedures and the outcomes according to substrate or arrhythmic mechanism targeted. These were classified as follows: atrioventricular nodal reentrant tachycardia (AVNRT); accessory pathways (AP); atrioventricular node (AVN); focal atrial tachycardia (FAT); cavotricuspid isthmus (CTI); macro-reentrant atrial tachycardia/atypical flutter (MAT-AFT); atrial fibrillation (AF); idiopathic ventricular tachycardia (IVT); postinfarction ventricular tachycardia (PIVT); non-ischemic ventricular tachycardia (NI-VT).

The questionnaire requested information on the total number of procedures and patients treated, the number of successful procedures and successfully treated patients, the number of procedures performed with devices other than the conventional 4-mm distal electrode catheter (for example, 8-mm electrodes or irrigated tip electrodes) and the number and type of complications for each substrate targeted.

Criteria for success, complications and mortality were the same as in the previous registry. The site of AP and atrial arrhythmias was classified in accordance with the new definitions of the Working Group of Arrhythmias of the European Society of Cardiology.^{2,3}

Once completed, the questionnaires were sent to the secretariat of the SEA, where administrative staff assigned them a number (center code). The top half of

the first page, which contained the center identification code, was removed and filed separately to ensure confidentiality and the rest of the questionnaire was forwarded to the coordinators of the registry for analysis.

Statistical analysis

Numerical results were expressed as mean±standard deviation. Qualitative variables and proportions were analyzed using the χ^2 test and Fisher's test if necessary. Student's *t* test was used for quantitative variables. Success rates and complication rates were calculated as a percentage of the total number of patients. A *P* value <.05 was considered statistically significant. The statistical analysis was performed with the SPSS 11.0 program.

RESULTS

Infrastructure and resources

Forty-three centers answered the questionnaire, comprising approximately 90% of the centers invited to participate. Table 1 shows the characteristics of the participating centers and Annex 2 lists their location. A digital x-ray room was available in 46.5% of the centers (n=20). The x-ray room was used exclusively for electrophysiological procedures in 67% of the centers (n=28). A median of four days per week were dedicated to electrophysiology (range, 1-5 days). Scheduled implantation of permanent pacemakers was also performed in 28 rooms (65%) and automatic defibrillators in 27 (63%). In addition, 63% of the rooms (n=27) performed scheduled external cardioversion and a further 21 rooms (49%) performed scheduled internal cardioversion. Event recorders were implanted in 10 rooms and tilting table studies were performed in eight.

Intracavitary signals were recorded using a digital polygraph system in 41 laboratories (95.3%). Twenty centers (47.5%) had non-fluoroscopic intracardiac navigation systems. Specific types included CARTO® (7 laboratories), LOCALISA® (10 laboratories) and EN-SITE® (1 laboratory). Two centers had two of these systems. Six laboratories also performed intracardiac echocardiography. All laboratories used radiofrequency current as the energy source for catheter ablation. Two centers carried out cryoablation techniques.

Table 2 lists the staff in the publicly funded centers. Two or more full-time staff physicians were employed in the electrophysiology laboratory in 66% of the centers (n=25). Twelve centers (31.6%) also had student doctors and 20 centers (52.6%) had two or more registered nurses in the electrophysiology laboratory.

TABLE 1. Characteristics of hospital centers participating in the Spanish Registry of Catheter Ablation for 2002 (n=43)

	No (%)
University hospital	34 (79)
Level	
Tertiary	38 (88)
Secondary-district	3 (7)
Not specified	2 (5)
Health care sector	
Public	38 (88.4)
Exclusively private	5 (11.6)
Department responsible	
Cardiology	41 (95.3)
ICU	1 (2.3)
Pediatric center	1 (2.3)
Heart surgery	34 (79)

ICU indicates intensive care unit.

Laboratory practice

Heparin anticoagulation was used by all laboratories for ablation procedures with transseptal catheterization, and by 91% of the laboratories (n=39) for arterial catheterization. However, it was used by only 6 laboratories for venous catheterization and by 3 centers for diagnostic electrophysiological studies. The mean time from effective application of radiofrequency to when procedure was considered successful was 28±7 minutes (range, 15-60 minutes; median, 30 minutes).

Twenty-nine centers performed transseptal catheterization. This procedure was performed exclusively by electrophysiologists in 11 centers, whereas in 24 centers, electrophysiologists participated as operators. Eight centers did not perform this technique and six centers did not complete this section.

Overall results

A total of 5006 ablation procedures were performed in the 43 participating centers, corresponding to a mean number of procedures per center of 116±78 (median, 103; range, 13-432). Figure 1 shows the distribution of the number of procedures per laboratory. The results (substrate type, success, complications), however, refer only to the 42 centers that supplied usable information. Thus 4970 ablation procedures in 4755 patients were included in the final analysis.

The overall success rate by patient was 93% (4411/4755), the rate of major complications was 1.2% (n=56) and the mortality rate was 0.04% (n=2). These data are similar to those from 2001 (Figure 2). One patient died after an AVNRT ablation procedure and another after a FAT procedure. The cause of death in both cases was pulmonary embolism.

The overall the success rate by center was 92±4% (range, 81%-99%; median, 92.4%), and the percentage

TABLE 2. Human resources of laboratories of public hospitals (n=38) participating in the Spanish Registry of Catheter Ablation for 2002

	Mean ± SD	Range	Median	Total
Physicians	2.18±0.5	1-4	2	83
Full-time	1.6±0.8	0-3	2	60
No. student doctors	0.6±1.2	0-6	0	21
No. residents	1±0.5	0-2	1	39
No. RN	1.6±0.8	1-4	2	54
No. RA				7

SD indicates standard deviation; RA, radiologist assistant; RN, registered nurse.

of major complications was 1.1±1.4% (range, 0%-6.25%; median, 0.7%). The overall success rate was greater than or equal to 90% in 76% of the centers (n=42), and 40% (n=17) of centers reported no complications. Fifteen centers (47%) reported a success rate greater than or equal to 90% and no complications. Most catheter ablation procedures used 4-mm tips, but the 8-mm tip was used more often for two substrates (TCI and MAT-AFT ablation). Eleven AP ablation procedures used cryoablation.

Results by substrate

The most frequently targeted substrate was AVNRT, followed by AP, CTI and AVN. Ablations of FAT, FA and PIVT were done less often, and the frequency of these 3 procedures was similar. The substrates targeted least often were TVI, MAT-AFT and NI-VT (Table 3, Figures 3 and 4).

The mean number of different types of substrate treated at a given center was 7±1.6 (median, 7; range, 4-

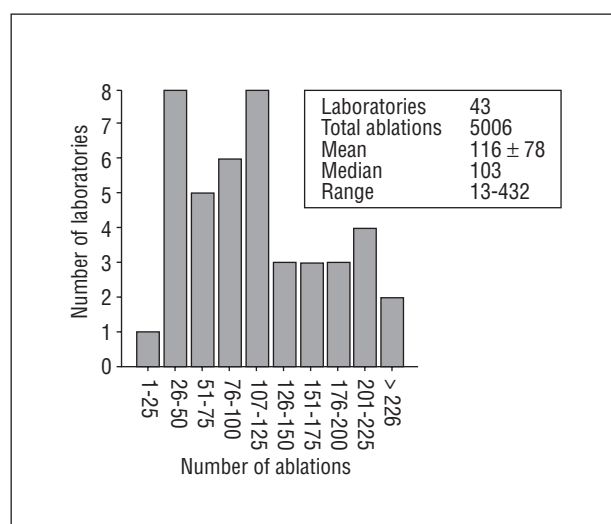


Fig. 1. Number of electrophysiology laboratories in the Spanish Registry by number of catheter ablation procedures performed in 2002.



Fig. 2. Overall outcomes (success, complications, mortality) observed in 2002 and 2001.

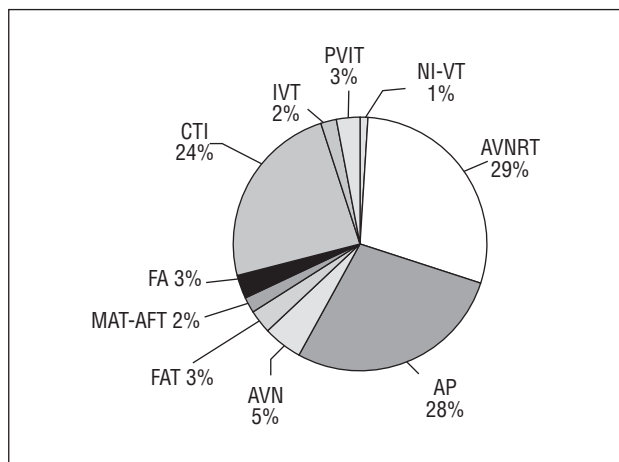


Fig. 3. Relative frequency of the different catheter ablation substrates in Spain during 2002. AVNRT indicates atrioventricular nodal reentrant tachycardia; AP, accessory pathways; AVN, atrioventricular node; FAT, focal atrial tachycardia; CTI, cavotricuspid isthmus; MAT-AFT, macro-reentrant atrial tachycardia/atypical flutter; AF, atrial fibrillation; IVT, Idiopathic ventricular tachycardia; AT, atrial tachycardia; VT, ventricular tachycardia; PIVT, postinfarction ventricular tachycardia; NI-VT, non-ischemic ventricular tachycardia.

10). Only 6 centers (14%) performed ablation of all substrates included in the analysis. All centers performed ablation of AVNRT and AP, half performed ablation of MAT-AFT and less than 20 centers performed ablation of FA and NI-VT. Ablation of the remaining substrates was reported by at least 30 centers (Figure 5).

The rates of success and major complications are presented by substrate in Table 4 and Figures 6 and 7.

Atrioventricular nodal reentrant tachycardia

A total of 1415 ablation procedures were performed in 1400 patients (33±23 patients per center; range,

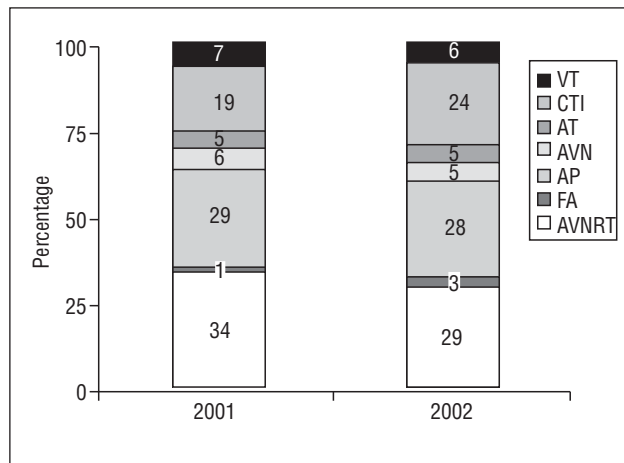


Fig. 4. Relative frequency of different target substrates during 2002 and 2001.

AVNRT indicates atrioventricular nodal reentrant tachycardia; AP, accessory pathways; AVN, atrioventricular node; CTI, cavotricuspid isthmus; AF, atrial fibrillation; AT, atrial tachycardia; VT, ventricular tachycardia.

3-132). All procedures were performed with conventional ablation catheters except two (0.14%), which used an 8-mm tip catheter.

The number of patients treated successfully was 1383 (98.7%). Nine patients (0.6%) had major complications, 5 (0.3%) of which were AV block. One patient (0.07%) died within a few days of ablation because of massive pulmonary thromboembolism. The success rate was greater than 90% for all centers, and 34 centers (81%) reported no complications.

Accessory pathways

Overall, 1416 AP ablation procedures were performed in 1350 patients (32±19 patients per center; ran-

TABLE 3. Presentation of substrates/arrhythmic mechanism targeted as a percentage of total number of procedures in each center

	Mean ± SD	Median	Range
AP	30.5±8.5	28.5	11.6-57
AVNRT	29±8	30	12.5-46.6
CTI	22.5±3+9.5	22	6-46
AVN	8.5±7.6	6	0.5-33
FA	6±5	5.6	0.5-21
FAT	4±2	4	0.8-9
PIVT	3±2	3	0.6-9
TVI	2.6±1.6	2.4	0.7-7.7
MAT-AFT	2.4±2	2	0.5-6.7
NI-VT	2±1.3	1.3	0.5-5

SD indicates standard deviation; AVNRT, atrioventricular nodal reentrant tachycardia; AP, accessory pathways; AVN, atrioventricular node; FAT, focal atrial tachycardia; CTI, cavotricuspid isthmus; MAT-AFT, macro-reentrant atrial tachycardia/atypical flutter; AF, atrial fibrillation; IVT, Idiopathic ventricular tachycardia; PIVT, postinfarction ventricular tachycardia; NI-VT, non-ischemic ventricular tachycardia.

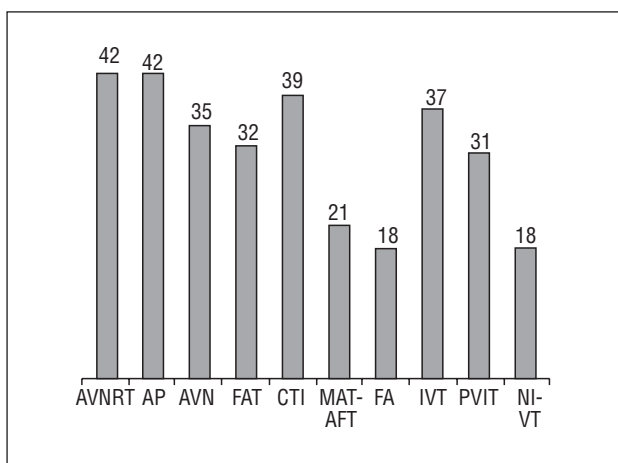


Fig. 5. Number of electrophysiology laboratories in the Spanish Registry targeting the different substrates.

ge, 4-109). Details of the accessory pathways were provided by 37 centers (n=1252). The most frequent pathway was the left free wall (52%), followed by the inferior paraseptal region (24%), the right free wall (14%) and the area near the bundle of His (10%). Non-conventional catheters were used in 70 procedures (8-mm tip distal electrode catheter in 34 procedures, irrigated tip catheter in 25) and cryoablation was used in 11 procedures.

The outcome was successful in 1252 patients (93%), and major complications were reported in 12 (0.9%). The success rates by accessory pathway were 97% for the left free wall ablation, 87.2% for inferior paraseptal ablation, 92.5% for right free wall ablation and 76.4% for ablation near the bundle of His. A success rate greater than 90% was achieved by 28 centers (67%), and no major complications were reported by

TABLE 4. Outcome of catheter ablation according to substrate or mechanism of arrhythmia, as recorded in the Spanish Registry of Catheter Ablation for 2002

	Success rate (%)			Rate of complications (%)		
	Mean ± SD	Median	Range	Mean±SD	Median	Range
AVNRT	98±2	100	93-100	0.8±2.5	0	0-14
AP	92±7	93	70-100	1.2±2.7	0	0-12.5
AVN	99±3	100	85-100	1±3.7	0	0-20
CTI	92±10	96	65-100	0.4±1.5	0	0-8
FAT	75±29	83	0-100	1.6±6.6	0	0-33
MAT-AFT	52±47	54	0-100	3.4±11	0	0-50
FA	73±35	87	0-100	6.6±9.7	0	0-25
TVI	77±31	100	0-100	3.2±10.5	0	0-50
PIVT	84±25	100	0-100	2±9	0	0-50
NI-VT	67±39	83	0-100	8±26	0	0-100

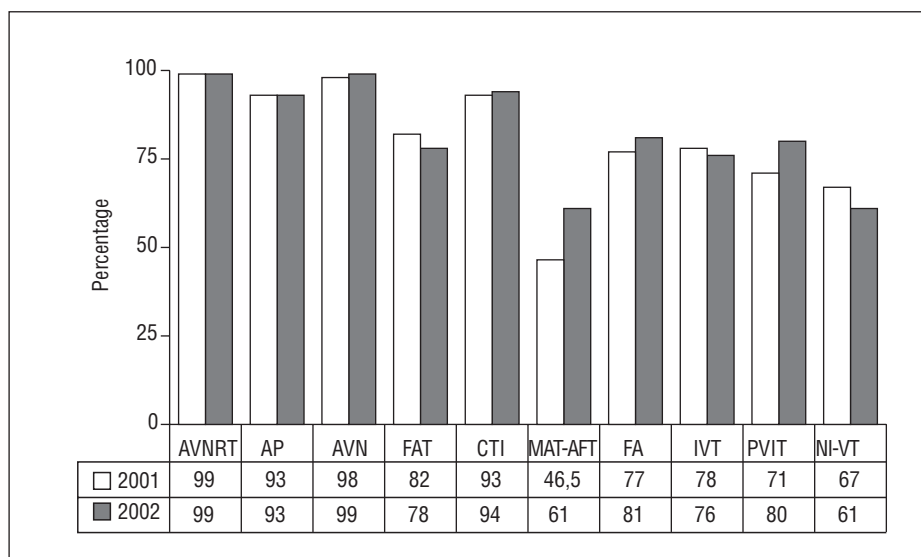
SD indicates standard deviation; AVNRT, atrioventricular nodal reentrant tachycardia; AP, accessory pathways; AVN, atrioventricular node; FAT, focal atrial tachycardia; CTI, cavotricuspid isthmus; MAT-AFT, macro-reentrant atrial tachycardia/atypical flutter; AF, atrial fibrillation; IVT, Idiopathic ventricular tachycardia; PIVT, postinfarction ventricular tachycardia; NI-VT, non-ischemic ventricular tachycardia.

31 (74%). Left free wall AP ablation was the most common location in centers that reported no complications (58 ± 13% vs 48 ± 12%; P<.05) whereas AP ablation in the area near the bundle of His was more common in centers that reported complications (13±8% vs 7.5±6%; P<.1).

Cavotricuspid isthmus

A total of 1169 procedures were performed in 1117 patients (28±23 patients per center; range, 3-94). Thirty-five centers provided information on the type of flutter treated. The counterclockwise type was treated in 955 patients, and the clockwise type in 93 pa-

Fig. 6. Success rate of catheter ablation in Spain by target substrate during 2002 compared to 2001. AVNRT indicates atrioventricular nodal reentrant tachycardia; AP, accessory pathways; AVN, atrioventricular node; FAT, focal atrial tachycardia; CTI, cavotricuspid isthmus; MAT-AFT, macro-reentrant atrial tachycardia/atypical flutter; AF, atrial fibrillation; IVT, Idiopathic ventricular tachycardia; PIVT, postinfarction ventricular tachycardia; NI-VT, non-ischemic ventricular tachycardia.



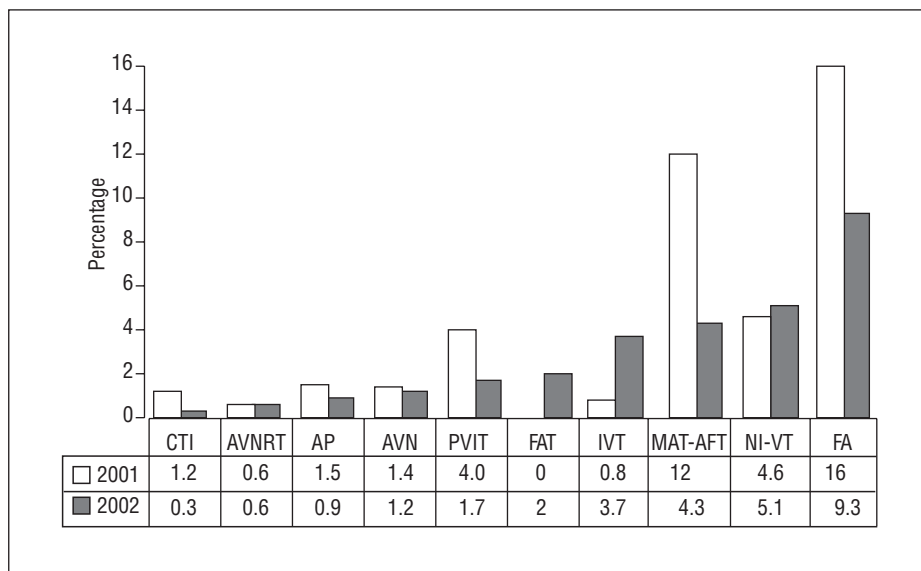


Fig. 7. Rate of major complications of catheter ablation in Spain by target substrate during 2002 compared to 2001.

AVNRT indicates atrioventricular nodal reentrant tachycardia; AP, accessory pathways; AVN, atrioventricular node; FAT, focal atrial tachycardia; CTI, cavotricuspid isthmus; MAT-AFT, macro-reentrant atrial tachycardia/atypical flutter; AF, atrial fibrillation; IVT, Idiopathic ventricular tachycardia; PVIT, post-infarction ventricular tachycardia; NI-VT, non-ischemic ventricular tachycardia.

tients. Ablation of the inferior vena cava was performed in 15 patients. Non-conventional catheter ablation was used in 91.3% (1024/1124) of the procedures for which information on the catheter type was available. The most common type of catheter used was the 8-mm tip distal electrode catheter (n=782) followed by the irrigated tip catheter (n=236).

The outcome was successful in 1048 patients (94%) and complications were reported in four patients (0.36%), namely two arterial complications, one AV block and one embolism. A success rate greater than or equal to 90% was reported by 27 centers (69%) and no complications were reported by 35 (90%).

Atrioventricular node ablation

The types of AVN modulation procedure were not reported separately; therefore all procedures refer to ablation. The participating centers performed 264 procedures in 258 patients (7±4 patients per center; range, 1-18). An 8-mm tip catheter tip was used in 23 procedures.

The procedure was successful in 255 patients (99%) and there were three major complications (1.1%), namely an arterial complication, a venous complication and an episode of congestive heart failure. A success rate of 100% was reported in 32 centers (91%) and no complications were reported in 31 centers (88%).

Focal atrial tachycardia

The participating centers performed 166 procedures in 149 patients (4.6±5.3 patients per center; range, 1-31). Non-conventional catheters were used in 28 procedures: 21 with 8-mm tip catheters and seven with irrigated tip catheters.

The procedure was successful in 116 patients (78%) and three major complications were reported (pericardial effusion, cardiac tamponade and pulmonary embolism). One patient died due to pulmonary embolism. In centers that reported tachycardia site, success was achieved in 78.5% (84/107) for right atrial tachycardia compared to 80% (25/31) for left atrial tachycardia (P=NS). 18 centers (56%) achieved a success rate greater than or equal to 80% and 30 centers (94%) reported no complications.

Macroreentrant atrial tachycardia/atypical atrial flutter

A total of 78 procedures were performed in 70 patients (3.3±3.6 patients per center; range, 1-13). The location of the substrate was reported by 18 centers (n=69 patients). The right atrium was treated in 43 patients and the left atrium in 18. A non-conventional catheter was used for 42 procedures (8-mm tip distal electrode catheter in 29 patients and an irrigated tip catheter in 12 patients; an unspecified model was used for one procedure).

Success was achieved in 43 patients (61.4%) and complications arose from three procedures (4.3%). These complications were atrioventricular block, cerebrovascular accident (CVA) and another unspecified complication. The success rate was 60% for right atrial tachycardia and 44.4% for left atrial tachycardia (P=NS). A success rate greater than 60% was achieved by 10 centers (47.6%) and 18 centers (86%) reported no complications.

Atrial fibrillation

This substrate was targeted in 18 centers, of which 17 reported the number of patients successfully treated.

ted. A total of 170 procedures were carried out in 151 patients (8 ± 12 per center; range, 1-40). Success was achieved in 114 of 141 patients analyzed (81%) and 14 patients (9.3%) developed complications. These complications were 4 pericardial effusions, 2 cardiac tamponades, 2 embolisms, 2 CVAs, 1 arterial complication, 1 ischemic episode and 2 cases of asymptomatic stenosis of pulmonary veins.

A success rate greater than or equal to 80% was achieved in 59% of the centers (10/17). 11 centers reported no complications (61%).

Idiopathic ventricular tachycardia

The participating centers performed 109 procedures in 106 patients (2.8 ± 2.1 patients per center; range, 1-9). For the 35 centers (n=97 patients) that specified VT location, the right ventricular outlet tract was the most common (55.6%; n=54) followed by fascicular location (19.5%; n=19) and the left ventricular outlet tract (8.2%; n=8). Ventricular tachycardias in other locations were treated in 12 patients (12.4%). In 10 procedures, 8-mm distal electrode catheters were used, whereas 9 procedures were performed with irrigated tip catheters.

Success was reported in 81 patients (76.4%) and 4 patients developed major complications (3.7%): 2 cases of pericardial effusion, 1 embolism and 1 unspecified complication. The success rate was 83.3% for right ventricular outlet tachycardia, 84% for fascicular tachycardia and 75% for left ventricular outlet tract tachycardia. A success rate greater than or equal to 80% was achieved in 23 centers (62%) and no complications were reported by 33 (89%).

Postinfarction ventricular tachycardia

A total of 137 procedures were performed in 115 patients (3.7 ± 3.9 patients per center; range, 1-15). Ablation was performed with 8-mm tip distal electrode catheters in 38 procedures and with irrigated tip catheters in 24 procedures. When substrate ablation occurred during sinus rhythm, the acute outcome was not reported and therefore not analyzed.

Success was achieved in 92 patients (80%), and 2 patients (1.7%) developed complications, 1 of which was AV block and the other CVA. A success rate greater than or equal to 80% was achieved in 22 centers (71%) and 29 centers (93.5%) reported no complications.

Non-ischemic ventricular tachycardia

A total of 46 procedures were performed in 39 patients (3 ± 1.7 patients per center; range, 1-8). Ablation was performed with 8-mm tip distal electrode catheters in 6 procedures and with irrigated tip catheters in

a further 6. 14 patients with ventricular tachycardias caused by bundle-branch reentry were treated, with a successful outcome in 13 patients (93%). Success was achieved in only 3 of the 9 patients (33.3%) with arrhythmogenic right ventricular dysplasia.

Overall success was achieved in 24 patients (61.5%), and 2 (5.1%) had complications, namely AV block in 1 patient and another unspecified complication. A success rate greater than 60% was achieved at 11 centers (61%), and no complications were reported.

DISCUSSION

The advantages of compiling a national ablation registry are compelling.¹ The compilation of subsequent registries confirms the participants' commitment to disseminate the results, which show the progress being made with this therapeutic technique.⁴ For the second consecutive year, 90% of the centers that perform invasive cardiac electrophysiology in Spain participated in the registry. This, along with improvements in the quality of completed questionnaires, allows further consolidation of the information thus obtained.

Comparison with previous registries

In the preceding registry we reported a comparison with other published registries. The NASPE has recently published a report⁵ that collates recommendations for catheter ablation treatment in which the success rates and complication rates in the prospective registry are used as reference values.⁶ The Portuguese Society of Cardiology periodically publishes the Portuguese Catheter Ablation Registry.^{7,8} All centers in Portugal that carry out ablation participate, but this registry comprises many fewer patients and centers than the Spanish Registry (759 ablations in 11 centers in the Portuguese Registry for 2002),⁸ and does not specify outcomes or complications. No other national registries are available, thus we cannot perform an exhaustive comparison of the results. The compilation of a new European ablation registry (MERFS) is planned, although detailed information is not yet available (www.escardio.org).

Nevertheless, some data can be compared with the registry for 2001 while recognizing that this comparison is necessarily limited because not all centers participated in both registries. Almost all centers (n=40) provided data for both years, 3 centers provided data for the first time in the 2002 registry, and 3 centers did not provide data for 2002 but did so for the 2001 registry.

Although the number of centers (n=43) participating in this registry is the same as for the previous year, the quality of the data is better. The number of centers providing information on the hospital and

electrophysiological laboratory was similar, but we analyzed data for 42 centers (97.6%) by substrate in this registry, as compared to data for 36 centers in the 2001 registry (83.7%). This allowed us to analyze more patients (4755 vs 3783 in 2001). Our registry also includes more patients than the MERFS survey.⁹

Human and material resources

The equipment recommended by NASPE⁵ and by the Spanish Society of Cardiology¹⁰ is not often found in Spanish electrophysiology laboratories. The x-ray room in which the ablation procedures were performed was used exclusively for electrophysiological studies at 67% of the centers—more than in the previous registry (58%). A x-ray room dedicated solely to electrophysiological procedures was available in 73% of the centers in the public sector, and these rooms were in operation 3.7 ± 1.4 days/week, a figure almost unchanged with respect to the 2001 registry (3.6 ± 1.4 days). In fact, only 16 centers (47%) dedicated all five working days to electrophysiological studies (the same number as in 2001). Last year we pointed out that these figures will largely determine the number of procedures performed.¹ This in turn will influence the number of people waiting for ablation procedures: 28 public centers reported a total of 1833 patients (65 ± 80 patients per center) on their waiting lists for ablation at the end of 2002.

The number of non-fluoroscopic intracardiac navigation systems ($n=22$) has increased notably from 2001 ($n=11$). The number of centers with intracardiac echocardiography has also increased (4 in 2001 vs 6 in 2002). In 2002, 2 centers used cryoablation techniques compared to only one in 2001.

Greater investment in technology has not been accompanied by a significant increase in the number of physicians in the public sector. The mean number of physicians who work in the electrophysiology laboratory in 2002 (2.2 ± 0.56) is same as in 2001 (2.2 ± 0.64). The number of physicians in the private sector is lower than this (1.8 ± 0.8). The mean number of physicians who work full-time in the electrophysiology and arrhythmia laboratory has not varied either (1.6 ± 0.8), and in fact has hardly changed since 1995 (1.6 ± 0.7).¹¹ Contrary to some reports, the performance of other techniques (pacemaker and defibrillator implantation, programmed cardioversion) does not seem to determine whether an electrophysiological laboratory has 2 or more full-time physicians.¹⁰ The number of full-time physicians is, however, significantly associated with the number of ablation procedures performed.

A novel feature of this registry was the analysis of who performs transseptal catheterization in electrophysiological laboratories. This technique was performed exclusively by electrophysiologists at 38% of

the centers that carried out this type of procedure and replied to this part of the questionnaire. We do not have previous data for comparison, but we can reasonably assume that electrophysiologists will perform this procedure more often as the number of ablation procedures to treat atrial fibrillation increases, regardless of the type of electrophysiology unit.

Results and substrates treated

As in the previous registry, 10 substrates were analyzed. Three of these (AVNRT, AP, CTI) were targeted more often than the others, and each accounts for more than 20% of the total number of procedures. Atrioventricular nodal reentrant tachycardia remains the most frequent target substrate, although between 2001 and 2002 its share of the total number of procedures dropped by 15%. Two substrates have increased their share significantly (Figure 4): cavotricuspid isthmus (24% in 2002 vs 19% in 2001) and atrial fibrillation (3% in 2002 vs 1% in 2001). These arrhythmias are highly prevalent in the general population in Spain,^{12,13} and the data may reflect the acceptable results obtained with ablation.¹⁴ Indeed, ablation seems more effective than antiarrhythmic drugs in preventing recurrences.^{15,16} For typical recurrent flutter, cavotricuspid isthmus ablation is currently considered the therapy of choice (class I, level A).⁵

The proportion of VT ablation has stabilized at 6%-7%, though this figure may rise in coming years due to the more extended use of non-fluoroscopic navigation systems and treatment of unmappable VT.^{17,18}

The success rate of catheter ablation in this registry (93%) was similar to that reported in other registries, and as in other registries, success varied depending on the substrate treated (Figure 6). Thus, the success rate was greater than 90% for four substrates (AVNRT, AP, AVN, CTI), in line with the results from 2001. The greater success rate for left free wall AP in other registries¹⁹ is probably due to a greater frequency of presentation.

For the other 6 substrates, the success rate varied from 61% (MAT-AFT and NI-VT) to 81% (FA). No significant changes from the previous registry were expected given the low number of procedures per center, although progress on the learning curve, improvements in technology and new target sites²⁰ will improve these results. One difference between the 2 registries deserves mention. The success rate for MAT-AFT substrate has increased considerably (46.5% in 2001 vs 61% in 2002; $P=.12$), possibly because of factors such as use of new mapping techniques and the more frequent use of 8-mm tip and irrigated tip catheters (49% in 2001 vs 66% in 2002; $P=.07$).

Complications and mortality

The rate of major complications remains acceptable (1.2%) and is similar to that obtained in the previous registry (1.5%). The most common complications (n=12) were atrioventricular (AV) block and pericardial effusion/cardiac tamponade. We note that the rate of AV block in AVNRT ablation seems to have stabilized at around 3/1000 patients. This is satisfactory in view of the benign nature of this arrhythmia. The complication rate for AP ablation is low (0.9% in this registry) but the indication of ablation for an asymptomatic patient should be considered carefully because of the serious nature of some complications²¹ (class III indication according to NASPE recommendations).⁵ The AP site may influence the rate of complications: more AP ablations in the area near the bundle of His are performed at centers reporting complications than at centers reporting no complications. The use of cryoablation (reported by one center for AP ablation) may reduce the rate of AV block for this substrate.²²

Greater use of 8-mm tip and irrigated tip catheters (3% in 2001 vs 17% in 2002) may have been responsible for the increased rate of complications reported for FAT ablation (0% in 2001 vs 2% in 2002), particularly as two of the 3 complications were pericardial effusion.

The rate of complications has decreased for other substrates (PIVT, NI-VT and FA). The decrease for FA (16% in 2001 vs 9.3% in 2002) is particularly notable. The rate of ischemic events after ablation of this substrate decreased sharply (from 9% in 2001 to 2% in 2002) probably because of greater experience and caution when handling the catheters and sheaths. In this registry, detection of anastomosis of pulmonary veins (which developed without symptoms) by nuclear magnetic resonance was reported in 2 patients. Saad et al²³ have recently reported a rate of pulmonary vein stenosis of 5% (more than half with symptoms). The increase in the number of procedures performed and systematic use of nuclear magnetic resonance²⁴ may lead to the detection of more cases.

Mortality in this registry (0.04%) was lower than that observed in the 2001 registry (0.1%), and is similar to that of the NASPE registry⁶ (0.03%). The substrates in the 2 patients who died are not normally associated with structural heart disease (AVNRT and FAT). We should mention, however, that the patient with AVNRT had hypertensive heart disease, and that in both cases death was due to massive pulmonary thromboembolism some days after the ablation procedure. Some authors suggest the use of anticoagulation in some patients in ablation procedures involving the right side of the heart, particularly when the procedures are prolonged.⁵ Nevertheless, the rate of pulmonary thromboembolism in 2002 was 0.06% (n=3 patients).

Limitations

This registry, like all such registries of activity, is limited only by the retrospective and voluntary nature of data collection. The SEA is compiling a prospective registry that will improve the quality of data and allow more complete analyses to be performed. Although the voluntary nature may influence the degree of participation, almost 90% of the centers returned the questionnaire. We should also mention that well-defined criteria for acute effectiveness are still unavailable for some substrates such as atrial fibrillation—with new and still-evolving approaches to treatment—and some substrates such as ventricular tachycardia or macro-reentrant atrial tachycardia/atypical flutter, for which new mapping systems have been introduced to increase success. The interpretation of outcomes in such cases may vary according to the center.

CONCLUSIONS

Like the previous registry, the Spanish Registry of Catheter Ablation for 2002 compiles one of the largest samples of ablation procedures published to date. This registry can be considered representative of the activity and outcome of this procedure in Spain. The effectiveness of this procedure in Spain remains high (93%) and the rates of major complications (1.1%) and mortality (0.4%) are still low.

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List of physicians responsible for data management in the centers participating in the Spanish Registry of Ablation for 2002

J. Amador, A. Arenal, Arcocha, A. Barrera, A. Bodegas, J. Brugada, J.A. Cabrera, J.R. Carmona, E. Castellanos, J. Esteve, C. Expósito, I. Fernández Lozano, M.L. Fidalgo, H. Fornieles, A. García Alberola, I. García Bolao, J. García García, D. García Medina, J. Hernández, C. Ledesma, M. López Gil, J. Martí, J. Martínez, J.L. Martínez Sande, J.L. Merino, A. Moya, A. Pachón, A. Pastor, A. Pedrote, L. Pérez Álvarez, N. Pérez Castellano, A. Quesada, Rodríguez Entem, G. Rodrigo Trallero, E. Ruiz Granel, X. Sabaté, J. Segura, L. Tercedor, and M. Torner.

ANNEX 1

Spanish Registry of Ablation 2002..... **Center code :**

Hospital:

Demographic data:

Address:

Province: Zip code :

Telephone: Extension: Fax:

Physician responsible for data management: Contact cell phone:

E-mail contact:



Spanish Registry of Ablation 2002 **Center code:**

Autonomous region.....

Hospital type*: University/Tertiary/Secondary-District
Public/Private/Military *Circle all applicable .

Department: Cardiology department/Cardiology section (Internal Medicine Department)/Intensive care/Other

Cardiovascular surgery at the center: Yes/No

No. of inhabitants served by the hospital:

No. of patients on ablation waiting list on 31/12/2001:

No. of patients outside district on ablation waiting list on 31/12/2001:

Laboratory staff:

No. of staff physicians*: No. of full-time staff physicians*:

No. research fellows/grant holders/years:

No. of residents/year: (e.g. one every 6 months would be: 1/year):

No. assistant nurses/RNs:

No. radiologist assistants:

No. of auxiliary assistant nurses/RNs:

Laboratory information:

No. and type of x-ray rooms: Conventional____/Digital_____

Room dedicated exclusively to electrophysiology/pacemakers: Yes/No

Days of week dedicated to electrophysiology:

Are pacemakers implanted in the room?: Yes/No

Are automatic defibrillators implanted in the room?: Yes/No

Is scheduled cardioversion performed in the room?: Yes/No

Other procedures performed in the room:

Digital polygraph: Yes/No

Polygraph make and model

Special techniques available

Intracardiac non-fluoroscopic navigation: CARTO ENSITE LOCALISA

Other Describe:

Intracardiac echography: Yes/No

Cryoablation: Yes/No

Ultrasound ablation: Yes/No

Therapeutic activity

Total no. of patients treated by ablation:

Total no. of ablation procedures:

No. of substrates treated by ablation:

Total no. of successful ablation procedures:

Total no. of ablation procedures after recurrence:

Total no. of complications:

Normal laboratory policy

IV heparinization for diagnostic electrophysiology studies: Yes/No

IV heparinization for transvenous ablation: Yes/No

IV heparinization for arterial/transseptal ablation: Yes/No

Time to success after RF ablation:

Transseptal catheterization Not performed Electrophysiologists Interventional cardiologist

Electrophysiologists+Interventional cardiologist

ANNEX 1. (cont.)

Ablations by substrate: (atrioventricular nodal reentrant tachycardia, accessory pathways, AV conduction, focal atrial tachycardia, cavotricuspid isthmus, atypical atrial flutter/macro-reentrant atrial tachycardia, atrial fibrillation, idiopathic ventricular tachycardia, postinfarction macro-reentrant ventricular tachycardia, non-ischemic macro-reentrant ventricular tachycardia)

1. No. of patients/procedures:/.....
 No. of substrates treated by site:/...../.....
2. No. of patients with successful outcome:
 No. of successful procedures by site:/...../.....
3. No. of procedures with non-standard ablation catheter:
 - a) 8 mm
 - b) Irrigated tip
 - c) Cryoablation
 - d) Other (describe)
4. No. of complications:
 - a) AVB requiring pacemaker
 - b) Vascular complications (V/A)/.....
 - c) Pericardial effusion/CT/.....
 - d) Embolism/CVA/TIA/.....
 - e) AMI or ischemia
 - f) CHF or APE
 - g) Other (describe)
5. Perioperative death
6. Comments:

ANNEX 2. Electrophysiology laboratories by autonomous region and province participating in the Spanish Registry of Catheter Ablation in 2002

ANDALUSIA	CASTILE-LA MANCHA	GALICIA
<i>Almería</i>	<i>Toledo</i>	<i>La Coruña</i>
Hospital Torrecárdenas	Hospital Virgen de la Salud	Hospital Clínico de Santiago de Compostela
<i>Cordoba</i>	CASTILE AND LEON	Hospital Juan Canalejo
Hospital Reina Sofía	<i>Leon</i>	MADRID
<i>Granada</i>	Hospital de Leon	Clínica Puerta de Hierro
Hospital Virgen de las Nieves	<i>Salamanca</i>	Hospital 12 de Octubre
<i>Malaga</i>	Hospital de Salamanca	Hospital de Alcorcón
Hospital Virgen de la Victoria	CATALONIA	Hospital Clínico San Carlos
<i>Seville</i>	<i>Barcelona</i>	Hospital de Getafe
Hospital Virgen de Valme	Ciudad Sanitaria de Bellvitge	Hospital Gregorio Marañón
Hospital Virgen del Rocío	Hospital Clínic	Hospital La Paz
ARAGON	Hospital del Mar	Fundación Jiménez Díaz
<i>Saragossa</i>	Hospital de la Santa Creu i Sant Pau	Clínica USP San Camilo*
Hospital Clínico de Zaragoza	Hospital Vall d'Hebron	Clínica de la Zarzuela*
ASTURIAS	Centro Cardiovascular Sant Jordi*	MURCIA
Hospital Central de Asturias	Clínica Sagrada Familia*	Hospital Virgen de la Arrixaca
BALEARIC ISLANDS	Hospital San Joan de Déu	NAVARRRE
Hospital Son Dureta	VALENCIAN AUTONOMOUS REGION	<i>Clínica Universitaria de Navarra*</i>
CANARIES ISLANDS	<i>Alicante</i>	Hospital de Navarra
<i>Gran Canaria</i>	Hospital General de Alicante	BASQUE COUNTRY
Hospital Insular	<i>Valencia</i>	<i>Biscay</i>
<i>Tenerife</i>	Hospital General de Valencia	Hospital de Basurto
Hospital Ntra. Sra. Candelaria	Hospital Clínico de Valencia	Hospital de Cruces
CANTABRIA		
<i>Santander</i>		
Hospital de Valdecilla		

*Exclusively private centers.