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## Special article

# Spanish Cardiac Catheterization and Coronary Intervention Registry. 30th Official Report of the Interventional Cardiology Association of the Spanish Society of Cardiology (1990-2020) in the year of the COVID-19 pandemic



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## Article history:

Received 7 July 2021

Accepted 4 August 2021

Available online 28 October 2021

## Keywords:

Cardiovascular disease

Drug-eluting stent

Myocardial infarction

Coronavirus

## ABSTRACT

**Introduction and objectives:** The Interventional Cardiology Association of the Spanish Society of Cardiology (ACI-SEC) presents its annual activity report for 2020, the year of the coronavirus disease (COVID-19) pandemic.

**Methods:** All Spanish centers with catheterization laboratories were invited to participate. Data were collected online and were analyzed by an external company, together with the members of the ACI-SEC.

**Results:** A total of 123 centers participated (4 more than 2019), of which 83 were public and 40 were private. Diagnostic coronary angiograms decreased by 9.4%, percutaneous coronary interventions by 10.1%, primary percutaneous coronary interventions by 4.1%, transcatheter aortic valve replacements by 0.9%, and left atrial appendage closure by 8.3%. The only procedures that increased with respect to previous years were edge-to-edge mitral valve repair (13.8%) and patent foramen ovale closure (19.4%). The use of pressure wire (5.5%), intravascular imaging devices and plaque preparation devices decreased (with the exception of lithotripsy, which increased by 62%).

**Conclusions:** In the year of the COVID-19 pandemic, the registry showed a marked drop in activity in all procedures except for percutaneous mitral valve repair and patent foramen ovale closure. This decrease was less marked than previously described, suggesting a rebound in interventional activity after the first wave.

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## Registro Español de Hemodinámica y Cardiología Intervencionista. XXX Informe Oficial de la Asociación de Cardiología Intervencionista de la Sociedad Española de Cardiología (1990-2020) en el año de la pandemia de la COVID-19

## RESUMEN

**Introducción y objetivos:** La Asociación de Cardiología Intervencionista de la Sociedad Española de Cardiología (ACI-SEC) presenta su informe anual de actividad de 2020, año de la pandemia de la COVID-19.

**Métodos:** Se invitó a participar a todos los centros españoles con sala de hemodinámica. La recogida de datos se realizó por vía telemática y una empresa externa, junto con los miembros de la ACI-SEC, llevó a cabo su análisis.

**Resultados:** Participaron 123 centros (4 más que el año previo), 83 públicos y 40 privados. Se observó una reducción del 9,4% de coronariografías, el 10,1% de intervenciones coronarias percutáneas, el 4,1% de angioplastias primarias, el 0,9% de válvulas aórticas transcáteter y el 8,3% de cierre de orejuelas. Los únicos procedimientos que se incrementaron con respecto a años previos fueron la reparación mitral con clips (13,8%) y el cierre del foramen oval permeable (19,4%). En cuanto a los dispositivos, disminuyeron las guías de presión (5,5%), la imagen intravascular y los dispositivos de preparación de placa (a excepción de la litotricia, que aumentó un 62%).

## Palabras clave:

Enfermedad cardiovascular

Stent farmacoactivo

Infarto de miocardio

Coronavirus

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◇ The collaborators are listed in appendix 1.

**Conclusiones:** El registro en el año de la pandemia de la COVID-19 demuestra una marcada caída en la actividad de todos los procedimientos a excepción de la reparación percutánea de la válvula mitral con clips y el cierre del foramen oval permeable. Dicha caída es menor que lo descrito previamente, lo cual indica un rebote de la actividad intervencionista tras la primera ola.

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### Abbreviations

ACI-SEC: Interventional Cardiology Association of the Spanish Society of Cardiology

PCI: percutaneous coronary intervention

TAVI: transcatheter aortic valve implantation

## INTRODUCTION

Since 1990, the Steering Committee of the Interventional Cardiology Association of the Spanish Society of Cardiology (ACI-SEC) has collected activity data from cardiac catheterization and interventional cardiology laboratories in Spain.<sup>1–5</sup> The data typically obtained from the national registry are very important because they shed light on the changes over time in interventional activity volume in Spain, the implementation and growth of new techniques and health care networks, and the variability among different regions. The annual registry proves the transparency of all of the registry centers and their commitment to continuous improvement.

In addition, the 30th registry report (1990–2020) is particularly important because it is a record of the first year of the SARS-CoV-2 pandemic. Various articles have shown that interventional activity significantly fell in the first months of the pandemic (March to May 2020) due to the coronavirus disease 2019 (COVID-19)-related saturation of the health care system, the drop in health care seeking due to fear of infection, or the effect of competing risk.<sup>6–9</sup> Thus, the present registry is vital for estimating the overall and regional impact of the pandemic on interventional activity in Spain in 2020.

Data were submitted voluntarily, online, and without audit. The database, which has been updated, is managed by an independent external company. Subsequently, the ACI-SEC committee cleaned the data, which were presented to the public in an online seminar on June 29, 2021, and in-person at the ACI-SEC congress in September 2021 in Málaga.

The objective of the present article was to present the 30th report on interventional activity in Spain, the first year of the COVID-19 pandemic.

## METHODS

### Design

The registry is retrospective and voluntary and the data are submitted online and without audit. The registry comprises 295 variables; 50 must be completed. Data collection was performed via an online database that was accessed through a link sent by e-mail to the responsible researcher in each center or through the ACI-SEC website.<sup>10</sup> The study period ran from January 1

to December 31, 2020. Data collection took place between April and May, 2021.

An external company (Tride, Madrid) and members of the ACI-SEC committee analyzed the data together. The data were cleaned by the ACI-SEC committee, and discordant data or data deviating from the trend in a center were verified with researchers in the center in question. None of the data from this registry have been published, although a summary was presented in the above-mentioned online seminar.

Absolute (n) and relative (%) data are reported. Comparisons were made with previous years and also among different autonomous communities.

### Study population

Via e-mail and/or telephone call, 126 hospitals were invited to participate; 84 were public and 42 were private (appendix 2). The study population was taken from the Spanish National Institute of Statistics for January 1, 2020.<sup>11</sup> The Spanish population was estimated at that time to be 47 450 795 inhabitants. The number of procedures per million population for the country as a whole was calculated using the total population.

## RESULTS

### Infrastructure and resources

In 2020, 123 of the 126 invited centers participated (97.6%). Of the 84 publicly-funded centers invited, 83 provided data (98.8%), while 40 of the 42 private centers provided data (95.2%). This represented an increase vs previous years (107 in 2017, 109 in 2018, 119 in 2019, and 123 in 2020). Compared with 2019, the same number of publicly-funded centers participated (n = 83) but there were 4 more private centers (36 in 2019 and 40 in 2020). In addition, 281 catheterization laboratories were recorded (vs 263 in 2019); of these, 160 (56.9%) were exclusively for cardiac catheterization, 77 (27.4%) were shared, 31 (11%) were hybrid, and 13 (4.7%) were supervised.

Regarding human resources, the centers reported that 496 interventional cardiologists, most (468) accredited by the ACI-SEC; 112 (23.9%) were women, which was a similar percentage to 2019 (23.7%). The number of fellows fell once again (67 vs 79 in 2019 and 90 in 2018). There was a slight uptick in the number of registered nurses (739) and radiology technicians (94).

### Diagnostic activity

In the first year of the COVID-19 pandemic and lockdowns, interventional diagnostic activity fell by 10.7% in Spain (147 000 vs 165 124 in 2019), which broke the upward trend of previous years and returned the levels to those of 2014. Of these procedures, most were coronary angiograms (131 946, a 9.4% reduction vs 2019), followed by endomyocardial biopsies and studies of patients with valvular heart disease.

As a consequence of the reduced activity, just 15 centers (12.3% of participating centers) performed more than 2000 coronary angiograms, vs 20 centers (16.8%) in 2019. As in previous years, the preferred access route was radial (90.5% of studies). The national average of coronary angiograms fell to 2806/million population; the steepest falls were recorded in the Region of Murcia, Cantabria, and Castile-La Mancha, while the lowest reductions per million population were in the Balearic Islands and the Chartered Community of Navarre.

Regarding cardiac computed tomography studies, 111 of the 122 centers reported the availability of this technique; the number of examinations fell from 14 156 in 2019 to 13 137 in 2020.

### Intracoronary diagnostic techniques

Pressure guidewire use consistently increased from 2011 to 2019, eventually tripling the original level. However, it fell in 2020 by 5.3% to 8683 procedures (figure 1). Intravascular ultrasound (IVUS) was relatively stable and optical coherence tomography dropped by 2.9%.

The highest penetrance of pressure guidewire or intravascular imaging was asymmetrical among autonomous communities (figure 2). Pressure guidewire use was highest in Navarre, the Basque Country, and Aragon (with 19 guidewires/100 percutaneous coronary interventions [PCIs]) and lowest in Castile-La Mancha and the Canary Islands (6/100 PCIs). In contrast, the highest penetrance of intravascular imaging was in Aragon and Murcia (21 and 20/100 PCIs, respectively); the lowest was in Andalusia and the Canary Islands.

### Coronary interventions

During the first year of the pandemic, the number of PCIs fell by 10.1%. Its levels are now around those of 2015. This reduction paralleled that in diagnostic activity because the PCI/coronary angiogram ratio was unchanged from previous years (0.52). The decrease also did not disproportionately affect any subgroup of patients because the percentages of women (19.1%) and patients older than 74 years (21%) were stable. The average rate in Spain was 1450 PCIs/million population (figure 3); the highest rates were seen in the Basque Country and Castile and León, as in previous years. Only 2 centers reported more than 1500 PCIs, while just 17 documented more than 1000 (13.9% of centers vs 22.7% in 2019).

Radial access became consolidated as the most commonly used approach for PCI and has maintained an upward trend from 2006 (29%) to 2020 (91.1%). Drug-eluting stent use became the norm in 2020; of 92 771 implanted stents, 89 706 were drug-eluting stents and all autonomous communities except Murcia (88%) exceeded 94%. The use of bioabsorbable devices or dedicated bifurcation stents was limited (<0.5%). Regarding the PCI type, most interventions were single-vessel PCIs and only 20% were multi-vessel. The stent/angioplasty ratio was similar to that of previous years (1.6 stents/PCI). Complex and high-risk interventional procedures also fell in the first year of the pandemic, with a highly pronounced reduction in the number of chronic occlusions (–25%) and of left main coronary artery interventions (a drop of 380 procedures [9.2%]) (figure 4). All plaque and calcium modification techniques fell, except lithotripsy, which increased by 62% to reach 586 balloons/y. The rotational atherectomy/lithotripsy ratio fell from 4.5 in 2019 to 2.2 in 2020. Circulatory assist device use was similar to that of previous years—247 Impella (Abiomed, United States) and 1020 balloon pumps—but extracorporeal membrane oxygenation (ECMO) use increased by 34% (from 113 in 2019 to 151 in 2020). This increase was probably related to COVID-19.

### Coronary interventions in acute myocardial infarction

In 2020, coronary angioplasty in acute myocardial infarction dropped by 1490 procedures to 21 039 (–5.5%). Of these, 94.3% were primary angioplasties; the remainder were rescue angioplasties or angioplasties after successful fibrinolysis. Primary angioplasty showed the steepest fall, while rescue angioplasty increased by 17%. The percentage of women fell from 27.8% in 2019 to 25% in 2020. The primary angioplasty rate fell in Spain to 422/million population (figure 5). This reduction occurred in most autonomous communities, except La Rioja, Galicia, the Canary Islands, and Madrid. Primary PCIs represented 29.5% of all angioplasties, a slight increase vs previous years. Regarding the number of primary angioplasties/center, the number of centers performing more than 300 primary angioplasties decreased from 26 to 2019 to 20 in 2020. At the other extreme, the number performing fewer than 50 increased from 34 to 40.

Concerning the technical aspects of primary angioplasty, the radial approach was the norm (91.1%), as in conventional angioplasty. Despite evidence against them, thrombus aspiration

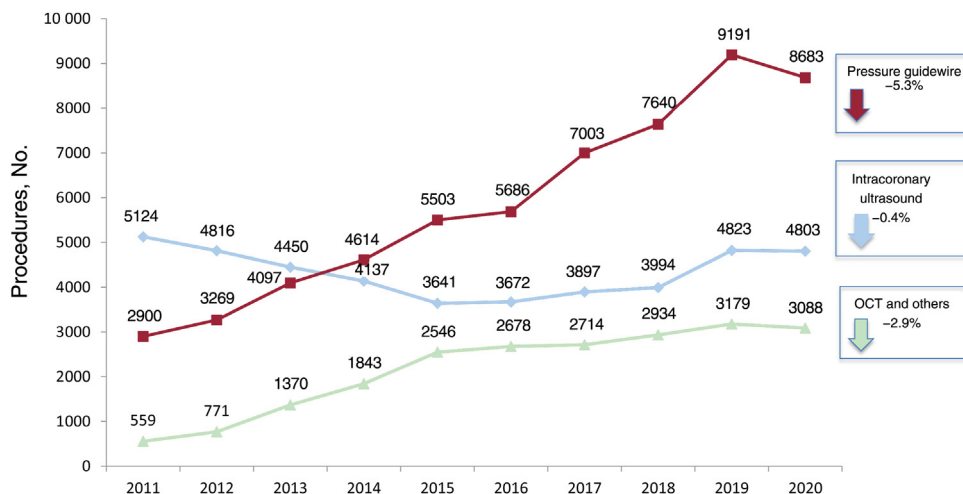
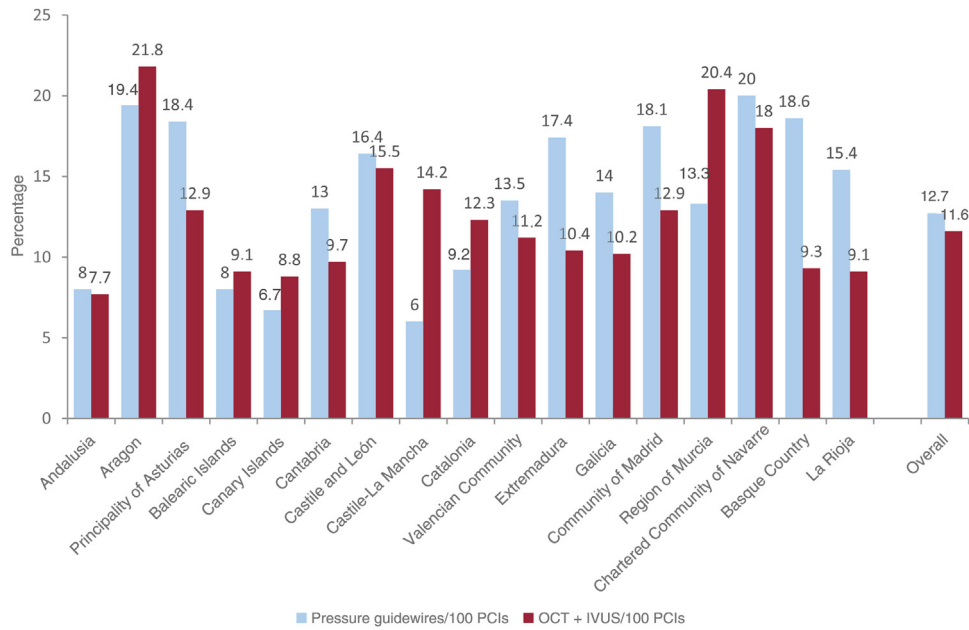


Figure 1. Changes over time in the numbers of the various intracoronary diagnostic techniques. OCT, optical coherence tomography.



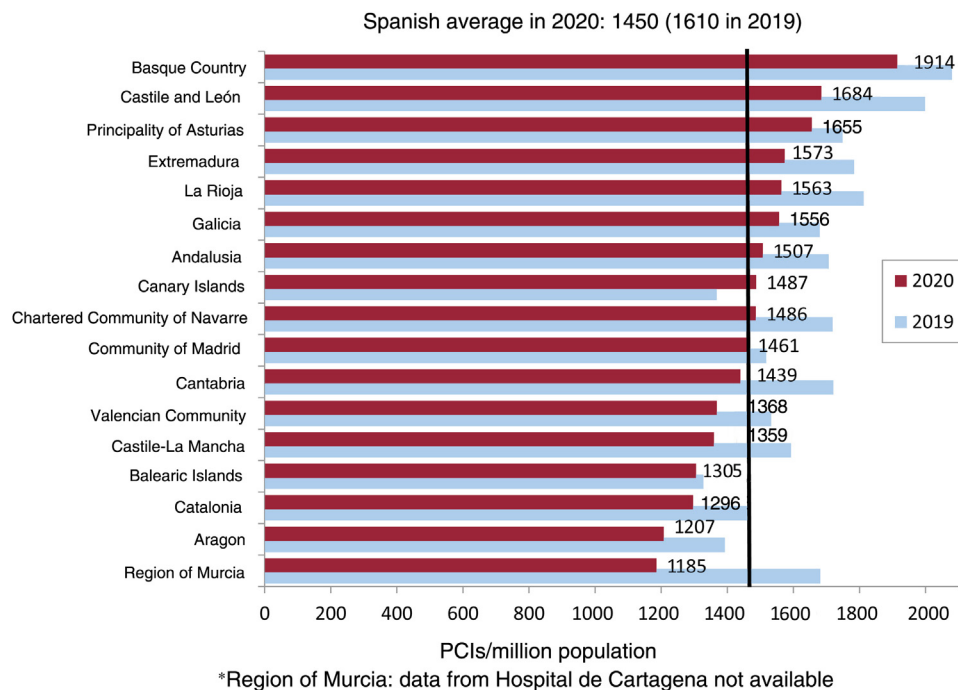
**Figure 2.** Intracoronary diagnostic techniques for every 100 PCIs in each autonomous community. IVUS, intravascular ultrasound; OCT, optical coherence tomography; PCI, percutaneous coronary intervention.

devices were used in 34% of cases. Glycoprotein IIb/IIIa inhibitors were administered in 16.4% of cases.

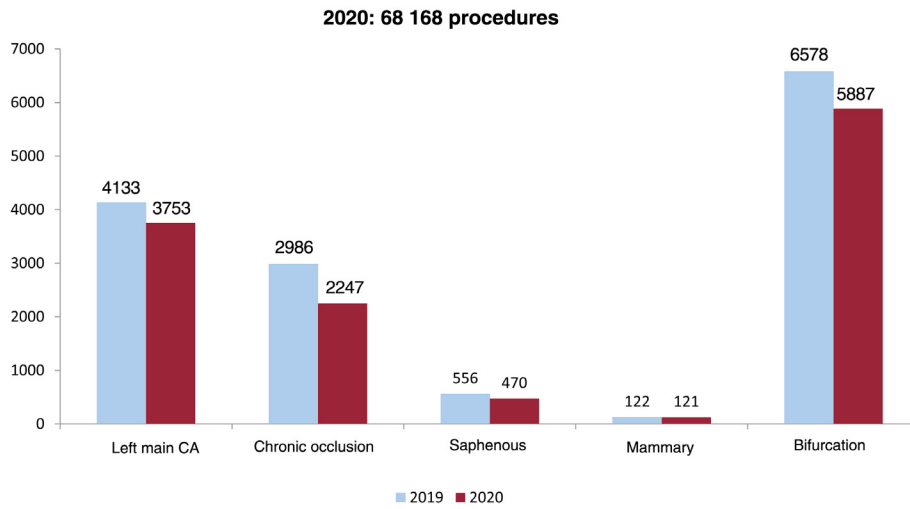
**Aortic valve interventions**

In 2020, 226 aortic valvuloplasties were performed, 30% fewer than in the previous year and a return to 2014 levels. The number of transcatheter aortic valve implantations (TAVIs), which had been consistently growing at about 20% to 37% per year since 2014,

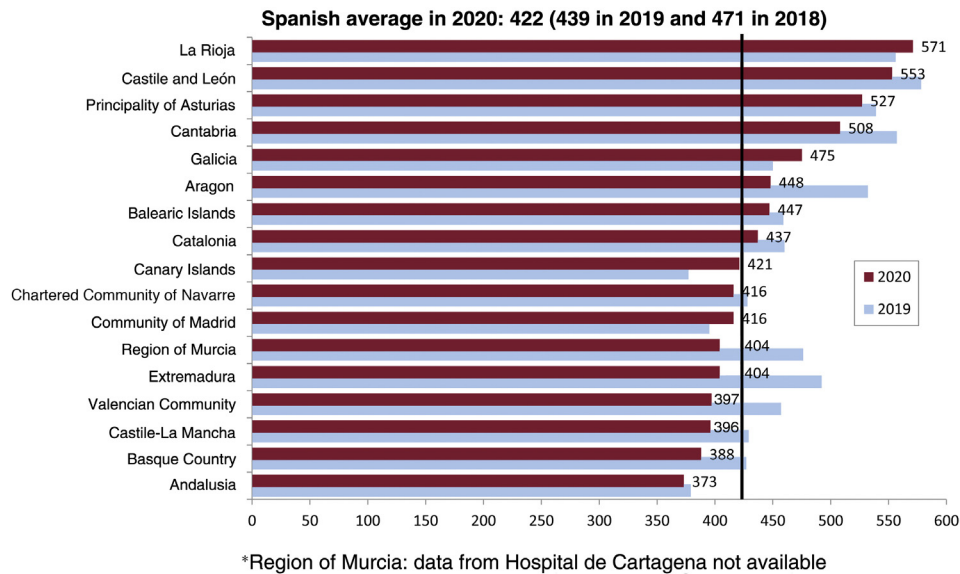
fell by 0.9% (4241 implants). Of these, 185 involved device implantation within another failed bioprosthesis (valve-in-valve). TAVI number per million population in Spain was 89.4 (figure 6) vs 90.9 in 2019. Cantabria, the Canary Islands, Catalonia, and the Balearic Islands showed increases from 2019, while the TAVI number per million population fell in the remaining autonomous communities. Nonetheless, the communities with the most TAVIs per million population were Galicia, Cantabria, and Madrid. Just 16 centers (14%) performed more than 100 implants, while most (75 centers, 65.8%) performed fewer than 50.



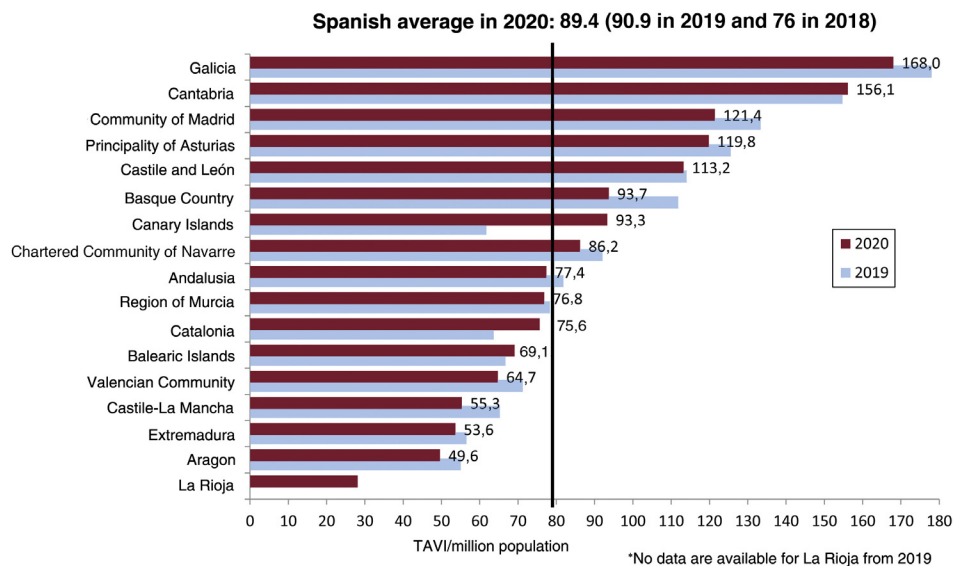
**Figure 3.** Percutaneous coronary interventions (PCIs) per million population in 2019 and 2020. Spanish average and total by autonomous community.



**Figure 4.** Numbers of complex percutaneous coronary interventions in 2019 and 2020. CA, coronary artery.



**Figure 5.** Primary angioplasties per million population in 2019 and 2020. Spanish average and total by autonomous community.



**Figure 6.** Transcatheter aortic valve implantations (TAVIs) per million population in 2019 and 2020. Spanish average and total by autonomous community.



Regarding the technical aspects, transfemoral access was the approach of choice in 96.2% of cases (93.0% percutaneous and 3.2% surgical). The nontransfemoral access routes chosen were the subclavian (2.2%) and, rarely, the transapical approach (<1%). The type of valve most frequently implanted in the 3904 cases with this information was the balloon expandable (1707, 43.7%) (Edwards Lifesciences, United States), followed by the Evolut self-expanding valve (1341, 34.3%) (Medtronic, United States) and the self-expanding Acurate Neo (406, 10.4%) (Boston Scientific, United States). Other valves implanted with lower frequency were Portico (293, 7.5%) (Abbott Vascular, United States) and, in lower numbers, Lotus (Boston Scientific), MyVal (Meril, India), and Allegra (Biosensors, Singapore). Regarding the patient profile, most patients (65.5%) were older than 80 years.

### Mitral and tricuspid valve interventions

In 2020, the downward trend in mitral valvuloplasties became consolidated; this trend has been evident since 2011. Overall, 164 procedures were performed in Spain, fewer than half that in 2011.

In addition, 31 prostheses were percutaneously implanted in the mitral position (most within the annulus or a failed bioprosthesis), which was more than double the number of previous years.

Despite the SARS-CoV-2 pandemic, there was significant growth in percutaneous mitral valve repair with the edge-to-edge clip technique. In total, 438 procedures were performed vs 385 in 2019 (a 14% increase); a total of 596 clips were implanted (giving a clip/procedure ratio of 1.4, which indicates no change vs 2019; 64% of procedures involved a single clip). Secondary mitral regurgitation was the most commonly treated etiology (50.1%), followed by degenerative (36.6%) and mixed (13.2%).

Tricuspid valve activity was still limited, although there was a notable increase vs 2019. Thus, 15 TAVIs were performed in the tricuspid position, 46 valves in the bicaval heterotopic position (6 in 2019 and 2 in 2018), and 37 clip repairs (18 in 2019).

### Nonvalvular structural interventions

Left atrial appendage closure, which grew by 43% in 2019, fell by 8% in 2020, dropping to 845 procedures. Of these, 489 patients used the Amulet device (Abbott Vascular, United States), 313 used the Watchman (Boston Scientific, United States), and 132 used the LAmbré (Lifetech Scientific, United States), which was the only device showing growth (38% vs 2019).

In total, 186 patients underwent paravalvular leak treatment (203 in 2019); there was a minute increase in the closure of mitral leaks (113 in 2019 vs 117 in 2020) and a decrease in that of aortic leaks (90 in 2019 vs 69 in 2020).

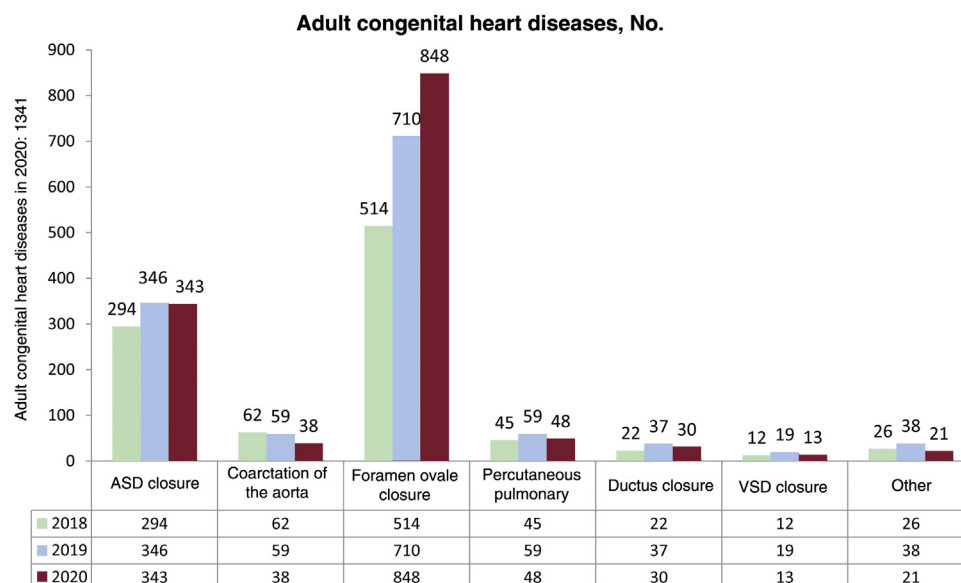
Moreover, there were 98 cases of alcohol septal ablation (114 in 2019), 36 coronary fistula occlusions (34 in 2019), 25 endovascular aortic repairs (50 in 2019), 18 renal denervations (39 in 2019), 17 pulmonary vein dilatations (11 in 2019), 16 coronary sinus reducers (9 in 2019), 13 interatrial shunts (9 in 2019), and 74 balloon pericardiectomies (64 in 2019). In addition, 103 percutaneous procedures were performed to treat pulmonary thromboembolisms in acute cases (vs 133 in 2019), as well as 119 in chronic cases (vs 162 in 2019).

### Interventions in adult congenital heart disease

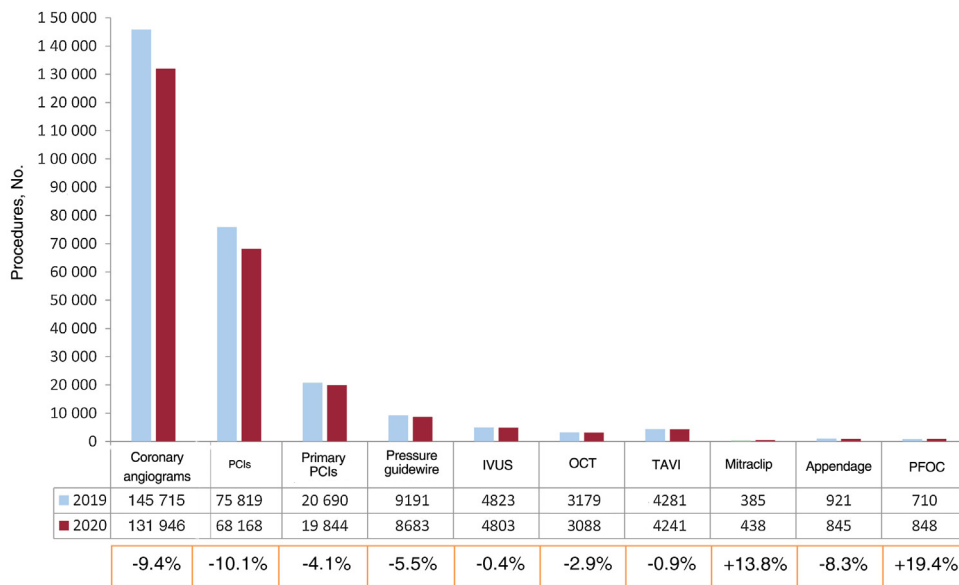
A total of 1341 procedures were performed in adult congenital heart diseases. This represented a 5.8% increase vs 2019, largely due to patent foramen ovale closure, which was the only procedure showing growth, with 848 cases (710 in 2019 and 514 in 2018) (figure 7). The other procedures fell vs previous years: 343 atrial septal defect closures, 38 aortic coarctation closures, 30 ductal closures, and 13 ventricular septal defects.

### DISCUSSION

We have summarized interventional activity in Spain in 2020, the first year of the SARS-CoV-2 pandemic (figure 8). The main findings were: a) most procedures showed notably decreased



**Figure 7.** Number of procedures in adult congenital heart diseases in 2018, 2019, and 2020. ASD, atrial septal defect; VSD, ventricular septal defect.



**Figure 8.** Overview of the relative increase or decrease in each procedure in 2020 vs 2019. IVUS, intravascular ultrasound; OCT, optical coherence tomography; PCI, percutaneous coronary intervention; PFOC, patent foramen ovale closure; TAVI, transcatheter aortic valve implantation.

activity in 2020 compared with the upward trend of previous years; *b*) only patent foramen ovale closure and mitral valve clip repair increased vs previous years (19.4% and 13.8%, respectively); and *c*) there was once again marked heterogeneity among autonomous communities in the penetrance of treatments with proven prognostic impact, such as primary angioplasty, pressure guidewires, and TAVI.

In previous studies, we showed that, during the first weeks of the lockdown in March and April 2020, some interventional procedures fell markedly, such as primary angioplasty<sup>6</sup> and TAVI.<sup>12</sup> However, this article is the first to compile the totality of procedures in Spain throughout 2020. Notably, the observed reduction was lower than that described during the first weeks of the first lockdown, which indicates a rebound in activity after the first wave of the pandemic. For example, a recent article reported reductions in PCI of 48% and in structural procedures of 81% in Spain,<sup>13</sup> whereas the current registry showed reductions of 10.1% in PCI and of < 1% in TAVI. Among all procedures, those with the steepest falls were diagnostic catheterizations and nonurgent PCIs, at close to 10%. It must be highlighted that, whereas primary angioplasty fell by 4.1%, rescue angioplasty increased, which may reflect greater penetrance of pharmacological reperfusion during the weeks of the worst hospital saturation in the first wave of the pandemic.<sup>14</sup>

Of the gamut of interventional procedures, those with the greatest falls were certain structural procedures such as TAVI. However, some even increased, such as mitral valve clip repair, tricuspid valve treatment, and patent foramen ovale closure. Of these, patent foramen ovale closure stood out, given that it is a preventive procedure and, thus, not clinically urgent, which suggests the huge growth remaining for this technique based on the latest scientific evidence regarding stroke recurrence prevention.<sup>15</sup>

A marked heterogeneity in the application of different treatments has become consolidated over the years among the various autonomous communities in Spain. This heterogeneity is particularly significant when it concerns techniques or procedures that are associated with a major prognostic impact and are based on solid scientific evidence. This is the case, for example, with the

pressure guidewire<sup>16</sup> (figure 2); whereas some autonomous communities such as Navarre, Aragon, Asturias, the Basque Country, and Madrid approach the European average of 1 pressure guidewire for every 5 PCIs, Castile-La Mancha, the Canary Islands, the Balearic Islands, and Andalusia performed less than 1 for every 12 PCIs. The case of TAVI is also particularly striking; severe aortic stenosis is the most frequent valvular heart disease in the adult population, affecting 5% of individuals older than 65 years and showing 97% mortality at 5 years.<sup>17</sup> Based on its proven effectiveness in recent studies, clinical practice guidelines award TAVI a strong recommendation.<sup>18</sup> Nevertheless, although some Spanish autonomous communities such as Galicia and Cantabria greatly exceeded the European average of 141 TAVIs/million population,<sup>17</sup> most were below; this was the case for Aragon and La Rioja in particular, which failed to reach even 50/million.

## CONCLUSIONS

In the first year of the COVID-19 pandemic, the Spanish Cardiac Catheterization and Coronary Intervention Registry revealed a marked decrease in activity in all procedures, except for percutaneous mitral valve clip repair and patent foramen ovale closure. This fall was lower than previously described, which indicates a rebound in interventional activity after the first wave of the pandemic.

## ACKNOWLEDGMENTS

The Steering Committee of the ACI-SEC would like to thank our collaborators for their work and effort, which make this registry possible, particularly given the difficult situation caused by the COVID-19 pandemic.

## FUNDING

None.



## AUTHORS' CONTRIBUTIONS

All authors significantly contributed to the data collection and the critical revision of the manuscript. R. Romaguera, S. Ojeda, I. Cruz-González, and R. Moreno drafted the manuscript.

## CONFLICTS OF INTEREST

None declared.

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## APPENDIX 2. CENTERS PARTICIPATING IN THE REGISTRY

Autonomous community	Center	Type of center
Andalusia	Hospital Virgen del Rocío	Public
	Hospital Universitario Puerta del Mar	Public
	Hospital Juan Ramón Jiménez Huelva	Public
	Hospital Universitario de Puerto Real	Public
	Hospital Universitario de Valme	Public
	Hospital Universitario de Jerez	Public
	Hospital Universitario Clínico San Cecilio	Public
	Hospital Virgen de las Nieves	Public
	Hospital Regional Universitario de Málaga	Public
	Hospital Universitario de Jaén	Public
	Hospital Virgen de la Victoria	Public
	Hospital Costa del Sol	Public
	Hospital Universitario Virgen Macarena	Public
	Hospital Universitario Torrecárdenas	Public
	Hospital Universitario Reina Sofía	Public
	Hospiten Estepona	Private
	Hospital Cruz Roja	Private
	Hospital Helicópteros Sanitarios	Private
	Viamed Santa Ángela de la Cruz	Private
	Hospital San Agustín	Private
Quirón Sagrado Corazón	Private	
Hospital Quirónsalud Córdoba	Private	
Aragon	Hospital Universitario Miguel Servet	Public
	Hospital Clínico Lozano Blesa	Public
Principality of Asturias	Hospital de Cabueñes	Public
	Hospital Universitario Central de Asturias	Public
	Centro Médico de Asturias	Private
Balearic Islands	Hospital Universitario Son Espases	Public
	Clínica Juaneda	Private
	Hospital Quirónsalud Palmaplanas	Private
	Hospital Juaneda Miramar	Private
	Policlínica Nuestra Señora del Rosario	Private
Canary Islands	Hospital Universitario de Canarias	Public
	Hospital Universitario Insular de Gran Canaria	Public
	Hospital Universitario de Gran Canaria Dr. Negrín	Public
	Hospital Universitario Nuestra Señora de Candelaria	Public
	Hospiten Rambla y Sur	Private
Cantabria	Hospital Marqués de Valdecilla	Public
Castile-La Mancha	Hospital General Universitario de Ciudad Real	Public
	Complejo Hospitalario Universitario Albacete	Public
	General Universitario Guadalajara	Public
	Complejo Hospitalario de Toledo	Public
Castile and León	Hospital Universitario de León	Public
	Hospital Universitario de Salamanca	Public
	Hospital Clínico Universitario de Valladolid	Public
	Universitario de Burgos	Public
	Hospital Recoletas Campo Grande	Private

**APPENDIX 2. CENTERS PARTICIPATING IN THE REGISTRY**

(Continued)

Autonomous community	Center	Type of center
Catalonia	Hospital del Mar	Public
	Hospital Vall d'Hebron	Public
	Parc Taulí	Public
	Hospital Universitari de Bellvitge	Public
	Hospital Universitario Joan XXIII	Public
	Hospital de Girona Dr. Josep Trueta	Public
	Hospital Universitario Arnau de Vilanova de Lleida	Public
	Hospital Clínic de Barcelona	Public
	Hospital Universitari Germans Trias i Pujol	Public
	Hospital Dexeus	Private
	Hospital de la Santa Creu i Sant Pau	Public
	Hospital Universitari Mútua de Terrassa	Public
	Centro Médico Teknon	Private
	Hospital General de Catalunya	Private
Extremadura	Complejo Hospitalario Universitario de Badajoz	Public
	Hospital Universitario de Cáceres	Public
	Hospital de Mérida	Public
Galicia	Hospital Álvaro Cunqueiro	Public
	Hospital Clínico Universitario de Santiago	Public
	Complejo Hospitalario Universitario A Coruña	Public
	Hospital Universitario Lucus Augusti	Public
	Hospital San Rafael A Coruña	Private
Community of Madrid	Hospital Universitario Ramón y Cajal	Public
	Universitario de la Princesa	Public
	Hospital Universitario 12 de Octubre	Public
	General Universitario Gregorio Marañón	Public
	Hospital Universitario Fundación Jiménez Díaz/Hospital General de Villalba	Public
	Hospital Universitario Puerta de Hierro-Majadahonda	Public
	Hospital Universitario de Torrejón	Public
	Hospital Universitario Fundación Alcorcón	Public
	Hospital Clínico San Carlos	Public
	Hospital Universitario La Paz	Public
	Hospital Rey Juan Carlos	Public
	Hospital Infanta Elena	Public
	Hospital Central de la Defensa Gómez Ulla	Public
	Hospital Universitario Sanitas La Zarzuela	Private
	Hospital Universitario Sanitas La Moraleja	Private
	Hospital Universitario Quirónsalud Madrid	Private
	Complejo Hospitalario Ruber Juan Bravo	Private
	Hospital Nuestra Señora del Rosario	Private
	Vithas Madrid La Milagrosa	Private
	Clínica Nuestra Señora de América	Private
	Hospital Ruber Internacional	Private
	Hospital HLA Universitario Moncloa	Private
	Clínica Universidad de Navarra	Private
Hospital La Luz	Private	
Hospital Quirónsalud Sur Alcorcón	Private	
HM CIEC, Hospital Universitario HM Montepríncipe, Hospital Universitario HM Madrid Norte Sanchinarro, HM CIEC, Hospital Universitario HM Puerta del Sur	Private	
Hospital San Rafael-Madrid	Private	
Region of Murcia	Hospital Universitario Virgen de la Arrixaca	Public
	Hospital la Vega Murcia	Private
	Hospital Quirónsalud Murcia	Private
Chartered Community of Navarra	Complejo Hospitalario de Navarra	Public
	Clínica Universidad de Navarra	Private

## APPENDIX 2. CENTERS PARTICIPATING IN THE REGISTRY

(Continued)

Autonomous community	Center	Type of center
La Rioja	Hospital San Pedro	Public
Valencian Community	Hospital Clínico Universitario de Valencia	Public
	Hospital General de Valencia	Public
	Hospital General Universitario de Castellón	Public
	Hospital Universitario San Juan de Alicante	Public
	Hospital la Ribera	Public
	Hospitales Torrevieja-Salud/Vinalopó Elche	Public
	Hospital Universitario y Politécnico La Fe	Public
	Hospital General Universitario de Alicante	Public
	Hospital de Manises	Public
	Hospital Dr. Peset	Public
	Hospital General Universitario Elche	Public
	Clínica Benidorm	Private
	Hospital Quirón Torrevieja	Private
	Hospital IMED Levante	Private
Basque Country	Hospital Universitario Araba-Txagorritxu	Public
	Hospital de Galdakao-Usansolo	Public
	Hospital Universitario de Cruces	Public
	Hospital de Basurto	Public
	Vithas Hospital Vitoria	Private
	Clínica IMQ Zorrotzaurre	Private
	Policlínica Gipuzkoa-Hospital Donostia	Public

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