The European Society of Cardiology Cardiac Resynchronization Therapy Survey II A comparison of cardiac resynchronization therapy implantation practice in Europe and France

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The European Society of Cardiology Cardiac Resynchronization Therapy Survey II: A comparison of cardiac resynchronization therapy implantation practice in Europe and France

Abbreviated title: French practice in the ESC-CRT survey II

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Summary

Background. – The first European Cardiac Resynchronization Therapy (CRT) Survey, conducted in 2008–2009, showed considerable variations in guideline adherence and implantation practice. A second prospective survey (CRT Survey II) was then performed to describe contemporary clinical practice regarding CRT among 42 European countries.

Aim. – To compare the characteristics of French CRT recipients with the overall European population of CRT Survey II.

Methods. – Demographic and procedural data from French centres recruiting all consecutive patients undergoing either de novo CRT implantation or an upgrade to a CRT system were collected and compared with data from the European population.

Results. – A total of 11,088 patients were enrolled in CRT Survey II, 754 of whom were recruited in France. French patients were older (44.7% aged ≥ 75 years vs 31.1% in the European group), had less severe heart failure symptoms, a higher baseline left ventricular ejection fraction and fewer co-morbidities. Additionally, French patients had a shorter intrinsic QRS duration (19.1% had a QRS < 130 ms vs 12.3% in the European cohort). Successful implantation rates were similar, but procedural and fluoroscopy times were shorter in France. French patients were more likely to receive a CRT pacemaker than European patients overall. Of note, antibiotic prophylaxis was reported to be administered less frequently in France, and a higher rate of early device-related infection was observed. Importantly, French patients were less likely to receive optimal drugs for treating heart failure at hospital discharge.

Conclusion. – This study highlights contemporary clinical practice in France, and describes substantial differences in patient selection, implantation procedure and outcomes compared with the other European countries participating in CRT Survey II.

Résumé

Contexte. – La première enquête Européenne sur la resynchronisation cardiaque (CRT) conduite entre 2008 et 2009 a montré d'importantes différences entre les pays participants en terme de pratiques cliniques et suivi des recommandations. Une deuxième étude prospective et incluant 42 pays a été réalisée afin de décrire plus précisément cette pratique clinique en Europe.

Objectif. – L'objectif est de comparer les caractéristiques de la population Française implantée d'une CRT à l'ensemble de la population Européenne.

Méthodes. – Les caractéristiques des patients et des procédures ont été collectées. Les patients recevant un primo-implantation ou un upgrade en CRT ont été inclus dans cette étude et comparés à la population Européenne.

Résultats. – 11,088 patients ont été inclus dans cette étude, et 754 sont Français. Les patients Français étaient plus âgés (44,7 % avaient > 75 ans vs 31,1 % en Europe), moins symptomatiques, avaient une fraction d'éjection plus élevée et moins de co-morbidités. Les patients Français présentaient également une durée de QRS plus court (19,1 % avec un QRS < 130 ms vs 12,3 % des patients Européens). Le taux de succès d'implantation était similaire entre les 2 groupes mais avec un temps de procédure et de fluoroscopie plus court en France. A noter qu'en France, moins de patients ont été déclarés avoir reçu une antibioprophylaxie avant procédure et ont présenté un taux plus élevé d'infection précoce. Enfin les Français reçoivent moins fréquemment un traitement optimal de l'insuffisance cardiaque à la sortie de l'hôpital.

Conclusion. – Cette étude montre des différences substantielles par rapport à la population Européenne, en termes de sélection de patients, d'implantation et de résultats précoces.

KEYWORDS

Cardiac resynchronization therapy;

Survey;

Heart failure;

Europe population;

French population

Abbreviations: AF, atrial fibrillation; CRT, cardiac resynchronization therapy; CRT-P, cardiac resynchronization therapy pacemaker; CRT-D, cardiac resynchronization therapy defibrillator; ESC, European Society of Cardiology; HF, heart failure; ICD, implantable cardioverter defibrillator; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association.

Background

Cardiac resynchronization therapy (CRT) improves mortality, morbidity and quality of life in patients with heart failure (HF) with severe left ventricular ejection fraction (LVEF) impairment and QRS prolongation on the electrocardiogram [1-7]. According to the current guidelines, CRT is recommended for appropriately selected patients with HF with a high level of evidence [6, 8]. However, as described in the first European Society of Cardiology (ESC) CRT survey (CRT Survey I), implanted patients in routine clinical practice often differ from those enrolled in randomized controlled studies [9]. Indeed, in CRT Survey I, among the 13 ESC member countries enrolled, implanters often extrapolated the benefits of CRT to a broader population, including older patients (aged > 75 years), those with a shorter QRS interval duration (< 120 ms) or atrial fibrillation (AF), and those upgrading from an existing permanent pacemaker or implantable cardioverter defibrillator (ICD) [9]. Additionally, this survey emphasized the disparity between regional and national implantation practices.

The ESC CRT Survey II, initiated jointly by the European Heart Failure Association and the European Heart Rhythm Association, was then designed to accurately describe our clinical practice regarding CRT implantation in a larger population drawn from more ESC member countries. A total of 42 countries were enrolled, which highlighted contemporary clinical practice of CRT and provided relevant information to improve adherence to guidelines. The present study aimed to describe the French patients undergoing CRT, and to compare this population with the overall European cohort.

Methods

Study design

The rationale and design of CRT Survey II have been published previously [10]. Of the 47 ESC member countries detailed in the European Heart Rhythm Association White Book [11], 42 agreed to participate, and 288 individual centres overall were enrolled. All consecutive patients planned for CRT pacemaker/CRT defibrillator (CRT-P/CRT-D) device implantation, *de novo* or upgrade, in a 15-month period (October 2015 to December 2016) were included, regardless of the success of the procedure. Generator replacements or revisions of existing CRT devices were excluded.

Data were collected prospectively using an online database. A central database was created and maintained at the data management centre at the Institut für Herzinfarktforschung in Ludwigshafen, Germany. The data management centre also performed the analyses. CRT Survey II included two internet-based questionnaires [10]. The first was a one-time questionnaire completed by participating centres, and provided information on hospital type, size, population served, number and specialty of implanting physicians, infrastructure, facilities, types of imaging equipment employed, implantation routines for their CRT device programme and the follow-up options provided. The second questionnaire was an electronic case report form for each patient, which collected demographic, medical history and clinical data, as well as procedural and postprocedural details. Of note, short-term outcomes, including adverse events and complications during the index hospitalization, were collected, but information on longer-term outcome was not. Importantly, data from unsuccessful CRT implantations were also included. Ethics approval from the relevant ethics committees in France was obtained. The study protocol complied with the Declaration of Helsinki and Good Clinical Practice.

Statistical analysis

Continuous variables are presented as means with standard deviations, as appropriate. Categorical variables are presented as absolute values and percentages. Continuous variables were compared with non-parametric Mann-Whitney *U* tests, whereas categorical variables were compared with Pearson's χ^2 test. Descriptive statistics were calculated for the available cases. All *P* values are the results of two-tailed tests, and a value < 0.05 was considered significant. Statistical analysis was carried out using SAS statistical software, version 9.1 (SAS Institute, Cary, NC, USA).

Results

Baseline characteristics

During the 15-month enrolment period, a total of 11,088 patients were included in CRT Survey II, 754 of whom were recruited at 14 French centres. As described in Table 1, French patients were significantly older than those in the European cohort, with a higher proportion of CRT-P implantation and patients aged ≥ 75 years (44.7% vs 31.1%; *P* < 0.001). Co-morbidities were less common among the French patients,

with significantly lower rates of hypertension, diabetes mellitus and obstructive lung disease. History of myocardial infarction and ischaemic cardiomyopathy aetiology were also less frequent among the French patients, who presented with a higher rate of non-ischaemic aetiology (57.9% vs 49.2%; $P < 0.001$) associated with less reported valvular heart disease (15.7% vs 28.0%). No significant difference was observed in terms of the serum concentration of cardiac markers, but the French group had more severe renal function. Additionally, both populations had a similar prevalence of AF, although French patients were more likely to experience paroxysmal AF (46.9% vs 33.8%; $P < 0.001$). In both groups, patients were mostly in New York Heart Association (NYHA) functional class II or III, but there were 3.5 and 1.6 times more French patients in NYHA class I and class IV, respectively, compared with the European population. Regarding echocardiographic data, LVEF was significantly higher in the French group, with a higher rate of patients with LVEF > 35% (17.1% vs 12.7%), despite there being fewer patients with permanent pacemaker indications. Conversely, mitral regurgitation was less common in French patients, as > 50% had no mitral regurgitation compared with < 20% in the European population.

Preprocedural baseline electrocardiogram characteristics

Baseline electrocardiogram characteristics are described in Table 2. In both groups, there were similar proportions of patients in sinus rhythm and AF, with distributions of two-thirds and one-third of patients, respectively. Compared with the European group, French patients had a longer PR interval duration, but a significantly shorter QRS interval duration (154 ± 29 vs 157 ± 27 ms). Indeed, 19.1% of the French population had a QRS < 130 ms compared with 12.3% of the overall European cohort. In addition, a lower proportion of French patients had a QRS > 150 ms compared with the European group (62.9% vs 69%). A similar proportion of left bundle branch block was found in the two populations, but right bundle branch block QRS morphology was more usually present among the French CRT candidates at the time of implantation (9.2% vs 6.4%).

Perprocedural CRT implantation characteristics

As described in Table 3, a total of 760 CRT procedures were performed among the 754 patients enrolled in the French group and 10,456 procedures were performed in the 10,334 patients in the European group.

Successful device implantation rates were 97.6% in France and 97.3% in Europe. In France, a CRT-P was more frequently implanted compared with in the European population (34.5% vs 29.9%). Nevertheless, a CRT-D was the most common device implanted in both groups. Procedural duration was significantly shorter in France (89.2 ± 37.8 vs 100.5 ± 46.7 minutes; $P < 0.001$), and was associated with a shorter fluoroscopy time (16.1 ± 15.4 vs 17.9 ± 17.2 minutes; $P < 0.001$). A multipolar left ventricular lead was more frequently implanted in the French group than in the European group (70.5% vs 56.1%). Administration of prophylactic antibiotics was reported significantly less frequently in France (95.9% vs 98.8%).

Regarding left ventricular lead site implantation, lateral and posterior placements were equally distributed between the two groups (lateral: 83.6% in France vs 84.2%; posterior: 10.8% in France vs 11.6%), but the middle left ventricular segment was more commonly achieved in France (76.5% vs 70.9%). Of note, coronary sinus venogram with or without occlusion was performed less often by French physicians. Additionally, despite a higher rate of left ventricular position optimization with QLV delay or biventricular paced QRS duration, French patients experienced less of a decrease in QRS interval duration: biventricular paced QRS duration of 140 (120, 160) in France vs 136 (120, 150) ms. Indeed, the French group had a lower difference between paced and intrinsic QRS duration compared with the European population: median –13 (interquartile range –34, 5) ms vs –20 (–40, –2) ms, respectively. Furthermore, 38.7% of the French patients exhibited a residual paced QRS > 150 ms compared with 30.6% of the European group.

Outcomes and hospital discharge

Periprocedural complication rates were similar between in both groups (5.0% vs 5.7%), but coronary sinus dissection was twofold lower in France, giving an important message for analysis of quality control. Similarly, there was no difference in the overall rates of periprocedural device-related complications (3.8% vs 4.1%), but the French population exhibited 3.5 times more device-associated infections compared with the European cohort (0.6% vs 0.2%) (Table 4). Lastly, French patients experienced higher rates of major adverse events during postprocedural hospitalization (7.0% vs 4.6%) – especially infections (1.3% vs

0.5%). Consequently, the total postprocedural duration of hospitalization was higher in France: median 4 (interquartile range 3, 7) vs 3 (2, 7) days (Table 4).

Additionally, significant differences were noted regarding HF drug therapy at hospital discharge (Table 5). Indeed, French patients were significantly less likely to receive beta-blockers, angiotensin-converting enzyme inhibitors/angiotensin II receptor blockers and mineralocorticoid receptor antagonists than European patients (79.0% vs 89.7%, 75.1% vs 87.2% and 29.8% vs 65.6%, respectively).

Discussion

The main findings of this French CRT survey were that French CRT candidates differ from European CRT candidates, especially in terms of a lower QRS duration, and that perioperative management in France is suboptimal, with less reported use of antibiotic prophylaxis, more complications and fewer patients on optimal medical therapy for HF.

Patient selection in France

Our results showed that French CRT candidates seem to be in “better health” than the European population. Despite being older, their HF was less advanced, with a higher proportion having NYHA class I/II clinical status, a higher baseline LVEF at implantation associated with lower mitral regurgitation and more paroxysmal AF. Additionally, the French cohort exhibited fewer co-morbidities overall, but had more severe chronic renal dysfunction. This result is supported by the French CeRtiTude CRT registry, which observed an increase in the proportion of elderly patients receiving a CRT device in the past decade. Indeed, among 1705 French CRT candidates enrolled in CeRtiTude registry between 2008 and 2010, fewer patients were aged > 75 years (33%) compared with almost half (44.7%) of the French population in CRT Survey II performed between 2015 and 2016 [12]. Similarly, the analysis of 400,000 CRT procedures performed between 2003 and 2013 in the USA showed that the mean age at implantation increased over the study period, especially for CRT-Ps [13]. These results are supported by a recent work that compared the long-term survival of 1775 patients implanted with a CRT-P or CRT-D. Indeed, the authors described that patients with CRT-Ps were significantly older than those receiving CRT-Ds. However, this work importantly highlighted that both groups had similar 5-year survival rates. Additionally, the rate of sudden

cardiac death was similar in patients with or without an ICD combined with CRT, whereas progressive HF still represents the most common cause of death in patients surviving the first 5 years after CRT implantation [14]. These results may reflect a greater certainty of CRT benefit in higher age groups overall, especially CRT-P implantation. Of note, current French guidelines suggest that CRT may remain effective despite advanced age in selected patients, provided that they have few co-morbidities – particularly septuagenarians and octogenarians [15].

More off-guideline CRT indications in France

This real-life survey in France has highlighted a higher proportion of off-guideline CRT indications. Indeed, up to 10% of the French patients were in NYHA class I, and experienced no symptoms and no activity limitation. This is not in accordance with the current guidelines, but we do not have data about the results of the exercise test that is performed frequently in France. Occasionally “asymptomatic” patients may exhibit significant limited performance during an exercise test. It may be possible that such patients were implanted because of a primary ICD indication or that these patients had previously had more symptomatic HF, which had improved with drug therapy.

Additionally, 10.2% of CRT candidates had a QRS < 120 ms, and 19.2% had an intrinsic QRS interval duration < 130 ms. This is in accordance with the 2013 ESC guidelines on pacing and CRT, which were used when the survey started, with a cut-off value of 120 ms; now, according to the 2016 guidelines, this QRS duration theoretically represents a CRT contraindication (Class III, Level A), and has been previously associated with an increase in mortality [8, 16]. Furthermore, the French group had 2.5 times more patients with a normal ejection fraction at the time of implantation than European group. Lastly, 17.1% of French patients with HF had an LVEF > 35%, three times more than in the CeRtiTude cohort (5.3%), suggesting a current off-label extension of the CRT indication in France over the last decade [12]. However, we must remember that patients implanted with permanent AF or upgrading indications may have an LVEF > 35%, but do not have off-label indications. These results are consistent with the first clinical indication for CRT in France, which is HF or left ventricular dysfunction with ICD indication. Unlike in the European population, HF with wide QRS is not the major CRT indication in France.

CRT Survey II has confirmed that French clinicians are not in concordance with the other countries regarding indications. Clinical practice should be guided by clinical trials, but clinicians may have their own impression of “optimal treatment”, and offer it to individual patients, many of whom do not fulfil the criteria in the guidelines. Accordingly, in France, many devices were implanted in asymptomatic patients (NYHA class I) with mild LVEF impairment. Nevertheless, the overall French population had a Class I CRT indication, with symptomatic HF, severe LVEF impairment and wide left bundle branch block > 150 ms.

Need to improve perioperative management in France

Importantly, our work has highlighted that French patients experienced a higher rate of early in-hospital complications than the European group – especially device-related infections (0.6% vs 0.2%). This poor outcome is probably driven by the significantly lower proportion of use of prophylactic antibiotics reported in France, and calls for discussion and improvements. Indeed, a lack of antibiotic prophylaxis has been described as an independent predictor of infection [17]. Similarly, a meta-analysis of antibiotic prophylaxis, using a regimen of preprocedural and postprocedural administration, suggested a significant reduction in the incidence of infection, and is recommended in the current guidelines [18]. Additionally, advanced age has been described as independent predictor of device infection, and patients aged > 60 years have a 2.5-fold increased risk of infection [19]. Furthermore, several publications have concluded that early complications are increased in elderly patients [20, 21], suggesting that careful geriatric assessment should be performed before device implantation, to ensure that undernutrition, frailty, cognitive impairment and weak autonomy are not disregarded [14].

CRT Survey II also highlighted that the French population less often received optimal HF drug therapy at hospital discharge, as 79.0%, 75.1% and 29.8% received beta-blockers, angiotensin-converting enzyme inhibitors/angiotensin II receptor blockers and mineralocorticoid receptor antagonists, respectively, compared with 89.7%, 87.2% and 65.6% in the European group. Optimal medical therapy in association with CRT is crucial in patients with HF, and has been associated with a lower risk of death or HF than in CRT recipients without optimal treatment in follow-up [22]. However, introducing and titrating HF drugs may be challenging in elderly patients with renal dysfunction, which may explain this suboptimal medical management [23].

Study limitations

Although the number of patients enrolled in this survey was large, there were substantial differences between countries. Overall, investigators estimated that about 11% of patients implanted with CRT in participating countries were enrolled in the survey, but they could not assess the degree of selection bias in the choice of enrolled patients. In France, 6.3% of total implantations were captured during the survey. Sites may have been less likely to report unsuccessful implantations or cases with a poor outcome, accounting for low rates of complications and mortality. Additionally, patient characteristics and early postprocedural outcomes should be interpreted carefully. Indeed, long-term follow-up data were not collected, and the impact of larger biventricular paced QRS on patient survival in France is unknown. Indeed, this survey focused on the early postimplantation period, and future CRT response, left ventricular reverse remodelling, HF events and quality of life cannot be extrapolated from the postprocedural biventricular paced QRS duration.

Conclusions

Compared with the European population, French patients were more often asymptomatic, associated with higher rates of QRS < 130 ms and LVEF > 35% at the time of CRT implantation. Importantly, a higher rate of early device-related infection occurred, probably driven by less antibiotic prophylaxis administration. This survey provides important information about our daily clinical practice, and is a plea for greater adherence to guidelines for better management of patients with HF, and improved quality control programmes.

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Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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Table 1 Baseline characteristics of the French and European groups.

	France (*n* = 754)	Europe (*n* = 10,334)	*P*	OR (95% CI)
Age (years)	71.5 ± 11.0	68.3 ± 10.8	< 0.001	
Age ≤ 65 years	177/739 (24.0)	3301/10,300 (32.0)		0.67 (0.56–0.79)
65 years < age < 75 years	232/739 (31.4)	3793/10,300 (36.8)		0.79 (0.67–0.92)
Age ≥ 75 years	330/739 (44.7)	3206/10,300 (31.1)		1.79 (1.54–2.08)
Male sex	572/751 (76.2)	7794/10,301 (75.7)	0.76	
Body mass index (kg/m²)	26.8 ± 5.0	27.9 ± 4.9	< 0.001	
Hypertension	407/716 (56.8)	6555/10,202 (64.4)	< 0.001	
Diabetes mellitus	188/717 (26.2)	3240/10,204 (31.8)	0.002	
Obstructive lung disease	70/719 (9.7)	1245/10,203 (12.2)	0.049	
Chronic kidney disease (eGFR < 60 µmol/L)	222/718 (30.9)	3173/10,189 (31.1)	0.90	
Myocardial infarction	162/721 (22.5)	3795/10,205 (37.2)	< 0.001	
Previous cardiac implanted electronic device	209/719 (29.1)	2850/10,273 (27.7)	0.44	
Cardiomyopathy aetiology			< 0.001	
Ischaemic	266/719 (37.0)	4609/10,234 (45.0)		0.72 (0.61–0.84)
Non-ischaemic	416/719 (57.9)	5037/10,234 (49.2)		1.42 (1.22–1.65)
Other	37/719 (5.1)	588/10,234 (5.7)		0.89 (0.63–1.25)
Valvular heart disease	113/719 (15.7)	2855/10,201 (28.0)	< 0.001	

AF	303/718 (42.2)	4156/10,202 (40.7)	0.44	
Type of AF			< 0.001	
Paroxysmal	142/303 (46.9)	1406/4156 (33.8)		1.73 (1.36–2.18)
Persistent	47/303 (15.5)	947/4156 (22.8)		0.62 (0.45–0.86)
Permanent	111/303 (36.6)	1778/4156 (42.8)		0.77 (0.61–0.98
Missing	3/303 (1.0)	25/4156 (0.6)		
HF hospitalization during last year	327/718 (45.5)	4751/10,199 (46.6)	0.59	
NYHA class				
I–II	358/705 (50.8)	4095/10,143 (40.4)	< 0.001	1.52 (1.31–1.78)
III–IV	347/705 (49.2)	6048/10,143 (59.6)	< 0.001	0.66 (0.56–0.76)
Laboratory results				
NT-proBNP (ng/mL)	2719 (1160, 5919)	2373 (1037, 5340)	0.14	
BNP (ng/mL)	426 (199, 894)	421 (148, 1128)	0.843	
Serum creatinine (µmol/L)	103 (83, 137)	100 (83, 128)	0.01	
Haemoglobin (g/dL)	13.2 ± 0.9	13.3 ± 0.7	0.048	
Echocardiography				
Mean LVEF (%)	30.5 ± 8.8	28.3 ± 8.1	< 0.001	
LVEF < 25%	143/709 (20.2)	2836/10,096 (28.1)		0.65 (0.54–0.78)
25% ≤ LVEF ≤ 35%	445/709 (62.8)	5981/10,096 (59.2)		1.16 (0.99–1.36)
LVEF > 35%	121/709 (17.1)	1279/10,096 (12.7)		1.42 (1.16–1.74)

LVEF > 50%	28/709 (3.9)	167/10,096 (1.7)		2.44 (1.63–3.68)
LVEDD (mm)	63.4 ± 10.8	63.5 ± 9.1	0.49	
Mitral regurgitation			< 0.001	
None	317/587 (54.0)	1703/9413 (18.1)		5.32 (4.48–6.30)
Mild	154/587 (26.2)	4490/9413 (47.7)		0.39 (0.32–0.47)
Moderate	93/587 (15.8)	2553/9413 (27.1)		0.51 (0.40–0.63)
Severe	23/587 (3.9)	667/9413 (7.1)		0.53 (0.35–0.82)
Clinical indication for CRT				
HF with wide QRS	355/693 (51.2)	6195/10,230 (60.6)	< 0.001	0.68 (0.59–0.80)
HF or LV dysfunction and indication for ICD	380/693 (54.8)	4848/10,230 (47.4)	< 0.001	1.35 (1.15–1.57)
PPM indication + expected pacing dependency	117/693 (16.9)	2377/10,230 (23.2)	< 0.001	0.67 (0.55–0.82)
Evidence of medical dyssynchrony	77/693 (11.1)	1183/10,230 (11.6)	0.72	0.96 (0.75–1.22)

Data are expressed as mean ± standard deviation or *n*/N (%). AF: atrial fibrillation; BNP: B-type natriuretic peptide; CI: confidence interval; CRT: cardiac resynchronization therapy; eGFR: estimated glomerular filtration rate; HF: heart failure; ICD: implantable cardioverter-defibrillator; LV: left ventricular; LVEF: left ventricular ejection fraction; LVEDD: left ventricular end-diastolic dimension; NT-proBNP: N-terminal prohormone of B-type natriuretic peptide; NYHA: New York Heart Association; OR: odds ratio; PPM: permanent pacemaker.

Table 2 Preprocedural electrocardiogram characteristics.

	France (n = 754)	Europe (n = 10,334)	P	OR (95% CI)
Heart rate (beats/min)	72 ± 17	72 ± 16	0.21	
Sinus rhythm	473/688 (68.8)	7023/10,148 (69.2)	0.84	
AF	182/688 (26.5)	2596/10,148 (25.6)	0.64	
PR interval duration (ms)	197 ± 51	189 ± 50	< 0.001	
Intrinsic QRS interval duration (ms)	154 ± 29	157 ± 27	0.004	
Intrinsic QRS < 130 ms	110/576 (19.1)	1106/8959 (12.3)	< 0.001	1.68 (1.32–2.08)
130 ms ≤ intrinsic QRS < 150 ms	104/576 (18.1)	1675/8959 (18.7)	0.70	0.96 (0.77–1.19)
150 ms ≤ intrinsic QRS < 180 ms	259/579 (45.0)	1675/8959 (47.2)	0.30	0.91 (0.77–1.08)
Intrinsic QRS ≥ 180 ms	103/576 (17.9)	1951/8959 (21.8)	0.027	0.78 (0.63–0.97)
QRS morphology				
Only left bundle branch block	500/650 (76.9)	7338/9767 (75.1)	0.31	
Only right bundle branch block	60/650 (9.2)	628/9767 (6.4)	0.005	1.48 (1.12–1.95)
Other	60/650 (13.8)	1801/9767 (18.4)	0.003	0.71 (0.57–0.89)
AV block II/III	104/676 (15.4)	1922/10,024 (19.2)	0.015	0.77 (0.62–0.95)
Pacemaker dependent	114/687 (16.6)	1397/10,065 (13.9)	0.048	1.23 (1.00–1.52)
Paced QRS duration (ms)	174 ± 37	182 ± 30	0.06	

Data are expressed as mean ± standard deviation or *n*/N (%). AF: atrial fibrillation; AV: atrioventricular; CI: confidence interval; OR: odds ratio.

Table 3 Perprocedural cardiac resynchronization therapy implantation characteristics.

	France (n = 754)	Europe (n = 10,334)	*P*	OR (95% CI)
Number of attempts	760	10,456	NA	
Successful implantation (%)	97.6	97.3	0.53	
Prophylactic antibiotics	657/685 (95.9)	9870/9987 (98.8)	< 0.001	0.28 (0.18–0.42)
Procedure duration (minutes)	89.2 ± 37.8	100.5 ± 46.7	< 0.001	
Fluoroscopy duration (minutes)	16.1 ± 15.4	17.9 ± 17.2	< 0.001	
Type of device			< 0.001	
CRT-P	241/699 (34.5)	3015/10,070 (29.9)		1.23 (1.05–1.45)
CRT-D	458/699 (65.5)	7055/10,070 (70.1)		0.81 (0.69–0.95)
RV lead location			< 0.001	
Apex	287/607 (47.3)	5993/9646 (62.1)		0.55 (0.46–0.64)
Septum	292/607 (48.1)	3441/9646 (35.7)		1.67 (1.42–1.97)
RV outflow tract	28/607 (4.6)	212/9646 (2.2)		2.15 (1.44–3.22)
LV lead location				
Left anterior oblique view			0.19	
Anterior	30/604 (5.6)	413/9696 (4.3)		
Lateral	505/604 (83.6)	8160/9696 (84.2)		

Posterior	65/604 (10.8)	1123/9696 (11.6)		
Right anterior oblique view			0.018	
Basal	64/537 (11.9)	1441/9582 (15.0)		
Middle	411/537 (76.5)	6789/9582 (70.9)		
Apical	62/537 (11.5)	1352/9582 (14.1)		
Epicardial	38/645 (5.9)	929/9888 (9.4)	0.004	
LV lead placement unsuccessful	7/652 (1.1)	54/9942 (0.5)	0.08	
LV lead type			< 0.001	
Unipolar	2/691 (0.3)	75/9910 (0.8)		0.38 (0.09–1.55)
Bipolar	202/691 (29.2)	4276/9910 (43.1)		0.54 (0.46–0.64)
Multipolar	487/691 (70.5)	5559/9910 (56.1)		1.87 (1.58–2.21)
Coronary venogram performed	468/629 (74.4)	9168/9900 (92.6)	< 0.001	0.23 (0.19–0.28)
Venogram performed with occlusion	110/441 (24.9)	4376/9081 (48.2)	< 0.001	0.36 (0.29–0.45)
Dilatation of coronary vein performed	11/629 (1.7)	240/9909 (2.4)	0.28	
Phrenic nerve stimulation tested	581/647 (89.8)	8975/9921 (90.5)	0.58	
LV position optimized (QLV/paced QRS duration)	295/597 (49.4)	3189/9710 (32.8)	< 0.001	2.00 (1.69–2.36)
AV node ablation (for patient with AF)	74/181 (40.9)	760/2569 (29.6)	0.001	1.65 (1.21–2.24)
VV programming performed before discharge	336/666 (50.5)	5626/9911 (56.8)	0.00147	0.78 (0.66–0.91)
Postimplantation ECG				
Paced QRS duration (ms)	140 (120, 160)	136 (120, 150)	0.003	

Paced QRS < 130 ms	218/638 (34.2)	3259/9438 (34.5)	0.85	0.98 (0.83–1.17)
130 ms ≤ paced QRS < 150 ms	173/638 (27.1)	3325/9438 (35.2)	< 0.001	0.68 (0.57–0.82)
150 ms ≤ paced QRS < 180 ms	191/638 (29.9)	2330/9438 (24.7)	0.003	1.30 (1.09–1.55)
Paced QRS ≥ 180 ms	56/638 (8.8)	524/9438 (5.6)	< 0.001	1.64 (1.23–2.18)
Paced – intrinsic QRS duration (ms)	–13 (–34, 5)	–20 (–40, –2)	< 0.001	

Data are expressed as *n*/N (%), mean ± standard deviation or Median (interquartile range) unless otherwise indicated. AF: atrial fibrillation; AV: atrioventricular; CI: confidence interval; CRT-D: cardiac resynchronization therapy defibrillator; CRT-P: cardiac resynchronization therapy pacemaker; ECG: electrocardiogram; HF: heart failure; ICD: implantable cardioverter-defibrillator; LV: left ventricular; NA: not applicable; OR: odds ratio; RV: right ventricular.

Table 4 Periprocedural complications.

	France (n = 754)	Europe (n = 10,334)	*P*
Periprocedural complication	38/754 (5.0)	586/10,334 (5.7)	0.49
Death	2/754 (0.3)	6/10,334 (0.1)	0.041
Bleeding	6/754 (0.8)	102/10,334 (1.0)	0.61
Requiring intervention	1/754 (0.1)	34/10,334 (0.3)	0.35
Pocket haematoma	5/754 (0.7)	80/10,334 (0.8)	0.74
Pneumothorax	7/754 (0.9)	105/10,334 (1.0)	0.82
Haemothorax	1/754 (0.1)	8/10,334 (0.1)	0.61
Coronary sinus dissection	7/754 (0.9)	207/10,334 (2.0)	0.038
Pericardial tamponade	3/754 (0.4)	25/10,334 (0.2)	0.41
Other	16/754 (2.1)	156/10,334 (1.5)	0.19
Device-related complication	29/754 (3.8)	419/10,334 (4.1)	0.78
Lead dislocation or displacement	7/715 (1.0)	181/10,115 (1.8)	0.11
RV lead	1/7 (14.3)	54/170 (31.8)	0.33
LV lead	4/7 (57.1)	89/170 (52.4)	0.80
Atrial lead	2/7 (28.6)	32/170 (18.8)	0.52
Phrenic nerve stimulation	7/715 (1.0)	116/10,115 (1.1)	0.68

Lead malfunction	1/715 (0.1)	22/10,115 (0.2)	0.66
Infection	4/715 (0.6)	16/10,115 (0.2)	0.016
Major adverse events during hospitalization after procedure	53/754 (7.0)	475/10,334 (4.6)	0.002
Myocardial infarction	0/714 (0.0)	8/10,102 (0.1)	0.45
Stroke	0/714 (0.0)	6/10,102 (0.1)	0.52
Infection	9/714 (1.3)	51/10,102 (0.5)	0.009
Worsening heart failure	5/714 (0.7)	73/10,102 (0.7)	0.95
Worsening renal function	11/714 (1.5)	93/10,102 (0.9)	0.10
Arrhythmias	11/714 (1.5)	112/10,102 (1.2)	0.36
Other	23/714 (3.2)	185/10,102 (1.8)	0.009
Discharge status			0.20
Alive	706/711 (99.3)	10095/10,134 (99.6)	
Dead	5/711 (0.7)	40/10,134 (0.4)	
Total length of hospital stay (days)	4 (3, 7)	3 (2, 7)	< 0.001

Data are expressed as *n*/N (%) or median (interquartile range). LV: left ventricular; RV: right ventricular.

Table 5 Heart failure medication at hospital discharge.

	France (*n* = 754)	Europe (*n* = 10,334)	*P*	OR (95% CI)
Beta-blocker	553/700 (79.0)	8919/9948 (89.7)	< 0.001	0.43 (0.36–0.53)
ACE inhibitor/ARB	526/700 (75.1)	8637/9903 (87.2)	< 0.001	0.44 (0.37–0.53)
Mineralocorticoid receptor antagonist	208/697 (29.8)	6474/9876 (65.6)	< 0.001	0.22 (0.19–0.26)
Loop diuretic	545/699 (78.0)	8076/9936 (81.3)	0.031	0.82 (0.68–0.98)
Amiodarone	155/697 (22.2)	1670/9850 (17.0)	0.002	1.40 (1.16–1.69)
Ivabradine	29/697 (4.2)	564/9846 (5.7)	0.08	
Digoxin	13/697 (1.9)	1087/9847 (11.0)	< 0.001	0.15 (0.09–0.27)
Oral anticoagulation	285/684 (41.7)	4643/9893 (46.9)	0.008	0.81 (0.69–0.95)
Antiplatelet agent	301/754 (39.9)	4545/10,334 (44.0)	0.030	0.85 (0.73–0.98)
Dual antiplatelet therapy	61/700 (8.7)	920/9847 (9.3)	0.58	
Triple therapy	7/698 (1.0)	211/9923 (2.1)	0.043	0.47 (0.22–0.99)

Data are expressed as *n*/N (%). ACE: angiotensin-converting enzyme; ARB: angiotensin II receptor blocker; CI: confidence interval. OR: odds ratio.