Special article

Update in Cardiac Arrhythmias and Pacing

Ignacio García-Bolao, a,*, Francisco Ruiz-Mateas, b Victor Bazan, c Antonio Berruezo, d Oscar Alcalde, a Juan Leal del Ojo, e Juan Acosta, d Manuel Martínez Sellés, f and Ignacio Mosquera g

a Unidad de Arritmias, Departamento de Cardiología y Cirugía Cardíaca, Clínica Universidad de Navarra, Universidad de Navarra, Pamplona, Spain
b Unidad de Estimulación Cardíaca, Área de Cardiología, Hospital Costa del Sol, Marbella, Málaga, Spain
c Unidad de Arritmias, Servicio de Cardiología, Hospital del Mar, Universidad Autónoma de Barcelona, Barcelona, Spain
d Unidad de Arritmias, Servicio de Cardiología, Instituto del Tórax, Hospital Clínic e IDIBAPS, Barcelona, Spain
e Unidad de Electrofisiología y Arritmias, Servicio de Cardiología, Hospital La Fe de Valencia, Sevilla, Spain
f Departamento de Cardiología, Hospital General Universitario Gregorio Marañón, Madrid, Spain
g Unidad de Arritmias, Hospital Universitario A Coruña, A Coruña, Spain

Article history:
Available online 10 February 2015

Keywords:
Ablation
Arrhythmias
Atrial fibrillation
Elderly patients
Electrophysiology
Pacing

ABSTRACT

This article discusses the main advances in cardiac arrhythmias and pacing published between 2013 and 2014. Special attention is given to the interventional treatment of atrial fibrillation and ventricular arrhythmias, and on advances in cardiac pacing and implantable cardioverter defibrillators, with particular reference to the elderly patient.

© 2014 Sociedad Española de Cardiología. Published by Elsevier España, S.L.U. All rights reserved.

Tiemas de actualidad en arritmias y estimulación cardiaca

RESUMEN

En este trabajo se comentan los principales avances en arritmias y estimulación cardiaca aparecidos entre 2013 y 2014 seleccionados como más relevantes. Se revisan especialmente las publicaciones referidas al tratamiento intervencionista de la fibrilación auricular y de las arritmias ventriculares, y los avances en estimulación cardiaca y desfibrilador automático implantable, con mención especial al paciente mayor.

© 2014 Sociedad Española de Cardiología. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

Abbreviations

AF: atrial fibrillation
EF: ejection fraction
ICD: implantable cardioverter defibrillator

ADVANCES IN THE TREATMENT OF ATRIAL FIBRILLATION

The elevated prevalence of atrial fibrillation (AF) in Spain1 and its high social and health impact is driving scientific developments in AF ablation, particularly in the development of different techniques and candidate selection.

Overall Outcomes of Ablation in Different Populations

The efficacy of first AF ablation procedures in an optimum candidate (paroxysmal AF without heart disease or atrial dilatation) is between 60% and 80%. Data from a recently published meta-analysis unequivocally confirmed that ablation was clearly superior to pharmacological treatment, with a recurrence of 28% and 65%, respectively.2 The CAMTAF2 survey showed that ablation was also superior to medical treatment in patients with heart failure, depressed ejection fraction (EF), and persistent AF. Ablation not only improved EF (from 32 [8%] to 40 [12%]), but also quality of life, oxygen consumption, and B type natriuretic peptide levels. However, this study showed that a single procedure had only moderate efficacy (38%), as 11 of 26 patients (42%) required at least a second procedure.

The RAAFT-2 study showed that ablation was superior to antiarrhythmic drugs as a first treatment for paroxysmal AF, although the recurrence rate was 55% after a suboptimal first procedure.4

This year saw the publication of the results of the Spanish SARA multicenter study, which was the first randomized controlled trial

* Corresponding author: Unidad de Arritmias, Departamento de Cardiología y Cirugía Cardíaca, Clínica Universidad de Navarra, Avda. de Pio XII 36, 31008 Pamplona, Spain.
E-mail address: igarcia@unav.es (I. García-Bolao).

http://dx.doi.org/10.1016/j.rec.2014.11.007
1885-5857/© 2014 Sociedad Española de Cardiología. Published by Elsevier España, S.L.U. All rights reserved.
to compare the efficacy of catheter ablation with antiarrhythmic drug treatment in patients with persistent atrial fibrillation.\(^5\) In 146 patients, the efficacy of ablation was clearly superior to antiarrhythmic drugs (70.4% and 43.7%, respectively) in suppressing the number of AF episodes per year, with an absolute risk reduction of 26.6%.

The rate of severe procedure-related complications has decreased (especially complications related to pulmonary vein stenosis) and is currently between 1% and 5%.\(^9\)

**Advances in Techniques and Ablation Strategy**

Pulmonary vein isolation by radiofrequency catheter ablation using nonfluoroscopic navigation systems remains the standard AF ablation technique (Figure 1), regardless of the use of segmented images of the left atrium obtained by computed tomography angiography or magnetic resonance imaging (MRI). New diagnostic maneuvers during AF ablation include documenting local capture and exit block in a pulmonary vein during pacing from the ipsilateral pulmonary vein. This maneuver confirms the electrical isolation of the pulmonary veins, which are connected by endocardial (carina) or epicardial connections in more than 80% of cases.\(^7\)

Randomized trials have yet to confirm the potential usefulness of catheters that monitor the direction and degree of contact between the tip and the atrium.\(^8\)

Second-generation balloon cryoablation has an efficacy of around 80%.\(^9\) In Spain, 80% of hospitals providing AF ablation perform less than 50 such procedures per year,\(^9\) so the availability of a simple technique with a short learning curve is particularly important. These characteristics are associated with cryoablation. A study conducted in a similar hospital described efficacy and safety data that were apparently comparable with those obtained in cryoablation series from 10 high-volume hospitals.\(^10\)

The TTOP-AF study\(^11\) on phased ablation using multielectrode radiofrequency catheters reported a 44% recurrence at 6 months in patients with persistent AF and long-standing persistent AF. Asymptomatic thrombus formation in the ablation catheter and pulmonary vein stenosis raises doubts concerning this technique, in addition to the already known problem of silent cerebral lesions associated with this technique.

Finally, in patients with paroxysmal AF, the identification of stable rotors as ablation guides has recently been shown to have better efficacy at 1 year than pulmonary vein isolation alone (82% and 45%, respectively).\(^12\) However, in general, the favorable outcomes of these types of additional ablation strategies have not been replicated in subsequent studies.

**Clinical Practice Guidelines Updates**

The 2104 American Heart Association, American College of Cardiology, and Heart Rhythm Society practice guidelines\(^13\) consider symptomatic paroxysmal AF refractory to ≥ 1 antiarrhythmic drug a class I indication (level of evidence A) for ablation and a class IIa indication if AF is persistent. Ablation as first-line therapy is considered acceptable (class IIb), although only in patients with paroxysmal AF and without structural heart disease (Table 1). Other than isolating the pulmonary veins, no specific recommendations are provided on the ablation strategy to be followed in patients with nonparoxysmal AF.

**Screening Patients for Ablation: Toward Better Selection**

After 16 years of experience in AF ablation, efficacy and procedure-related complications rates are excellent, although there is still room for improvement. In addition to the impact of technical progress and improvements in operator skill, in the near future further improvement may be due to patient selection rather than type of AF, atrial size, and the presence of structural heart disease.

In 2014, 3 new clinical characteristics related to atrial remodeling—apnea-hypopnea, the extent of atrial fibrosis, and atrial sphericity (the latter 2 characteristics quantified by MRI)—have been confirmed as strong predictors of arrhythmia recurrence after ablation (in up to 70% of cases).\(^14–16\) Prevalence data (> 50% of patients with AF have these 3 characteristics to some degree) and the rate of arrhythmia recurrence suggest that these characteristics should be screened for prior to ablation.

**Percutaneous Closure of the Left Atrial Appendage**

One of the most studied topics in 2014 was percutaneous closure of the left atrial appendage as adjunctive treatment of AF (Figure 2). Most studies of percutaneous closure using the Amplatzer device\(^17,18\) or Watchman device\(^19\) have shown the
Table 1

<table>
<thead>
<tr>
<th>Indications for Atrial Fibrillation Catheter Ablation to Maintain Sinus Rhythm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class I</strong></td>
</tr>
<tr>
<td>1. Symptomatic paroxysmal AF refractory or intolerant to at least 1 class I or III antiarrhythmic drug (level of evidence: A)</td>
</tr>
<tr>
<td><strong>Class IIa</strong></td>
</tr>
<tr>
<td>1. Symptomatic persistent AF refractory or intolerant to at least 1 class I or III antiarrhythmic drug (level of evidence: A)</td>
</tr>
<tr>
<td>2. Recurrent symptomatic paroxysmal AF before starting antiarrhythmic drugs, after weighing the risks and benefits of drug and ablation treatment (level of evidence: B)</td>
</tr>
<tr>
<td><strong>Class IIb</strong></td>
</tr>
<tr>
<td>1. Persistent long-term symptomatic AF refractory or intolerant to at least one antiarrhythmic drug class I or III (level of evidence: B)</td>
</tr>
<tr>
<td>2. Symptomatic persistent AF before initiating antiarrhythmic drugs (level of evidence: C)</td>
</tr>
<tr>
<td><strong>Class III</strong></td>
</tr>
<tr>
<td>1. Patients who cannot be treated with anticoagulants during and after the procedure (level of evidence: C)</td>
</tr>
<tr>
<td>2. AF ablation should not be performed with the sole intention of discontinuing anticoagulation (level of evidence: C)</td>
</tr>
</tbody>
</table>

AF, atrial fibrillation.
Adapted from January et al. with permission.

noninferiority of these devices to warfarin. Procedural success rates have clearly improved (between 95% and 98%) and complications rates have been reduced (between 2% and 4%) in patients with absolute contraindications to anticoagulation therapy7,18 and in patients without them.19 In addition, cost-effectiveness studies have shown the clear benefit of this strategy.20

Finally, the combined strategy of AF ablation and percutaneous closure of the left atrial appendage has emerged as a promising and highly attractive hybrid treatment in subgroups of patients with symptomatic AF who require suspension of anticoagulation therapy.21

Developments in the Pharmacological Treatment of Atrial Fibrillation: Antiarrhythmic Drugs and Anticoagulants

A study on dronedarone that included 4856 patients suggested that, apart from its debated antiarrhythmic efficacy, concerns regarding liver disease and sudden death from proarrhythmia may have been exaggerated, as no deaths from either cause were observed in this large population.22

According to the recently published AFBAR registry, 23 42% of patients with AF undergoing heart rate control take digoxin either alone or in combination with beta blockers. Despite previous evidence, digoxin use is not associated with increased all-cause mortality, all-cause hospitalization, or hospitalization in patients with heart failure.

The assessment and comparison of the new oral anticoagulants for stroke prevention remains a current and pressing issue.

This year saw the publication of a study that compared the new drug edoxaban with warfarin. Edoxaban was noninferior to warfarin in the prevention of embolic events and there were fewer major bleeding events (20%) and fewer deaths from cardiovascular causes.24 The results of several registries have also been published on the use of the new oral anticoagulants in the real world and have shown that their efficacy and the risk of bleeding are similar to those observed in clinical trials.25,26 The use of the new oral anticoagulants has results similar to those of warfarin in other clinical situations, such as during cardioversion.27 These data have led to the publication of a specific guideline on this issue.28

Winkle et al.29 have suggested replacing anticoagulation therapy with antiplatelet therapy in patients with prior stroke who have undergone effective AF ablation (no recurrence 2 years after ablation). This suggestion should be taken with caution and freedom from AF should be demonstrated, because other studies have found that the withdrawal of anticoagulation therapy is an independent predictor of mortality.

Previous registries have shown that anticoagulant therapy is underused in elderly patients with AF, but none has done so as clearly as the registry of stroke survivors with atrial fibrillation conducted in Glasgow.30 Anticoagulation therapy was prescribed in only 34% in these patients (mean age 78 years) and age was clearly associated with the nonprescription of anticoagulant therapy.

ADVANCES IN THE TREATMENT OF VENTRICULAR ARRHYTHMIAS

Substrate Ablation of Ventricular Tachycardia

Bipolar voltage mapping is useful for identifying high-voltage areas within the scar and is a classic method to identify slow conduction channels, which are critical isthmus sites in ventricular tachycardia circuits and the target of ablation procedures.31 However, the ratio of slow conduction channels identified by this method to the ventricular tachycardia isthmuses has been challenged in a recent study showing that only 30% of slow conduction channels identified by voltage mapping were associated with the isthmus site of any ventricular tachycardia.32 In addition, a recent study in a series of patients with arrhythmogenic right ventricular dysplasia showed that only 40% of the isthmus sites of induced ventricular tachycardia were found in slow conduction channels identified by voltage mapping.33 This study identified more slow conduction channels by tagging the electrograms with delayed components that are sequentially activated than those found by voltage mapping, including most (60%) of the slow conduction channels forming the ventricular tachycardia isthmus, thus suggesting the need to incorporate the former method in the substrate ablation of ventricular tachycardia.

The use of late enhancement cardiac MRI to identify and characterize the arrhythmia substrate has proven to be very useful in planning and guiding ventricular tachycardia ablation proce-
dures. In a recent series, most ventricular tachycardia ablation procedures (96%) were performed in segments with delayed enhancement, whose presence in epicardium identified the epicardial origin of the ventricular tachycardia with a sensitivity
of 80% and a specificity of 89%. Other recent studies have suggested that ventricular tachycardia ablation procedures could be facilitated by visualizing the 3-dimensional structure of the substrate by using 3-dimensional cardiac MRI with integrated electroanatomic mapping systems.

Visualizing the substrate can be complicated in patients with nonischemic cardiomyopathy, because they commonly have isolated pockets of scar tissue in the midportion of the interventricular septum that is masked by the surrounding healthy tissue during bipolar mapping. A recent study has shown that mapping during right ventricular basal septal pacing in patients with septal scar revealed slowed conduction areas and the presence of late potentials that were not observed during sinus rhythm mapping.

Recent studies have proposed the use of selective techniques to isolate the substrate or eliminate slow conduction channels. These techniques include circumferential ablation with electrical isolation of the substrate or scar dechanneling with multipolar catheters to selectively ablate relatively earlier late potentials in the delayed component.

Ablation of Premature Ventricular Complex

Premature ventricular complex ablation in patients with depressed EF has recently been shown to be associated with progressive clinical and functional improvement (including improved EF), regardless of the cause of ventricular dysfunction and whether it was induced or worsened by premature ventricular complex. A baseline premature ventricular complex burden >13% identified patients who would benefit from ablation.

Implantable Cardioverter Defibrillators: Avoiding Inappropriate Therapies and Stratifying the Risk of Sudden Death

The recent ADVANCE III randomized trial analyzed the effect of long detection settings CE in primary and secondary prevention patients. An increase from the nominal setting of 18 to 24 detection intervals to 30 to 40 detection intervals was associated with a 25% reduction in implantable cardioverter defibrillator (ICD) treatments and a 34% reduction in shocks.

The risk stratification of sudden death after myocardial infarction remains a topic of investigation. Zaman et al analyzed the usefulness of electrophysiological study to guide ICD implantation in the acute postinfarction stage in a series of patients undergoing primary angioplasty who presented EF <40% in the first 4 days after myocardial infarction. Patients with EF <30% or <35% and functional class NYHA II/III with a negative electrophysiology study result had ventricular arrhythmia-free survival and a sudden death rate similar to patients with EF >40%.

These findings suggest that a negative electrophysiological study could identify patients with severely depressed EF in the acute postinfarction phase as being at low risk of sudden death and not needing ICD implantation. On the other hand, Izquierdo et al analyzed the additional value of measuring infarct size by cardiac MRI for predicting arrhythmic events in patients undergoing primary angioplasty. They found that almost all of the adverse events at 2 year follow-up were observed in patients with large infarcts (>23.5 g/m²) and EF <35%, whereas none were observed in patients with severely depressed EF and small infarcts during the same period.

These studies demonstrate the low specificity of EF in predicting arrhythmic events and the need to develop new tools to optimize the selection of patients for ICD implantation in the acute postinfarction phase.

Regarding new technologies, a totally subcutaneous ICD (Figure 3) with exclusively extravascular components is now available for routine use in some patient subgroups. Although there is a lack of randomized studies, the results of the prospective EFFORTLESS S-ICD registry in a cohort of almost 500 patients suggest that the subcutaneous ICD has efficacy and event rates similar to those of conventional ICDs and prevents the complications, sometimes severe, associated with intracavitary electrodes.

The mean age of patients implanted with an ICD is increasing. The most recent Spanish ICD Registry (2012), which included pediatric patients with ICDs, reported a mean age at implantation of 62 years (range, 7-90 years). The Italian ClinicalService Project Group analyzed more than 6300 patients who underwent ICD implantation and demonstrated the importance of age and comorbidity in the vital prognosis of these patients. These data are of special relevance in elderly patients, because death often has a noncardiac cause in this group. This year, a joint document was published by the Spanish Society of Geriatrics and Gerontology, the Spanish Society of Palliative Care, and the Geriatric Cardiology Section of the Spanish Society of Cardiology on the management of the patients with ICDs in the final stages of life. It is increasingly common to find elderly people with ICDs with advanced end-stage disease, including refractory heart failure, oncological diseases, organ failure, or other neurodegenerative diseases with poor short-term prognosis. The article addressed the process of decision making in the final stage of life and presented an algorithm indicating the steps to follow from the time the patient requests an ICD until the time of its deactivation. However, to establish

![Figure 3. Subcutaneous cardioverter-defibrillator with an entirely extravascular single lead. @:Generator; * Distal tip of subcutaneous lead.](image_url)
recommendations applicable to clinical practice, consensus docu-
ments need to be developed that include the knowledge and
perspective of all the subspecialties, particularly electrophysiology
and cardiac pacing, involved in this clinical context.

Conte et al\(^48\) published a study that described the relatively
benign prognosis of Brugada syndrome in a group of elderly
patients (\(N = 437\)). The best outcomes were observed in the
subgroup of older patients (older than 70 years; \(n = 25\)). After a
mean follow-up of 54 (18) months, no patients older than 70 years
experienced arrhythmic events.

**NEW DEVELOPMENTS IN CARDIAC PACING**

**Leadless Pacemakers and Biological Systems**

Two studies have been published that may represent a
paradigm shift in the field of medium- to long-term cardiac
pacing. Reddy et al\(^46\) tested the safety and clinical performance of a
leadless pacemaker implanted in 33 patients. The VVI device,
which includes the electronic circuits, lithium battery, and leads,
was implanted in the right ventricular apex. The implantation
success rate was 97%. One patient had cardiac perforation and
tamponade and subsequently died as a result of the stroke. The R-wave,
impedance, and pacing threshold values at 3 months were stable
and similar to those of conventional devices with active fixation leads.
Hu et al\(^50\) studied the effects of minimally invasive somatic
reprogramming in 12 pigs. After complete heart block was induced,
the pigs were randomized to receive a percutaneous injection of
green fluorescent protein (control group) or the Tbx18 gene into the
right ventricle. Gene delivery reprogrammed ordinary cardiomyocytes
and converted them into cells with the characteristics of the
sinoatrial node.

**Sleep Apnea Syndrome**

A prospective European study\(^51\) that included 40 patients
compared the apnea-hypopnea index assessed by polysomnogra-
phy with the respiratory disturbance index assessed by a
pacemaker transthoracic impedance sensor featuring the Sleep
Apnea Monitoring algorithm. An optimal cutoff value for the
respiratory disturbance index of 20 events/h identified patients
with pacemakers with severe apnea-hypopnea syndrome with
a sensitivity of 89%, a positive predictive value of 89%, and a
specificity of 85%.

**Minimum Ventricular Pacing Systems**

In a randomized trial, Botto et al\(^52\) investigated whether the
minimization of ventricular pacing using AAI (R) or DDD (R) mode
was superior to standard DDD mode in patients without
permanent atrioventricular block. Although a significant reduction
was observed in the rate of ventricular pacing (minimal ventricular
pacing 5% vs DDD, 86%; \(P < .0001\)), there was no significant
difference in the primary endpoint (cardiovascular hospitalization)
or secondary targets (persistent AF, permanent AF, and composite
of death and cardiovascular hospitalization).

**Pacing Alternative Sites**

Lau et al\(^53\) recently compared whether pacing at the right atrial
appendage vs the low right atrial septum can prevent the
development of persistent AF in 385 patients with paroxysmal
AF and sick sinus syndrome. The study found that pacing at the
right atrial septum did not prevent the development of persistent
AF at 3.1 years of follow-up. A prospective, randomized, double-
blinded, crossover study compared EF afer long-term His or para-
His pacing with right ventricular septal pacing.\(^54\) The primary
endpoint was the effect on EF, which was significantly lower after
1 year of right ventricular septal pacing than after 1 year of His
pacing. There were no significant differences in clinical parame-
ters, quality-of-life assessments, or complications, but pacing
thresholds were significantly more stable and lower in right
ventricular septal pacing leads.

**Remote Monitoring of Cardiac Pacing**

The HomeGuide Registry\(^55\) and the REFORM\(^56\) and TRUST\(^57\)
clinical trials suggest that remote monitoring is safe, enables
longer in-office follow-up intervals, and improves adherence to
scheduled follow-up. The recent European Heart Rhythm Associa-
tion Registry\(^58\) has described the current state of this technology in
Europe.

**NEW DEVELOPMENTS IN CARDIAC RESYNCHRONIZATION
THERAPY**

**Mild Heart Failure, Narrow QRS Complex, or Moderate
Ventricular Dysfunction**

The results of the REVERSE study\(^59\) and the Multicenter
Automatic Defibrillator Implantation Trial with Cardiac Resyn-
chronization Therapy (MADIT-CRT)\(^60\) suggest that the benefit of
cardiac resynchronization therapy in asymptomatic or mild heart
failure patients is maintained at a follow-up of 5 years. However,
the NARROW-CRT\(^61\) and EchoCRT\(^62\) studies showed that cardiac
resynchronization therapy does not benefit patients with a QRS
complex duration \(\leq 120\) ms-130 ms.

Based on the evidence provided by these and other studies, the
latest guidelines on cardiac resynchronization therapy have
highlighted the limited benefit of this technique in patients with
narrow QRS complexes (Table 2).\(^63\) Finally, a substudy of the
REVERSE study suggested that cardiac resynchronization therapy
produced similar clinical benefit in patients with EF between 30%
and 40% and patients with more severe ventricular dysfunction.\(^64\)

**Optimization of Response to Cardiac Resynchronization
Therapy and Technological Advances**

The use of additional selection criteria, such as beta-adrenergic
receptors\(^65\) or cardiac magnetic resonance assessment of dyssyn-
chrony,\(^66\) could lead to improved response to cardiac resynchro-
nization therapy. In addition, some studies published this year
suggest that left ventricular pacing sites with greater electrical\(^67\) or

**Table 2**

<table>
<thead>
<tr>
<th>Type of conduction abnormality</th>
<th>Class of Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left bundle branch block with QRS &gt; 150 ms</td>
<td>I</td>
</tr>
<tr>
<td>Left bundle branch block with QRS 120-150 ms</td>
<td>I</td>
</tr>
<tr>
<td>No left bundle branch block with QRS &gt; 150 ms</td>
<td>IIa</td>
</tr>
<tr>
<td>No left bundle branch block with QRS 120-150 ms</td>
<td>IIb</td>
</tr>
<tr>
<td>QRS &lt; 120 ms</td>
<td>III</td>
</tr>
</tbody>
</table>

Adapted from Varma et al\(^57\) with permission.
CONFLICTS OF INTEREST

None declared.

REFERENCES


lines on the management of implantable cardioverter defibrillators at the end of
characteristics, management, and prognosis of elderly patients with
Permanently Leadless Cardiac Pacers: Results of the LEADLESS Trial.
49. Bell MR, Tawkins JS, Cho HCH, Marban E, Gogolin E. Biological pacemaker
created by minimally invasive somatic reprogramming in pigs with complete
pacemaker transhoracic pacemaker senses with an advanced algorithm to
identify severe: The DREAM European study. Heart Rhythm. 2014;4:
842–8.
ventricular pacing compared with conventional dual-chamber pacing for elec-
tric replacement in chronically paced patients: Results of the Prefer for Electric
for Atrial Fibrillation Suppression Evaluation Study. Prospective randomized study
to assess the efficacy of site and rate of atrial pacing on long-term progression of
atrial fibrillation in sick sinus syndrome: Septal Pacing for Atrial Fibrillation
53. Kronborg MB, Mortensen PT, Poulsen SH, Gerdes JC, Jensen HK, Nielsen JC. His
or para-His pacing preserves ventricular function in atrioventricular block: a
double-blind, randomized, crossover study. Europace. 2014;16:
441–7.
ness of remote monitoring of CIDEs in detection and treatment of clinical and
Quarterly vs yearly clinical follow-up of remotely monitored recipients of
prophylactic implantable cardioverter-defibrillators: results of the REFORM
56. Varma N, Michalski J, Stambler B, Pavri BB. Superiority of automatic remote
monitoring compared with in-person evaluation for scheduled ICD follow-up in
the TRUST trial—testing execution of the recommendations. Eur Heart J.
57. Hernández-Madrid A, Lewalter T, Proclemer A, Pison I, Lip GY, Blomstrom-
Lundqvist C. Remote monitoring of cardiac implantable electronic devices in
Europe: Results of the European Heart Rhythm Association Survey. Europace.
Long-term impact of cardiac resynchronization therapy in mild heart failure: 5-
A randomized study of cardiac resynchronization therapy defibrillator versus
dual-chamber implantable cardioverter-defibrillator in ischemic cardiomy-
opathy with narrow QRS: the NARROW-CRT study. Circ Arrhythm Electrophysiol.
Study Group. Cardiac-resynchronization therapy in heart failure with a narrow
62. Fernández-Loyo I, Mateos FR, Ocaña J, Sancho Tello MJ, García Bolao I, Martínez
Ferrer J, et al. Comments on the 2013 ESC Guidelines on Cardiac Pacing and
Impact of ejection fraction on the clinical response to cardiac resynchronization
receptor gene polymorphism and left ventricular reverse remodeling after cardiac
resynchronization therapy: Preliminary results. Europace. 2013;15:
1475–81.
65. Bilchick KC, Kuruvilla S, Hamrani YS, Ramachandran R, Clarke SA, Parker KM,
et al. Impact of mechanical activation, scar, and electrical timing on cardiac
of the longest intrapatient left ventricular electrical delay may predict acute
hemodynamic improvement in patients after cardiac resynchronization ther-
67. Daya HA, Alam MB, Adelstein E, Schwartzman D, Jain S, Marek J, et al. Echo-
cardiography-guided left ventricular lead placement for cardiac resynchroniza-
tion therapy in ischemic cardiomyopathy patients. Heart Rhythm.
dimensional improvements: acute hemodynamic and subjective symptomatic
assessment with pressure-volume loops in cardiac resynchronization therapy
