IMPLANTABLE CARDIOVERTER DEFIBRILLATOR AND EXERCISE

ABSTRACT

Sudden Cardiac Death (SCD) in patients with different arrhythmogenic cardiac diseases may be prevented by Implantable Cardioverter Defibrillators (ICD). SCD accounts for up to 50% of all cardiovascular mortality worldwide, and is mainly due to malignant ventricular arrhythmias. The ICD is a proven effective therapy to prevent SCD in high-risk cardiac patients and is considered standard therapy for primary and secondary prophylaxis of SCD in many indications. Such patients may be athletic and/or physically active people. Indications for ICD therapy in primary or secondary prevention in athletes are similar to those for the general population. The group of young and physically active patients eligible for primary ICD implantation is rapidly growing. Because intense physical activity may trigger ventricular arrhythmias and also may favour inappropriate shock delivery that impacts quality of life, international recommendations were given for no more thenIa intensity sports (low dynimic and low static ones) and moderate leisure-time physical activity to patients with an ICD. Untill recently, there were no data describing the safety of return to play for athletes receiving an ICD, and consensus recommendations restricted ICD patients to competitive sports no more vigorous than bowling or golf. However, recent findings of The ICD Sports Registry indicate that there were no failures to defibrillate and no injuries related to arrhythmia or shock in athletes who continued sports after receiving an ICD, neither during competition or practice, nor during other physical activity or rest. If the decision is to continue exercise practice despite the ICD, it is of paramount importance adequately program the ICD. Based on the most recent evidence, the last consensus statement from the AHA/ACC on athletic eligibility now allows sports participation with an ICD as a IIB recommendation, “may be considered” (1). This review discusses some specific considerations about exercise in patients with an ICD. Current restriction from competitive sports is discussed, as well as new insights that alter these recommendations for sports participation.

Keywords: Defibrillators, Implantable; exercise; sports; physical activity; sudden cardiac death.

RESUMO

A morte súbita cardíaca (MSC) em pacientes com diferentes doenças cardíacas arritmogénicas pode ser evitada por desfibriladores cardioversores implantáveis (CDIs). Como a atividade física intensa pode desencadear arritmias ventriculares e também pode favorecer a aplicação inadequada de choques que afetam a qualidade de vida, as recomendações internacionais foram dadas para desportos de intensidade não mais do que Ia (baixa dinâmica e baixa estática) e atividade física moderada de lazer para pacientes com um CDI. A restrição atual de desportos competitivos é discutida nesta revisão, bem como novas evidências que alteram essas recomendações para a participação desportiva. A MSC é responsável por até 50% de toda a mortalidade cardiovascular em todo o mundo e deve-se principalmente a arritmias ventriculares malignas. O CDI é uma terapêutica comprovadamente eficaz para prevenir MSC em pacientes cardíacos de alto risco e é considerada a terapêutica padrão para prevenção primária e secundária de MSC em várias indicações. Esses pacientes podem ser atletas e

/ ou fisicamente ativos. Esta revisão discute algumas considerações específicas sobre o CDI nessa população. As indicações para a terapia com CDI na prevenção primária ou secundária em atletas são semelhantes às da população em geral. O grupo de pacientes jovens e fisicamente ativos elegíveis para implantação primária de CDI está a crescer rapidamente. Até recentemente, não havia dados descrevendo a segurança do retorno ao jogo para atletas portadores de CDI, e recomendações de consenso restringiam os pacientes com CDI a desportos competitivos não mais vigorosos do que bowling ou golfe. Descobertas recentes do registo "The ICD Sports Registry" indicam que não há falhas na desfibrilhação e nenhuma lesão relacionada com arritmia ou choque em atletas que continuam a praticar desportos após receber um CDI, nem durante a competição ou prática, nem durante outra atividade física ou repouso. Se a decisão for de continuar a prática desportiva apesar do CDI, é de suma importância programar o CDI adequadamente. Com base nas evidências mais recentes, a última declaração de consenso da AHA / ACC sobre elegibilidade atlética agora permite a participação em desportos com um CDI como recomendação do IIB, "pode ser considerada" (1).

INTRODUCTION

The burden of sudden cardiac death (SCD) in the young is disproportionately larger because of their greater life expectancy and the tragic impact on communities. Since 1980, the implantable cardioverter-debifibrillator (ICD) is proven to be effective in preventing SCD in patients of all ages, including children and adolescents, with cardiac disease at high risk of ventricular arrhythmias (2). For patients with risk factors, ICDs are more cost-effective for the young recipients because of the greater life expectancy. (1)

The potential benefits of physical activity and sports participation for young patients include decreased risk for obesity, metabolic syndrome, coronary and peripheral artery disease, stroke, diabetes mellitus, and other physical disorders (3). There are additional benefits of exercise including a positive effect on general mental health, decreased risk for depression, and improvement in feelings of wellbeing, all of which improve overall quality of life (4).

Prospectively collected data have been published on a large series of athletes who continued to compete after receiving an ICD. In the initial report of the ICD Sports Registry, published in 2013, 372 athletes competed in organized and/or dangerous sports, for a median follow-up time of 2.5 years. Although many did receive shocks, both appropriate and inappropriate, during competition, as well as during other physical activity and at rest, there were no incidences of any of the primary endpoints—no death or resuscitated arrest due to failure of the ICD, and no significant injury. Most athletes who received shocks during sports resumed their sports after ward, suggesting that the benefit of sports participation for their quality of life outweighed the negative psychological impacts of the shock. Long term data were recently published, now on 440 athletes with close to 4 years of follow-up, with similar results (5). Based on these data, return to play, even for sports of greater than IA intensity, may now be considered for the ICD patient. The type of sport may influence risk based on pathophysiology of the underlying cardiac disease. Data have also demonstrated that competitive sports may be safe for many patients with the long QT syndrome (LQTS) and other channelopathies, provided efficacy of treatment has been demonstrated,

appropriate precautionary measures are in place, and counselling of the athlete (and family) has occurred (6).

The group of young and physically active patients eligible for primary ICD implantation is rapidly growing. This is due to more widespread screening in family members with inherited arrhythmogenic conditions, channelopathies or cardiomyopathies, and to the rapid progress in genotypic identification of silent mutation carriers. The rationale for primary ICD implantation in some of them is that the first symptomatic manifestation of these diseases may be SCD exercise-related. Moreover, asymptomatic athletes are increasingly evaluated by pre-participation screening which may unmask not only cardiac disease, but also a high risk for unexpected sudden death (7). Whatever the circumstances of the cardiac disease diagnosis, when no causal therapy is available to prevent arrhythmia recurrences and when the risk of a potentially life-threatening arrhythmia is estimated to be high, the decision can be made to implant an ICD in an otherwise healthy and physically active patient.

Counseling of the athlete and family is critical, including information about the data and their limitations, as well as the possibility of shocks during sports. It is important to note that the indications for the ICD are the same for athletes as for other patients, and an ICD should not be implanted for the primary purpose of sports participation. The topic of return to play for youth is even more complex than for older patients because of the added interplay between patients and parents, their emotional connections, and often divergent perceived value of sport in life.

In the shared decision-making model, the role of the physician and caregivers is to explain the risks and benefits of options and to understand how to reconcile these options with their own values. Shared decision has been used successfully in pediatric populations (8).

A key part of a shared decision-making conversation involves helping patients understand the data and how it may apply to their own situation. Current guidelines encourage regular exercise for all youth because of important physical, social, and emotional long-term benefits.

This review aims to discuss some specific considerations about exercise in patients with an ICD and to review current restriction from competitive sports, as well as new insights that alter these recommendations for sports participation.

METHODS

Relevant published scientific articles focusing on the relationship between exercise and ICD were searched via the PubMed using the Medical Subject Headings (MeSH) terms ‘‘((defibrillators, implantable) AND (sport OR exercise OR physical activity)). All searches were limited to: original articles written in English; patients aged >18 years; and those published in the last 5 years. This initial search strategy was supplemented by a manual search of the references for included papers and the most recent review articles.

DATA COLLECTION

The titles and abstracts of all studies identified by the search strategy were reviewed in order to determine eligibility. All elegible studies were read in full. The

following data were extracted from all included studies: patient with implantable cardioverter-defibrillator (ICD) and practing exercise or sport; sudden cardiac death (SCD); diseases related to ICD indication. Exclusion criteria from this review were old reviews; clinical cases not including additional or new information.

STUDY RESULTS

Until recently, athletes who required an ICD were restricted by professional societies consensus statements from continued competition. However, the prospective, international, observational, ICD Sports Registry of athletes participating in sports with ICDs indicated no sports-related deaths, failures to defibrillate, or injuries, suggesting that many athletes with ICDs can safely participate in sports. Now, as stated in a recent American College of Cardiology/American Heart Association scientific statement, sports participation with an ICD “may be considered” (“IIb” classification). Although ICDs can save lives, appropriate and inappropriate shocks affect quality of life and have devastating consequences (9). For athletes with ICDs, it is critical to know how to program the ICD optimally to minimize shocks while continuing to prevent death, hemodynamic collapse, or transient loss-of-consciousness due to a life-threatening arrhythmia. Programming an ICD in primary and secondary prevention circumstances for older patients with impaired ventricular function may be challenging, and general recommendations may not apply to athletes who are younger, more active, and with different disease conditions. Based on these trials and collaborative opinion, a recent consensus document has provided guidance regarding appropriate ICD programming (10).

While the ICD Registry demonstrated that it is safe for many athletes with ICDs to continue to compete, whether participation in competitive sports increases the risk of ventricular arrhythmias requiring shock for termination is not yet determined, as only those actively competing were enrolled. Two series suggest that the risk of sudden cardiac death (SCD) is higher in athletes than nonathletes. A landmark study from Italy (11), in which all athletes and all deaths are entered in centralized databases, found that, prior to introduction of ECG screening, SCD was more frequent in athletes. Also, in a prospective observational study of US high schools, SCD was more frequent in athletes than non-athletes. However, these were individuals with previously undiagnosed disease. Whether competitive sports participation increases likelihood of arrhythmia in patients who are appropriately treated and risk-assessed has not been determined. Small retrospective series of long QT syndrome (12) and hypertrophic cardiomyopathy (13) have not shown worse outcomes in athletes who continue sports participation versus the sedentary.

A subanalysis of the ICD registry compared the primary population with a subpopulation of intensive recreational athletes enrolled in Europe (8) (and not described in the papers focused on competitive athletes) and found that arrhythmias with physical activity were more common in those competing than those practicing sports recreationally. However, there were differences between the European and US athletes. In the general population, the “paradox of exercise” is well-described (14). While overall, sudden death is less common in those who exercise vigorously, the risk of an event is higher during exercise. While often considered a “paradox”, this is likely explained by the role of the

autonomic nervous system in arrhythmogenesis. Catecholamines are known to promote arrhythmias (15). For the well-conditioned, catecholamines will be highest when they are vigorously exercising.

The ICD Sports Registry did not evaluate if or to what degree vigorous exercise may exacerbate the progression of cardiomyopathies. For some of these entities, namely arrhythmogenic right ventricular cardiomyopathy (ARVC), increasing data suggest that vigorous exercise may accelerate the progression of the phenotype. For others, such as hypertrophic cardiomyopathy and dilated cardiomyopathy, data are lacking (16).

Leisure-time physical activity resumption is allowed from 6 weeks after implant, preferably after a control (sub)maximal exercise test. In case of appropriate or inappropriate ICD interventions, a few weeks refraining from sports could be reconsidered, to evaluate the effect of changes in medical therapy or ICD programming. Sports participation with strong and obligatory bodily contact (rugby, American football, shooting, martial arts) is contra- indicated (17). For other sports with a smaller collision risk (soccer, basketball, hockey), some have advocated padding of the ICD implantation site, although effectiveness of these protection systems has never been proved. Given the fact that there is latency between arrhythmia onset and ICD intervention to terminate it, physical activities during which dizziness or (pre)syncope would expose the patient or others to additional risks are relatively contra-indicated. Strong magnetic fields could, mostly temporarily, inhibit tachy-arrhythmia therapy or lead to inappropriate interventions. Patients should be instructed about this potentiality if encountering any sports-related exposition to electro-magnetic fields. Implantable cardioverter-defibrillator devices monitor physiological heart rates, arrhythmias, and sinus rate at which potential ventricular arrhythmias occur. Thus, a specific ‘monitoring zone’, with detection but without therapies, can be specifically programmed to gain more information in this regard. After a few months without problems, level of sports participation could be tailored to an individualized target heart rate, which can be monitored by the patient on a wrist device. Such advice should always be balanced vs. risk of exercise-triggered arrhythmias (10).

CONCLUSIONS

The ICD is a very important tool to prevent sudden arrhythmic death in people at risk of malignant ventricular arrhythmias. In athletes and physically active people, quality of life with an ICD and long-term acceptance of the therapy will be highly dependent on prevention of inappropriate shocks. In this population, as few and as simple leads as possible, devices with high longevity, careful programming tailored to characteristics of the patient’s physiological and pathological heart rhythms, rehabilitation with psychological counselling, and sometimes preventive bradycardic medication are required to achieve this goal. Concerning sport activity itself, balanced advice seems appropriate, based on the intermediate findings of the international ICD Registry. Whereas current recommendations do not allow for intensive or competitive sports, more leniency may be considered in some competitive athletes and is often possible in those who want to perform mild-to-moderate recreational activities.

REFERENCES

1. Lampert R, Olshansky B, Heidbuchel H, Lawless C, Saarel E, Ackerman M, et al. Safety of Sports for Athletes with Implantable Cardioverter-Defibrillators: Long-Term Results of a Prospective Multinational Registry. Vol. 135, Circulation. Lippincott Williams and Wilkins; 2017. p. 2310–2

2. Saarel EV, Law I, Berul CI, Ackerman MJ, Kanter RJ, Sanatani S, et al. Safety of Sports for Young Patients with Implantable Cardioverter-Defibrillators. CircArrhythm Electrophysiol. 2018;11(11): e006305.

3. Longmuir PE, Brothers JA, de Ferranti SD, Hayman LL, Van Hare GF, Matherne GP, Davis CK, Joy EA, McCrindle BW; American Heart Association Atherosclerosis, Hypertension and of physical activity for children and adults with congenital heart disease: a scientific statement from the American Heart Association. Circulation. 2013; 127:2147–2159.

4. Lampert R, Olshansky B, Heidbuchel H, Lawless C, Saarel E, Ackerman M, et al. Safety of Sports for Athletes with Implantable Cardioverter-Defibrillators: Long-Term Results of a Prospective Multinational Registry. Vol. 135, Circulation. Lippincott Williams and Wilkins; 2017. p. 2310–2.

5. R. L, B. O, H. H, E.V. S, C.E. L, M.J. A, et al. The ICD sports registry: Long-term follow up. Heart Rhythm, vol.13,n5, Supplement 2016.

6. Longo UG, RisiAmbrogioni L, Ciuffreda M, Maffulli N, Denaro V. Sudden cardiac death in young athletes with long QT syndrome: The role of genetic testing and cardiovascular screening. Vol. 127, British Medical Bulletin. Oxford University Press; 2018. p. 43–53.

7. Heidbuchel H, Carré F. Exercise and competitive sports in patients with an implantable cardioverter-defibrillator.Eur Heart J. 2014;35(44):3097-102.

8. Heidbuchel H, Willems R, Jordaens L, Olshansky B, Carre F, Lozano IF, et al. Intensive recreational athletes in the prospective multinational ICD Sports Safety Registry: Results from the European cohort. Eur J Prev Cardiol2019;26(7):764–75.

9. Al-Khatib SM, Stevenson WG, Ackerman MJ, Bryant WJ, Callans DJ, Curtis AB, et al. 2017 AHA/ACC/HRS guideline for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Hea. Heart Rhythm. 2018;15(10):e73–189.

10. Olshansky B, Atteya G, Cannom D, Heidbuchel H, Saarel E V., Anfinsen OG, et al. Competitive athletes with implantable cardioverter–defibrillators—How to program? Data from the Implantable Cardioverter–Defibrillator Sports Registry. Heart Rhythm. 2019;16(4):581–7.

11. Balaji S, DiLorenzo MP, Fish FA, Etheridge SP, Aziz PF, Russell MW, et al. Risk factors for lethal arrhythmic events in children and adolescents with hypertrophic cardiomyopathy and an implantable defibrillator: An international multicenter study. Heart Rhythm. 2019;16(10):1462–7.

12. Aziz PF, Sweeten T, Vogel RL, Bonney WJ, Henderson J, Patel AR, et al. Sports participation in genotype positive children with long QT syndrome. JACC Clin Electrophysiol. 2015;1(1–2):62–70.

13. Pelliccia A, Lemme E, Maestrini V, Di Paolo FM, Pisicchio C, Di Gioia G, et al. Does Sport Participation Worsen the Clinical Course of Hypertrophic Cardiomyopathy? Circulation. 2018;137(5):531–3.

14. Lampert R, Zipes DP. Updated Recommendations for Athletes with Heart Disease. Annu Rev Med. 2018;69:177-189.

15. Imberti JF, Underwood K, Mazzanti A, Priori SG. Clinical Challenges in Catecholaminergic Polymorphic Ventricular Tachycardia. Heart Lung Circ. 2016;25(8):777-83.

16. Berg SK, Thygesen LC, Svendsen JH, Christensen AV, Zwisler AD. Physical activity in primary versus secondary prevention indication implantable cardioverter defibrillator recipients 6-12 months after implantation - A cross-sectional study with register follow up. ArchPhysMedRehabil. 2015;96(3):426–31

17. Zipes DP, Link MS, Ackerman MJ, Kovacs RJ, Myerburg RJ, Mark Estes III N. Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 9: Arrhythmias and Conduction Defects. A Scientific Statement from the American Heart Association and American College of Cardiology. Circulation. 2015 Dec 1;132(22):e315-25.

17. Wyatt KD, List B, Brinkman WB, Prutsky Lopez G, Asi N, Erwin P, Wang Z, Domecq Garces JP, Montori VM, LeBlanc A. Shared decision making in pediatrics: a systematic review and meta-analysis. AcadPediatr. 2015; 15:573–583.

18. Baggish AL, Ackerman MJ, Lampert R. Competitive sport participation among athletes with heart disease: a call for a paradigm shift in decision making. Circulation. 2017; 136:1569–1571.

19. Maron BJ, Zipes DP, Kovacs RJ; American Heart Association Electrocardiography and Arrhythmias Committee of Council on Clinical Cardiology, Council on Cardiovascular Disease in Young, Council on Cardiovascular and Stroke Nursing, Council on Functional Genomics and Translational Biology, and American College of Cardiology. Eligibility and disqualification recommendations for competitive athletes with cardiovascular abnormalities: preamble, principles, and general considerations: a scientific

statement from the American Heart Association and American College of Cardiology. Circulation 2015; 132 (22): e256–e261.

20. Isaksen K, Halvorsen B, Munk PS, Aukrust P, Larsen AI. Effects of interval training on inflammatory biomarkers in patients with ischemic heart failure. ScandCardiovasc J. 2019;53(4):213–9.

21. Van den Bruck JH, Sultan A, Plenge T, Seuthe K, Mödder T, Iliadis C, et al. Incidence of myopotential induction in subcutaneous implantable cardioverter-defibrillator patients: Is the oversensing issue really solved? Heart Rhythm. 2019;16(10):1523–30.

22. Isaksen K, Munk PS, Valborgland T, Larsen AI. Aerobic interval training in patients with heart failure and an implantable cardioverter defibrillator: A controlled study evaluating feasibility and effect. Eur J PrevCardiol. 2015;22(3):296–303.

23. Nielsen KM, Zwisler AD, Taylor RS, Svendsen JH, Lindschou J, Anderson L, et al. Exercise-based cardiac rehabilitation for adult patients with an implantable cardioverter defibrillator. Cochrane Database Syst Rev.12;2(2):CD011828.

24. Piotrowicz E, Zieliński T, Bodalski R, Rywik T, Dobraszkiewicz-Wasilewska B, Sobieszczałska-Małek M, et al. Home-based telemonitored Nordic walking training is well accepted, safe, effective and has high adherence among heart failure patients, including those with cardiovascular implantable electronic devices: A randomised controlled study. Eur J PrevCardiol. 2015;22(11):1368–77.

25. Berg SK, Zwisler AD, Koch MB, Svendsen JH, Christensen AV, Pedersen PU, et al. Implantable cardioverter defibrillator specific rehabilitation improves health cost outcomes: Findings from the COPE-ICD randomized controlled trial. J Rehabil Med. 2015;47(3):267–272

26. Keene D, Shun-Shin MJ, Arnold AD, Howard JP, Lefroy D, Davies DW, et al. Quantification of Electromechanical Coupling to Prevent Inappropriate Implantable Cardioverter-Defibrillator Shocks. JACC Clin Electrophysiol. 2019;5(6):705–15.

27. Sawant AC, TeRiele ASJM, Tichnell C, Murray B, Bhonsale A, Tandri H, et al. Safety of American Heart Association-recommended minimum exercise for desmosomal mutation carriers. Heart Rhythm. 2016;13(1):199–207.

28. Backhuijs TAM, Joosten H, Zanen P, Nathoe HM, Meine M, Doevendans PA, et al. Are the current guidelines for performing sports with an ICD too restrictive? Br J Cardiol. 2016;23:16-20

29. Alswyan AH, Liberato ACS, Dougherty CM. A Systematic Review of Exercise Training in Patients with Cardiac Implantable Devices. J CardiopulmRehabil Prev. 2018;38(2):70–84.

30. Rosman L, Lampert R, Sears SF, Burg MM. Measuring physical activity with implanted cardiac devices: A systematic review. Am Heart Assoc. 2018;7(11):e008663.

31. Lampert R. Sport Participation in Patients with Implantable Cardioverter-Defibrillators. Curr Treat Options Cardiovasc Med. 2019;21(11):66.

32. Norrish G, Cantarutti N, Pissaridou E, Ridout DA, Limongelli G, Elliott PM, et al. Risk factors for sudden cardiac death in childhood hypertrophic cardiomyopathy: A systematic review and meta-analysis. Eur J PrevCardiol. 2017;24(11):1220-1230.

33. Liz Almeida R, Providência R, Gonçalves L. Use of implantable cardioverter-defibrillators in athletes: A systematic review. Rev Port Cardiol. 2015;34(6):411-9.

34. Wyatt KD, List B, Brinkman WB, Prutsky Lopez G, Asi N, Erwin P, Wang Z, Domecq Garces JP, Montori VM, LeBlanc A. Shared decision making in pediatrics: a systematic review and meta-analysis. AcadPediatr. 2015; 15:573–583

35. Bosman LP, Sammani A, James CA, Cadrin-Tourigny J, Calkins H, van Tintelen JP, et al. Predicting arrhythmic risk in arrhythmogenic right ventricular cardiomyopathy: A systematic review and meta-analysis. Heart Rhythm. 2018;15(7):1097–107.