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Impacto da Parada Cardíaca Induzida nas Funções Cognitivas após o Implante de Cardiodesfibrilador*

Impact of Induced Cardiac Arrest on Cognitive Function after Implantation of a Cardioverter-Defibrillator

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RESUMO

Silva MP, Rivetti LA, Mathias LAST, Cagno G, Matsui C — Impacto da Parada Cardíaca Induzida nas Funções Cognitivas após o Implante de Cardiodesfibrilador.

JUSTIFICATIVA E OBJETIVOS: *O cardiodesfibrilador implantável (CDI) foi introduzido na prática clínica em 1980 e é considerado o tratamento-padrão para indivíduos sob risco de desenvolverem disritmias ventriculares fatais. Com o intuito de garantir funcionamento adequado do cardiodesfibrilador, a energia necessária para o término da taquicardia ventricular ou da fibrilação ventricular deve ser determinada durante o implante, sendo esse procedimento chamado de teste do limiar de desfibrilação. Para a realização do teste é necessário que seja feita indução de fibrilação ventricular, para que o aparelho possa identificar o ritmo cardíaco e tratá-lo. O objetivo deste estudo foi verificar a ocorrência de disfunção cognitiva 24 horas após o implante de cardiodesfibrilador.*

MÉTODO: *Foi selecionada uma amostra consecutiva de 30 pacientes com indicação de colocação de cardiodesfibrilador implantável (CDI) e 30 pacientes com indicação de implante de marca-passo (MP). Os pacientes foram avaliados nos seguintes momentos: 24 horas antes da colocação do CDI ou MP com ficha de avaliação pré-anestésica, Mini Exame do Estado Mental (MEEM) e Confusion Assessment Method (CAM). Durante o implante do CDI ou MP foram medidas as variáveis: número de paradas cardíacas e tempo total de parada cardíaca. Vinte e quatro horas após colocação do CDI ou MP, foram avaliadas as variáveis: MEEM e CAM.*

RESULTADOS: *O teste de Fisher comprovou não haver diferença da freqüência de escores alterados do MEEM e do CAM entre os grupos antes e depois dos implantes. O tempo médio de PCR foi 7,06 segundos, com máximos e mínimos de 15,1 e 4,7 segundos.*

CONCLUSÕES: *A indução de parada cardíaca durante o teste do limiar de desfibrilação não levou à disfunção cognitiva 24 horas após o implante de cardiodesfibrilador.*

Unitermos: CIRURGIA, Cardíaca: parada cardíaca induzida; COMPLICAÇÕES: isquemia encefálica, manifestações neurológicas, transtornos cognitivos; EQUIPAMENTOS: desfibriladores implantáveis; marca-passo.

SUMMARY

Silva MP, Rivetti LA, Mathias LAST, Cagno G, Matsui C — Impact of Induced Cardiac Arrest on Cognitive Function after Implantation of a Cardioverter-Defibrillator.

BACKGROUND AND OBJECTIVES: *Implantable cardioverter-defibrillators (ICD) were introduced in clinical practice in 1980 and they are considered the standard treatment for individuals at risk for fatal ventricular arrhythmias. To ensure proper working conditions, the energy necessary to interrupt ventricular tachycardia or ventricular fibrillation should be determined during implantation by a test called defibrillation threshold. For this test, it is necessary to induce ventricular fibrillation, which should be identified and treated by the device. The objective of the present study was to determine the frequency of cognitive dysfunction 24 hours after the implantation of a cardioverter-defibrillator.*

METHODS: *Thirty consecutive patients with indication of cardioverter-defibrillator (ICD) placement and 30 patients with indication of implantable pacemaker (PM) were enrolled in this study. Patients were evaluated at the following moments: 24 hours before placement of the ICD or PM with a pre-anesthetic evaluation form, Mini Mental State Examination (MMSE), and Confusion Assessment Method (CAM); during implantation of the ICD or PM, the following parameters were determined: number of cardiac arrests and total time of cardiac arrest. Twenty-four hours after placement of the device, the following parameters were evaluated: MMSE and CAM.*

RESULTS: *Differences in the frequency of altered MMSE and CAM scores between both groups before and after implantation were not detected by the Fisher Exact test. The mean time of cardiac arrest was 7.06 seconds, with a maximal of 15.1 and minimal of 4.7 seconds.*

CONCLUSIONS: *Induction of cardiac arrest during defibrillation threshold testing did not cause cognitive dysfunction 24 hours after implantation of the cardioverter-defibrillator.*

Key Words: COMPLICATIONS: brain ischemia, neurologic manifestations, cognitive dysfunction; EQUIPMENT: implantable defibrillators; pacemaker; SURGERY, Cardiac: induced cardiac arrest.

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No presente estudo os pacientes foram submetidos, na maioria das vezes, a uma parada cardíaca. Murkin e col. [27] estudaram 14 pacientes com média de 12 episódios de indução de fibrilação ventricular e encontraram alteração em 71% destes. Adams e col. [28] avaliaram nove pacientes com média de 5,6 paradas cardíacas induzidas e não encontraram alteração cognitiva. Weigl e col. [29] avaliaram 21 pacientes com três paradas em média e encontraram pequeno grau de disfunção cognitiva no pós-operatório. Comparando esses dados, percebe-se que com um número maior de induções de parada cardíaca, durante o implante do cardiodesfibrilador, a ocorrência de disfunção cognitiva pode aumentar. Pacientes reanimados com sucesso depois de parada cardíaca sofrem disfunção cognitiva que parece estar relacionada com a demora nas medidas de reanimação [30].

O´Reilly e col. [31] compararam as funções cognitivas dos pacientes vítimas de parada cardiorrespiratória (PCR) intra-hospitalar, cujas medidas de reanimação se instalaram com mais rapidez, com pacientes com PCR extra-hospitalar e detectaram, em ambas, alteração de memória.

Embora no presente estudo tenha-se verificado segurança durante o período de isquemia encefálica, determinado pelas induções de fibrilação ventricular, isso deve ter ocorrido, sobretudo, em virtude do curto período de parada cardiorrespiratória imposto aos pacientes da amostra.

Técnicas que permitem períodos de isquemia prolongados com segurança têm sido desenvolvidas em diversas situações. Dentre várias, assumem papel importante, ainda em nível experimental: a hipotermia [32], por diminuir o metabolismo celular; o pré-condicionamento isquêmico, no qual curtos períodos de isquemia poderiam preparar a estrutura intracelular para o evento isquêmico subseqüente [33] e fármacos que protegeriam o encéfalo da isquemia e reperfusão [34].

Levando em consideração a amostra e o método utilizado, a indução de parada cardíaca por até 15,1 segundos durante o teste do limiar de desfibrilação não ocasionou disfunção cognitiva 24 horas após o implante de cardiodesfibrilador.

Impact of Induced Cardiac Arrest on Cognitive Function after Implantation of a Cardioverter-Defibrillator

Mauro Prado da Silva, TSA, M.D.; Luiz Antonio Rivetti, M.D.; Lígia Andrade Silva Telles Mathias, TSA, M.D.; Guilherme Cagno, M.D.; Christiano Matsui, M.D.

INTRODUCTION

Sudden cardiac arrest is one of the main causes of deaths in occidental developed nations, with an incidence of 500,000/year, in the USA, and 400,000/year, in Europe [1].

The implantable cardioverter-defibrillator (ICD) was introduced in clinical practice in 1980, and it is considered the standard of care for individuals at risk for fatal ventricular arrhythmias [2]. Several clinical studies have demonstrated its superiority in the prevention of sudden cardiac arrest when compared to pharmacological treatment [3-5].

To ensure the cardioverter-defibrillator works properly, the energy necessary to interrupt ventricular tachycardia or fibrillation should be determined during implantation, which is achieved by the fibrillation threshold test [6]. The energy should be high enough to guarantee the return to normal rhythm, but low enough to preserve the battery and increase the durability of the implant [7]. During this test, ventricular fibrillation is induced, and it should be identified and treated by the device [8]. This procedure foresees the possible development of damage secondary to ischemia of high blood flow-dependent organs due to their high metabolic rate such as the brain [9,10]. Some studies used electroencephalographic monitoring, brain oxygen consumption, S-100 protein measurement, and neuron-specific enolase to detect the presence of changes in the brain after cardiac arrest induced during the defibrillation threshold test, but without correlating those changes with clinically detectable cognitive dysfunction [11-15].

Very few information on the risk factors for the development of postoperative cognitive dysfunction is available; however, elderly patients with multiple comorbidities seem to be at higher risk for neurologic and cognitive complications, besides those patients who needed cardiac surgery with extracorporeal circulation [16-18].

The medical literature on the development of cognitive dysfunction within 24 hours after the procedure in patients undergoing cardioverter-defibrillator implantation is very limited and controversial, and, due to the high personal, social, and economical cost of this complication, evaluating its presence in this population is necessary, and this was the objective of this study.

METHODS

After approval by the Ethics on Research Committee of the Irmandade da Santa Casa de Misericórdia de São Paulo, 30 consecutive patients with indication of implantable cardioverter-defibrillator placement (G_{ICD}) and 30 patients with indication of pacemaker placement (G_{PM}) from November 2006 to February 2007, were selected.

Patients with neurological and psychiatric disorders, hearing impairment, visual impairment, motor deficit of the upper limbs, and/or younger than 18 years were excluded.

The tests used to identify changes in cognitive function included Mini Mental State Examination – MMSE (Chart I) [19,20] and the Confusion Assessment Method – CAM (Chart II) [21,22].

Patients who agreed to participate in the study were evaluated on the following moments.

– Twenty-four hours before implantation of the cardioverter-defibrillator or pacemaker, when they answered the following forms: pre-anesthetic evaluation card; Mini Mental State Examination and Confusion Assessment Method.

Chart I – Mini Mental State Examination

ORIENTATION IN TIME (1 point for each correct answer) 5 points
– What is the year?
– What is the season?
– What is the month?
– What is the day?
– What is the day of the month?

ORIENTATION IN SPACE (one point for each correct answer) 5 points
– In which state are we in?
– In which city are we in?
– In which borough are we in?
– What is this building we are in?
– In which floor are we in?

REGISTRATION (1 point for every word repeated correctly on the first attempt, although it can be repeated up to three times, for the sake of learning, in case of mistakes). 3 points
– Now pay attention. I am going to say three words and you will repeat them when I am finished. Right? The words are CAR (pause), VASE (pause), and BALL (pause). Now, repeat the words.

ATTENTION AND CALCULATION (1 point for each correct answer) 5 points
Now I would like you to subtract 7 from 100 and from the result subtract 7. Then continue to subtract 7 until I tell you to stop. Did you understand? [pause] Let us Begin. How much is 100 minus 7? (From a total of five subtractions, give one point for each correct answer). If the patient does not reach the maximal score, ask the patient to spell the word WORLD. Correct spelling mistakes and then ask the patient to spell the Word WORLD backwards. (Give one point for each correct position. Consider the higher score).

RECALL (1point for each word) 3 points
Ask: What are the three words I asked you to memorize?

LANGUAGE AND CONSTRUCTIVE VISUAL CAPACITY (1 point for each correct answer) 9 points
– (Point to the pencil and the watch and ask) What is this? (pencil) What is this? (watch).
– Now I am going to ask you to repeat what I am going to say. Right? Repeat: “No ifs, ands, or buts”.
– Now pay attention. I am going to ask you to perform a task (pause). Pick up this paper with your right hand (pause), fold it once with both hands (pause), and throw it on the floor.
– Please, read this and do what is written on the paper. Show the patient the paper with the command: CLOSE YOUR EYES.
– Ask: Please, write a phrase. If the patient does not answer, ask: Write about the weather (place a blank sheet of paper and a pencil or pen in front of the patient).
– Ask: Please, copy this drawing (show a piece of paper with intersecting pentagons and give him 1 point if he is correct).

– During implantation of the defibrillator-cardioverter or pacemaker, the following parameters were measured: number of cardiac arrests and total cardiac arrest time.
– Twenty-four hours after implantation of the cardioverter-defibrillator or pacemaker, when the following were evaluated: Mini-Mental State Examination and Confusion Assessment Method.

The size of the study population was calculated before collecting the data assuming a 30%-difference in the results of both groups, with an alpha error of 5% and beta error of 20%; therefore, 24 patients in each group would be necessary, but 30 patients were enrolled in each group to compensate for possible loss of follow-up.

Non-parametric Chi-square test was used to compare the schooling level. Fisher Exact test was used to compare gender and the scores at each assessment of cognitive function. The Student *t* test for independent samples was used to compare continuous parameters with normal distribution. The study has a confidence interval of 95%, and a $p < 0.05$ was considered significant.

The statistical tests used in this study are included in the statistical package Sigma Stat for Windows, version 2.03, SPSS Inc.

RESULTS

Table I shows the anthropometric data and schooling of patients in both groups.

Statistical tests used to assess the homogeneity of G_{ICD} and G_{PM} regarding gender, height, weight and schooling showed that both groups were comparable, but they were heterogeneous for age (Table I).

Table II shows the percentage of patients with altered Mini Mental State Examination (MMSE) and Confusion Assessment Method (CAM) scores 24 hours before and 24 hours after implantation if the defibrillator or pace-maker. Fisher Exact test did not show statistically significant differences in the frequency of altered MMSE scores between both groups in all three tests.

Twenty-four patients underwent one induction of ventricular fibrillation and six underwent two inductions.

Mean cardiorespiratory arrest time and respective standard deviation in patients in G_{ICD} were 7.06 and 3.61 seconds, with a maximal value of 15.1 sec and minimum of 4.7 sec.

Chart II – Confusion Assessment Method (CAM)

1. ACUTE ONSET
Is there evidence of acute change in the mental status from the patient's baseline?

2. INATTENTION
- 2.A – Did the patient have difficulty focusing attention, for example, being easily distractible, or having difficulty keeping track of what was being said?
- 2.B – If present or abnormal, did this behavior fluctuate during the interview, that is, tend to come and go or increase and decrease in severity?
- 2.C – If present or abnormal, describe this behavior.

3. DISORGANIZED THINKING
Was the patient thinking disorganized or incoherent such as rambling or irrelevant conversation, unclear or illogical flow of ideas, or unpredictable switching from subject to subject?

4. ALTERED LEVEL OF CONSCIOUSNESS
Overall, how would you rate this patient's level of consciousness? Alert (normal), vigilant (hyperalert, overly sensitive to environmental stimuli, startled very easily), lethargic (drowsy, easily aroused), stupor (difficult to arouse), coma (cannot be aroused), or uncertain?

5. DISORIENTATION
Was the patient disoriented any time during the interview, such as thinking that he or she was anywhere else than the hospital, on the wrong bed, or misjudging the time of the day?

6. MEMORY IMPAIRMENT
Did the patient demonstrate any memory problems during the interview, such as inability to remember events in the hospital or difficulty remembering instructions?

7. PERCEPTUAL DSITURBANCES
Did the patient show signs of perceptual disturbances, for example, hallucinations, illusions, or misinterpretations (such as thinking something was moving when it was not)?

8. ALTERED SLEEP-WAKE CYCLE
Did the patient have evidence of disturbance of the sleep-wake cycle, such as excessive daytime sleepiness or insomnia at night?

Table I – Anthropometric Data and Schooling of Patients in Groups G_{ICD} and G_{PM}

	G_{ICD}	G_{PM}	p
Age (years)*	53.03 ± 16.0	67.30 ± 9.1	$p^1 = 0.0001$
V.Max – V. Min (years)	77 – 19	86 – 45	
Weight (kg)*	66.7 ± 10.2	68.3 ± 10.7	$p^1 = 0.577$
Height (cm)*	166.0 ± 5.5	163.4 ± 7.7	$p^1 = 1.399$
Gender (F/M)	24 / 6	14 / 16	$p^2 = 0.063$
Schooling			$p^3 = 0.514$
Illiterate	5 (16.6%)	8 (26.6%)	
< 8 years of schooling	17 (56.6%)	17 (56.6%)	
≥ 8 years of schooling	8 (26.6%)	5 (16.6%)	

*Results expressed as Mean ± SD.
G_{ICD} = group with implantable cardioverter-defibrillator; G_{PM} = group with implantable pacemaker; p^1 = level of significance of the non-paired Student *t* test; p^2 = level of significance of the Fisher Exact test; p^3 = level of significance of the $\times^2$ test.

DISCUSSION

Neuropsychological tests have been used postoperatively to establish the presence of cognitive dysfunction in patients undergoing cardiac surgeries [23-25].

In the present study, postoperative cognitive dysfunction (POCD) was defined as a 30% change of the mean obtained 24 hours before the implantation. For this, the Mini Mental State Examination (MMSE), which has been successful in screening for cognitive dysfunction, was used. The Confusion Assessment Method (CAM), developed to detect delirium, since this alteration can be easily mistaken by POCD, which would affect the results of the study, was also used. The use of both tests was validated in Brazil [20,22].

Table II – Percentage of Altered Mini Mental State Examination (MMSE) and Confusion Assessment Method (CAM) Scores

	G_{ICD}	G_{PM}	p
24h before the procedure			
MMSE	0.0%	3.3%	1.000
CAM	0.0%	0.0%	1.000
24h after the procedure			
MMSE	3.3%	3.3%	1.000
CAM	0.0%	0.0%	1.000

Value of p – Fisher Exact test.
G_{ICD} = group with implantable cardioverter-defibrillator; G_{PM} = group with implantable pacemaker.

As for the anthropometric data, a significant increase in mean age was noted in the control group (G_{PM}) when compared to the study group (G_{ICD}) ($p < 0.0001$), which could hinder assessment of the results, since elderly patients have a tendency for lower scores on neuropsychological tests [26]. However, when comparing the results of those tests between both groups before implantation of the pacemaker or defibrillator, a significant difference was not detected ($p < 0.05$).

In the present study, most patients were subjected to one cardiac arrest. Murkin et al. [27] studied 14 patients with a mean of 12 episodes of induced ventricular fibrillation and found cognitive changes in 71% of the patients. Adams et al. [28] evaluated nine patients with a mean of 5.6 induced cardiac arrests and did not find any cognitive changes. Weigl et al. [29] evaluated 21 patients with a mean of three cardiac arrests and found some degree of postoperative cognitive dysfunction. Comparing those data, one can see that the incidence of cognitive dysfunction can increase with the increase in the number of induced cardiac arrests during implantation of the cardioverter-defibrillator.

Patients who have been successfully resuscitated after a cardiac arrest develop cognitive dysfunction that seems to be related with the delay in resuscitation maneuvers [30].

O'Reilly et al. [33] compared the cognitive function of patients who had an intra-hospital cardiac arrest and to whom the resuscitative maneuvers were instituted immediately, with patients that had extra-hospital cardiac arrest and, in both cases, they detected memory changes.

Although the present study detected the safety during the period of brain ischemia caused by the induction of ventricular fibrillation, this was probably due to the short duration of each episode of cardiac arrest imposed to the patients.

Techniques that allow prolonged ischemic periods in different situations with safety have been developed. Among them, the following, still experimental, are important: hypothermia [32], by reducing cellular metabolism; ischemic preconditioning, in which short periods of ischemia would prepare the intracellular structure for the subsequent ischemic event [33]; and drugs that would protect the brain from ischemia and reperfusion [34].

Considering the study population and the method used, induction of cardiac arrest for up to 15.1 seconds during the defibrillation threshold test did not cause cognitive dysfunction 24 hours after the implantation of the cardioverter-defibrillator.

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RESUMEN

Silva MP, Rivetti LA, Mathias LAST, Cagno G, Matsui C — Impacto de la Parada Cardíaca Inducida en las Funciones Cognitivas después del Implante de Desfibrilador cardiaco.

JUSTIFICATIVA Y OBJETIVOS: *El desfibrilador cardiaco implantable (DCI) fue introducido en la práctica clínica en el 1980 y se considera el tratamiento estándar para individuos bajo el riesgo de desarrollar arritmias ventriculares fatales. Con el interés de garantizar el funcionamiento adecuado del desfibrilador cardiaco, la energía necesaria para el término de la taquicardia ventricular o de la fibrilación ventricular, debe ser determinada durante el implante, siendo este procedimiento llamado test del límite de desfibrilación. Para la realización del test es necesario que se haga la inducción de la fibrilación ventricular, para que el aparato pueda identificar el ritmo cardíaco y tratarlo. El objetivo de este estudio fue verificar la incidencia de disfunción cognitiva 24 horas después del implante del desfibrilador cardiaco.*

MÉTODO: *Se seleccionó una muestra consecutiva de 30 pacientes con indicación de colocación de desfibrilador cardiaco implantable (DCI) y 30 pacientes con indicación de implante de marca-paso (MP). Los pacientes fueron evaluados en los siguientes momentos: 24 horas antes de la colocación del DCI o MP con ficha de evaluación preanestésica, Mini-Examen del Estado Mental (MEEM) y Confusion Assessment Method (CAM). Durante el implante del DCI o MP fueron medidas las variables: número de paradas cardíacas y tiempo total de parada cardíaca. Veinte y cuatro horas después de la colocación del DCI o MP, se evaluaron las variables: MEEM y CAM.*

RESULTADOS: *El test de Fisher mostró que no había diferencia de la frecuencia de puntuaciones alteradas del MEEM y del CAM entre los grupos antes y después de los implantes. El tiempo promedio de PCR 7,06, con máximos y mínimos de 15,1 y 4,7 segundos.*

CONCLUSIONES: *La inducción de parada cardíaca durante el test del límite de desfibrilación, no conllevó a la disfunción cognitiva veinte y cuatro horas después del implante del desfibrilador cardiaco.*