

Bispectral index recorded during prehospital cardiopulmonary resuscitation as a predictor of survival

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RECEIVED:

17-5-2011

ACCEPTED:

27-6-2011

CONFLICT OF INTEREST:

None

Objective: To determine the value of the bispectral index (BIS) for predicting survival in patients in cardiorespiratory arrest attended by advanced life support units.

Material and methods: One-year prospective observational study of 16 patients in cardiorespiratory arrest in Barcelona who were attended by advanced life support units. The BIS was monitored during prehospital advanced life support maneuvers.

Results: Basic life support measures were required in the great majority (88%) of cases. The cause of arrest was cardiac-related in 13 patients and the initial heart rhythm was shockable in 3. Circulation recovered spontaneously in 3 patients, 1 of whom died in the hospital. BIS values were lower in patients who recovered circulation spontaneously than in those who did not survive. Patients in cardiorespiratory arrest who received basic life support measures and whose initial rhythm was shockable had lower BIS values.

Conclusions: BIS values recorded during prehospital advanced life support maneuvers for cardiorespiratory arrest do not predict survival. [Emergencias 2012;24:35-38]

Key words: Cardiopulmonary resuscitation. Bispectral index monitoring. Out-of-hospital cardiac arrest. Brain ischemia.

Introduction

Cerebral and cardiopulmonary resuscitation (CPR) techniques applied in cases of sudden cardiac arrest (SCA) are aimed at recovering the victims neurological and cardiorespiratory status¹. Optimal neurological status depends primarily on adequate cerebral perfusion during CPR and there is currently no objective method of monitoring perfusion or brain activity during CPR².

EEG monitoring using the bispectral index (BI) has generated much interest as a method to monitor adequate cerebral perfusion during PCR but results are highly controversial: some investigators affirm a relationship between BI values and survival³⁻⁵ while others have concluded that there is none^{2,6}.

BI analyzes the EEG signal with respect to the parameters of frequency and amplitude. These signals are filtered for artifacts and statistically converted to a number via a dynamic algorithm.

The BI value is a number that ranges from 100 (awake) to 0 (patient brain electrical silence). This value represents a direct measure of brain state and reproduces the fluctuations of electrical activity produced by metabolic alterations, and therefore of brain activity¹.

The aim of this study was to determine whether BI values obtained during advanced life support (ALS) maneuvers in pre-hospital CPR carried out by the emergency medical system (EMS) teams were greater in patients with spontaneous return of circulation (ROSC) than in those without ROSC. Specifically, we aimed to analyze whether these BI values could determine ROSC and whether they were related with Utstein records.

Methods

We performed a prospective observational

study in a pre-hospital setting between July 2008 and April 2009. The study included all SCA patients attended by the EMS following ALS maneuvers recommended by the European Resuscitation Council (ERC) and in whom BI values were recorded during these maneuvers. We excluded those patients without BI monitoring or those with low-quality signal (less than 60).

In cases of SCA, ALS unit responders started CPR as recommended by ERC and placed the BI sensor on the patient's forehead to monitor the data continuously during the first few minutes of ALS without such placement hindering the resuscitation maneuvers. BI values analyzed were the first (initial BI) and the mean value obtained from three minutes recording (3-minute mean BI).

The dependent variable was the value of BI (both) and the independent variables were survival, neurological status at discharge, age, sex, location of the cardiac event, the etiology of SCA, the presence/absence of witnesses, treatment before EMS arrival on the scene, initial heart rhythm and recovery of spontaneous circulation (ROSC).

We performed a univariate and bivariate (inferential) descriptive analysis of the data: quantitative variables are expressed as means ($\pm$ standard deviation) and qualitative variables as percentages.

Groups were compared using Student's *t* test for quantitative variables and Pearson's correlation for quantitative variables. Differences with a *p* value <0.05 were considered statistically significant. All statistical analyses were performed with the Statistical Package for Social Sciences (SPSS) version 13.

Results

A total of 16 patients were included in the study. Mean age was 55 ± 3 years, mostly men (87.5%), and most (94%) events of SCA occurred outside a health center. However, almost all were witnessed (87.5%) and basic CPR was performed in 75% of cases. The origin was cardiac in 81% of cases, but the initial rhythm was shockable in only 19% ($n = 3$). In total, ROSC was achieved in three patients (19%) who were alive at hospital ED admission, although only two were discharged from hospital, both with CPC1.

BI sensor placement presented no difficulty nor did it interfere with ALS at any time. Good BI signal quality was obtained in most cases ($78.7 \pm$

6.7). Initial BI (36 ± 14.2) and 3-minute mean BI values (33.6 ± 12.5) were similar (not significant). Lower initial BI values were observed in patients with ROSC (22.7 ± 4.7) than in those who did not survive (37.9 ± 4.2), although this difference was not significant ($P = 0.1$) (Figure 1). Neither did we observe a significant difference in mean 3-minute BI ($P = 0.06$) between those who survived to hospital admission (23 ± 5) and those who did not survive (37.2 ± 11.7) (Figure 2 and Table 1).

Discussion

The results of initial and mean 3-minute BI monitoring during ALS maneuvers confirmed the findings of two previous studies carried out in the pre-hospital setting. In the first, involving 21 patients who received pre-hospital CPR, BI values collected on arrival of the EMS team were a poor indicator of cerebral perfusion². These results were attributed to artifacts produced by mechanical movements of the head during resuscitation, and delays between the start of CPR and BI monitoring. In the second study, Charlotte Chollet Xémard et al.⁶ monitored BI in 92 patients and found no relationship between BI values and the probability of ROSC. Unlike the previous study, BI was recorded very early but still no relationship with survival was found. Time-lag in monitoring BI values does not appear to influence the results⁶.

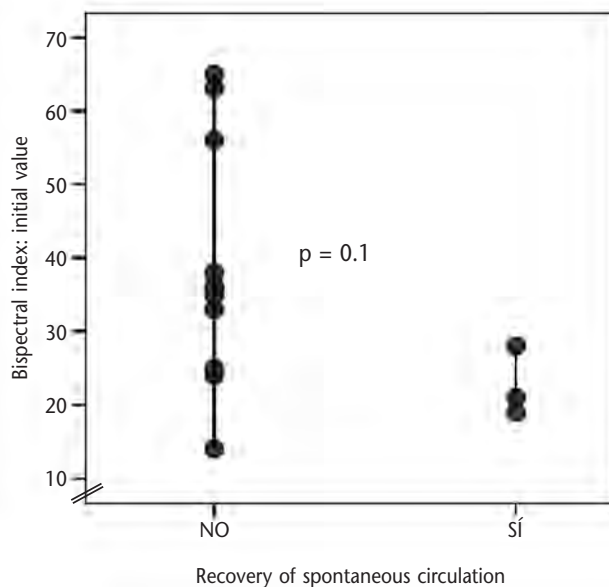


Figure 1. Relationship between the recovery of spontaneous circulation and the initial value of bispectral index.

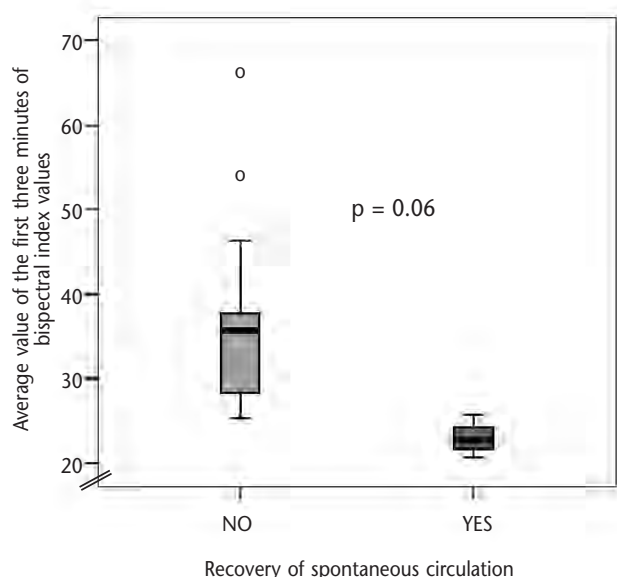


Figure 2. Relationship between the recovery of spontaneous circulation and the average of the first three minutes of the bispectral index values.

Electro-myographic values are known to overestimate BI and recent studies conclude that BI values in SCA are not acceptable as a clinical marker of cerebral perfusion given the multiple interferences during CPR which influence this parameter⁶.

External factors, such as chest compressions, external defibrillation, ambulance vibration, moving the patient to perform techniques such as endotracheal intubation or channeling a peripheral line may cause artifacts that influence the EMG and thus overestimate the BI values obtained^{7,8}.

Good cerebral perfusion may be achieved by effective chest compressions. In our study, EMS responders reported that they observed low values of BI when chest compressions were ineffective. We would therefore propose improved chest compression technique to achieve higher values of BI. Observable changes in BI values helped the rescue team to improve the quality of such compressions³.

The etiology, initial rhythm and the performance of CPR maneuvers before ALS failed to influence the BI values obtained in SCA. Therefore, BI values used in other indications not validated for anesthetic depth should be used with great caution until further clinical research provides evidence of their usefulness and limitations.

The major limitation of this study is the small sample size, because only one ALS unit was equipped with BI technology. However, our results are consistent with those of similar studies with larger sample sizes (performed in the pre-hospital setting and analyzing BI values obtained during CPR), which also concluded with negative results and found no relationship between BI and survival^{2,6}. In conclusion, bispectral index values obtained during ALS maneuvers do not predict survival in pre-hospital SCA patients nor neurological function in those who survive SCA.

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Table 1. Relationship between the Utstein records and initial values of the bispectral index (BIS) and the average of the first three minutes of BIS values

	Cardiac etiology			Previous CPR			Initial shockable rhythm		
	Yes	No	p	Yes	No	p	Yes	No	p
Initial BIS	33.8±15.2	40.7 ± 14.2	0.5	37.7 ± 16.1	27 ± 6	0.2	26.7 ± 7.1	37 ± 15.7	0.3
Average 3 min BIS	34.4 ± 12.5	35.1 ± 11.8	0.9	37.7 ± 12	25 ± 5	0.7	28.1 ± 7	36 ± 12.6	0.3

El pronóstico de la supervivencia mediante los valores del índice bispectral obtenidos durante la reanimación cardiopulmonar prehospitalaria

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Introducción: Determinar el valor pronóstico del índice bispectral (BIS) en cuanto a la supervivencia de pacientes con una parada cardiorrespiratoria (PCR) asistidos por unidades de soporte vital avanzado (SVA).

Método: Estudio prospectivo observacional durante un año en 16 pacientes que han sufrido una PCR en Barcelona, que fueron asistidos por unidades de SVA y a los que se les monitorizó los valores del BIS durante todas las maniobras de SVA prehospitalario.

Resultados: Se incluyen 18 pacientes. Las PCR fueron presenciadas en el 88% de casos y se les realizó soporte vital básico (SVB) previo a la gran mayoría. La causa fue cardíaca en 13 pacientes y el ritmo inicial fue desfibrilable en 3. Recuperaron circulación espontánea 3 pacientes, de los cuales uno falleció en el hospital y 2 fueron dados de alta con una categoría de perfusión cerebral (CPC) de 1. Los valores BIS fueron inferiores en los pacientes que recuperaron la circulación espontánea que en los que no sobrevivieron pero sin diferencias estadísticamente significativas. Los PCR de etiología cardíaca, a los que se les realizó SVB previo y donde el ritmo inicial fue desfibrilable, tampoco presentaron valores significativamente inferiores del BIS.

Conclusiones: Los valores del BIS obtenidos durante las maniobras de SVA no predicen la supervivencia de los PCR prehospitalarios. [Emergencias 2012;24:35-38]

Palabras clave: Reanimación cardiopulmonar. Valores del índice bispectral. Perfusión cerebral.

The Editorial Committee of EMERGENCIAS is grateful to all the members of the national and international Editorial Boards for their contributions to the Journal and to the members of the Committee of Experts for their review work and improving the quality of manuscripts published. It also wishes to make public their gratitude to the following individuals, not part of the Expert Committee, who assessed work and issued reports in 2011 at the request of the Editorial Committee.

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