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Research Article

Focus Protocol in Pediatric Patients with Extensive Burn Injuries and the Use of Propranolol in Cardiac Output Decrease

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Abstract

Objective: To review the effect of propranolol during the hypermetabolic phase in pediatric patients with extensive burn injuries.

Materials and Methods: Cardiac output and left ventricular ejection fraction were observed in 19 pediatric patients with extensive injuries by ultrasound protocol (FOCUS) during February-June 2019.

Results: A 22% decrease in cardiac output was demonstrated, which is considered a higher percentage compared to that mentioned in the literature.

Conclusion: The use of propranolol could be beneficial during the hypermetabolic phase in pediatric patients with extensive injuries.

Keywords: *Focused Cardiac Echocardiography; Left Ventricular Ejection Fraction; Cardiac Output; Pediatric Patient with Extensive Burn Injuries*

Abbreviations

CO: Cardiac Output; LVEF: Left Ventricular Ejection Fraction; BBSA: Burned Body Surface Area; FOCUS: Focused Cardiac Ultrasound

Introduction

Pediatric patients with extensive burn injuries are those with at least one of these characteristics:

- Burn of 10% or more of body surface area (BBSA), with type AB or B burn (2o. and 3o.) [1].
- Respiratory or smoke inhalation burns.
- High voltage electrical burns, burns associated with multiple traumas and burned patients with associated severe pathologies [2].

Severe burns are the type of injury that triggers the highest degree of hypermetabolism during the hyperdynamic phase of the metabolic response to trauma, which can persist for up to three years [3,4]. This phase is characterized by:

- Increased basal metabolic rate.

- Increased resting heart rate, cardiac output, and elevated heart work.
- Lipolysis and protein catabolism, resulting in loss of muscle mass and a subsequent increase in the risk of organ failure or death [5].

Propranolol as a beta-blocker modulates the post-traumatic hypermetabolic response in pediatric patients with extensive burn injuries. It is a drug therapy which administration over a two-week period has been shown to be effective in reducing myocardial oxygen requirements, lowering the patient's blood pressure and heart rate by 15 - 20% [3,6]. In addition, it increases the net protein balance in muscle, decreases lean mass loss, and decreases the basal metabolic rate [7].

Therefore, we describe the effect of propranolol to decrease cardiac output and its monitoring through the FOCUS protocol in pediatric patients with extensive burn injuries.

Materials and Methods

19 pediatric patients with extensive burn injuries were studied during February-June 2019 in a pediatric burn unit. The inclusion criteria were:

- Pediatric patients with more than 10% BBSA (etiology of the injury: scalding, direct fire, electrical, and Blast syndrome) from 1 year to 17 years 11 months 29 days of age and who also presented absence of cardiac conduction disturbances on the electrocardiogram.

FOCUS (Focused Cardiac Ultrasound) protocol was performed by a group of pediatric intensivist physicians. In accordance with the recommendations of the American Society of Echocardiography, the M mode of the Siemens Acuson equipment with a 4 MHz transducer was used. Traces were obtained in the subepicardial window and parasternal long axis, and the volumes of the left ventricle at the end of the diastole and systole were determined. These data were used to measure cardiac output.

Two measurements were made: The first on the fifth day of admission (propranolol at 0.5 mg/kg/day was immediately administered orally for 21 days) and the second on the twelfth day of in-hospital stay. Cardiac output measurements were made with patients in supine position, in the absence of crying and breathing freely.

The data were recorded for analysis in the program SPSS IBM Version 27. For continuous variables, they were expressed as percentages, mean, and standard deviation. To check whether the variables were normally distributed, the Kolgomorv-Smirnoff test was used. For the normally distributed continuous variables we used the Student t-test for dependent samples. All statistical calculations were performed with two queues and the statistical significance was established with a value of $p < 0.05$.

Results and Discussion

During the period from February 2019 to June 2019, 19 pediatric patients with extensive burn injuries were studied, of which 14 (73%) were male and 5 (27%) were female, with a mean age of 3.6 years and a standard deviation of 3.8 years.

Among the reasons for admission: 11 were due to burns by scalding (58%), 7 by direct fire (32%), 1 by Blast Syndrome (5%) and 1 by electricity (5%) (Table 1).

Etiology	Frequency	Percentage
Scalding	11	58%
Direct fire	6	32%
Blast syndrome	1	5%
Electricity	1	5%

Table 1: *Percentage according to the etiology of pediatric patients with extensive injury.*

On the 5th day of hospitalization, CO monitoring was performed by echocardiography, where the average was 3.72 L/min with a standard deviation of 1.30 L/min. For this reason, propranolol was initiated in these patients.

After 7 days of propranolol use (12 days of in-hospital stay), the mean of the CO was 3.01 L/min with a standard deviation of 1.01 L/min (Table 2).

	Cardiac output at the beginning of treatment		Cardiac output at the end of treatment		CI 95% (Ll; Ul)	P value
	Mean	SD	Mean	SD		
CO L/min	3.72	1.3	3.01	1.01	0.1; 1.31	0.025*

Table 2: *Comparison of cardiac output (CO) at the beginning and after 7 days of treatment with propranolol. Standard Deviation (SD); Cardiac output liter/minute (CO L/min); 95% confidence interval (95% CI); Lower limit (Ll); Upper limit (Ul); Student T test for dependent variables (*).*

The decrease in CO between the beginning and the end of treatment of each of the patients averaged 22.2%, and an SD of 16.8% (Table 3).

CO (decrease %)	Mean	SD	Range (min, max)	CI 95% (Ll; Ul)
	22.21	16.83	14.1, 30.32	14.1; 30.32

Table 3: *Percentage of cardiac output decrease (CO) in each of the pediatric patients with extensive burn injuries. Standard Deviation (SD); Cardiac Output (CO); 95% confidence Interval (95% CI); Lower limit (Ll); Upper limit (Ul); Minimum (min); maximum (max).*

The effects of propranolol in the acute phase of severe thermal injury in the pediatric population have been extensively studied. Herndon., *et al*. established that a dose of 0.5 - 1 mg/kg every 6 - 8 hours is adequate to achieve a 15 - 20% decrease in heart rate from baseline [8]. Beneficial effects at cardiovascular level have been identified since the first two weeks of use [9] however, there is currently no definitive guideline regarding appropriate dose and duration of treatment because it has not been possible to objectively establish when treatment should be initiated and under what scheme due to the diversity of clinical settings, so treatment should be individualized and based on sequential hemodynamic assessment [10].

Wiliams., *et al*. found that cardiac output decreased by 23% -/+ 3 at a dose of 1 mg/kg/day propranolol at a 30-day follow-up after injury [9]. In our patients, starting on day 7 of treatment, cardiac output decreased on average by 22% at a dose of 0.5 mg/kg/day propranolol.

The estimate of the benefit of this drug has been based on both clinical and biochemical variables. However, at the hemodynamic level it is difficult to standardize a form of monitoring that is minimally invasive, cost effective and reliable. An example of this is pulmonary thermodilution, which has become the gold standard in hemodynamic monitoring of critical patients [9,11], nevertheless, this technique represents a risk due to the condition of patients with extensive burn injuries. On the other hand, real-time and sequential hemodynamic monitoring has managed to decrease the mortality rate, so the use of ultrasound and the implementation of ultrasound protocols are of utmost importance to establish the right actions at the right time [12].

Sequential monitoring of the pediatric burn patient throughout the phases of the hypermetabolic response will make possible to establish the conditions in which treatment is initiated and to adjust, according to age, the requirements of the drug to maintain a favorable hemodynamic state and thus mitigate the repercussions of the hyperdynamic state [10].

It is important to consider the evidence regarding the use of propranolol as a pharmacological measure[6] and, if necessary, recommend its use in pediatric burn patients, as well as the evaluation of drug activity sequentially through ultrasonographic protocols [12].

Conclusion

Propranolol significantly decreases cardiac output in pediatric patients with extensive burn injuries when used during the hyperdynamic phase, causing decreased cardiac work and oxygen consumption; this allows for a decrease in the deleterious effects of the hypercatabolic phase.

The use of ultrasonographic protocols in critical pediatric patients allows a sequential assessment of hemodynamic status. This could be fundamental in the dosage and follow-up of these patients. We suggest to recognize the properties of this drug in order to include it as part of the protocols for the treatment of pediatric patients with extensive burn injuries.

Conflict of Interest

The authors declare that they have no conflicts of interest in relation to this article.

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