



ORIGINAL

Prognostic value of brachioradialis muscle oxygen saturation index and vascular occlusion test in septic shock patients[☆]



J. Marín-Corral^{a,*}, L. Claverias^a, M. Bodí^{a,c}, S. Pascual^{b,c}, A. Dubin^{d,e},
J. Gea^{b,c}, A. Rodríguez^{a,c}

^a Critical Care Department – University Joan XXIII Hospital – IISPV-URV, Tarragona, Spain

^b Respiratory Department – Hospital del Mar – IMIM. Department CEXS, UPF, Barcelona, Spain

^c CIBERES (CIBER Enfermedades Respiratorias), ISC III, Bunyola, Palma de Mallorca, Spain

^d Sanatorio Otamendi y Miróli, Servicio de Terapia Intensiva, Buenos Aires, Argentina

^e Cátedra de Farmacología Aplicada, Facultad de Ciencias Médicas, Universidad Nacional de La Plata, La Plata, Argentina

Received 1 May 2015; accepted 9 July 2015

Available online 26 September 2015

KEYWORDS

Near-infrared spectroscopy;
Septic shock;
Microcirculation;
Tissue oxygenation;
Mortality;
Prognosis

Abstract

Objectives: To compare rSO₂ (muscle oxygen saturation index) static and dynamic variables obtained by NIRS (Near Infrared Spectroscopy) in brachioradialis muscle of septic shock patients and its prognostic implications.

Design: Prospective and observational study.

Setting: Intensive care unit.

Subjects: Septic shock patients and healthy volunteers.

Interventions: The probe of a NIRS device (INVOS 5100) was placed on the brachioradialis muscle during a vascular occlusion test (VOT).

Variables: Baseline, minimum and maximum rSO₂ values, deoxygenation rate (DeOx), reoxygenation slope (ReOx) and delta value.

Results: Septic shock patients ($n=35$) had lower baseline rSO₂ (63.8 ± 12.2 vs. $69.3 \pm 3.3\%$, $p < 0.05$), slower DeOx (-0.54 ± 0.31 vs. $-0.91 \pm 0.35\%/s$, $p = 0.001$), slower ReOx (2.67 ± 2.17 vs. $9.46 \pm 3.5\%/s$, $p < 0.001$) and lower delta (3.25 ± 5.71 vs. $15.1 \pm 3.9\%$, $p < 0.001$) when compared to healthy subjects ($n=20$). Among septic shock patients, non-survivors showed lower baseline rSO₂ (57.0 ± 9.6 vs. $69.8 \pm 11.3\%$, $p = 0.001$), lower minimum rSO₂ (36.0 ± 12.8 vs. $51.3 \pm 14.8\%$, $p < 0.01$) and lower maximum rSO₂ values (60.6 ± 10.6 vs. $73.3 \pm 11.2\%$, $p < 0.01$). Baseline rSO₂ was a good mortality predictor (AUC 0.79; 95%CI: 0.63–0.94, $p < 0.01$). Dynamic parameters obtained with VOT did not improve the results.

[☆] This study has been supported by Instituto de Salud Carlos III, Ministerio de Ciencia e Innovación [Fondo de Investigaciones Sanitarias (FIS) PI10/01538 and PI13/02011], by Sociedad Española de Neumología y Cirugía Torácica [SEPAR 264/2012] and Agència de Gestió d'Ajuts Universitaris i de Recerca [AGAUR 2014-SGR926].

* Corresponding author.

E-mail address: jmarincorral@gmail.com (J. Marín-Corral).

Conclusion: Septic shock patients present an important alteration of microcirculation that can be evaluated by NIRS with prognostic implications. Monitoring microvascular reactivity in the brachioradialis muscle using VOT with our device does not seem to improve the prognostic value of baseline rSO₂.

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PALABRAS CLAVE

Espectroscopia cercana al infrarrojo;
Shock séptico;
Microcirculación;
Oxigenación tisular;
Mortalidad;
Pronóstico

Valor pronóstico del índice de saturación de oxígeno y el test de oclusión vascular en el músculo braquiorradial de pacientes con shock séptico

Resumen

Objetivo: Comparar las variables microcirculatorias estáticas y dinámicas obtenidas mediante espectroscopia cercana al infrarrojo en el músculo braquiorradial de pacientes con shock séptico y sus implicaciones pronósticas.

Diseño: Estudio prospectivo y observacional.

Ámbito: Unidad de Cuidados Intensivos.

Pacientes: Pacientes con shock séptico y voluntarios sanos.

Intervenciones: En el músculo braquiorradial de todos los sujetos se realizaron mediciones NIRS (del inglés Near Infrared Spectroscopy) durante un test de oclusión vascular.

Variables: Valores rSO₂ basal, mínimo y máximo, pendiente de desoxigenación, pendiente de reoxigenación y valor delta.

Resultados: Los pacientes con shock séptico (n = 35) presentaron unos valores basales de rSO₂ más bajos ($63,8 \pm 12,2$ frente a $69,3 \pm 3,3\%$; $p < 0,05$), una pendiente de desoxigenación y reoxigenación más lenta ($-0,54 \pm 0,31$ frente a $-0,91 \pm 0,35\%/s$, $p = 0,001$; $2,67 \pm 2,17$ frente a $9,46 \pm 3,5\%/s$, $p < 0,001$) y un delta menor ($3,25 \pm 5,71$ frente a $15,1 \pm 3,9\%$; $p < 0,001$) en comparación con los sujetos sanos (n = 20). De los pacientes con shock séptico, los no supervivientes presentaron unos valores basales de rSO₂ más bajos ($57,0 \pm 9,6$ frente a $69,8 \pm 11,3\%$; $p = 0,001$), de rSO₂ mínimo y máximo igualmente inferiores ($36,0 \pm 12,8$ frente a $51,3 \pm 14,8\%$; $p < 0,01$; $60,6 \pm 10,6$ frente a $73,3 \pm 11,2\%$; $p < 0,01$). El rSO₂ basal fue un buen factor predictivo de mortalidad (AUC 0,79; IC del 95%: 0,63-0,94; $p < 0,01$). Los parámetros dinámicos obtenidos mediante la prueba de oclusión vascular no mejoraron los resultados.

Conclusión: Los pacientes con shock séptico presentan una alteración importante de la microcirculación que se puede evaluar mediante la espectroscopia cercana al infrarrojo con implicaciones pronósticas. La monitorización de la reactividad microvascular en el músculo braquiorradial mediante el test de oclusión vascular con nuestro dispositivo no parece mejorar el valor pronóstico de la rSO₂ basal.

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Introduction

Septic shock remains the most frequent cause of death in non-coronary intensive care units.^{1,2} It is characterized by hemodynamic alterations associated with organ dysfunction. Although systemic oxygen transport is usually preserved after the resuscitation of septic shock, multiorgan failure frequently develops as a probable consequence of an imbalance between oxygen delivery and consumption (DO₂ and VO₂) at tissue level. Microcirculatory dysfunction could be involved in this phenomenon.

The microcirculatory derangements caused by sepsis consist in decreased functional vascular density and heterogeneity of capillary transit-time.³⁻⁷ They may persist despite the normalization of systemic hemodynamics and oxygen transport in the large blood vessels, having relevant prognostic implications. It is well known that recovery

of macrohemodynamic stability does not necessarily involve a parallel enhancement in microcirculation, organ function restoration, and a subsequent better prognosis.⁸⁻¹⁰ Therefore, some macrohaemodynamical markers such as blood pressure, cardiac output, and other systemic cardiovascular variables are not reliable predictors of the evolution of septic shock.¹¹ In contrast, the assessment of oxygen release to the peripheral tissues would better reflect the microcirculation status.

However, peripheral oxygenation depends on many different factors including the ensemble of small vessels, local blood flow, hemoglobin content and oxygen partial pressure, among others.⁶ This complexity has meant that clinicians have not been able to assess the status of microcirculation and peripheral tissue oxygenation at the bedside until last years. Nevertheless, both can be easily approximated with Near Infrared Spectroscopy (NIRS)¹² through

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