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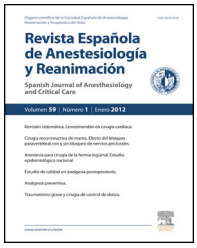

BRIEF REPORT

The changes in the oxygen saturations in the superior vena cava and the pulmonary artery are not the same during cardiac surgery☆

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KEYWORDS
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Hemodynamic monitoring;
Oxygen extraction ratio;
Pulmonary artery catheter

Abstract
Objective: To evaluate the changes over time (trend) in sign and magnitude for $S_{SV}O_2$ and S_VO_2 during and after cardiac surgery.
Patients and methods: A prospective and observational study was conducted on 34 cardiac surgery patients. Venous blood samples were taken simultaneously from the introductory ($S_{VC}O_2$) and distal (S_VO_2) port of the pulmonary artery catheter at predefined intervals. Systemic and pulmonary hemodynamic variables were measured at the same time. The trend was calculated as the difference between 2 consecutive measurements (tSO_2). Data were processed with ANOVA for multiple comparisons, Pearson correlation coefficient and Bland–Altman analysis.
Results: There was a significant correlation between $S_{VC}O_2$ and tS_VO_2 ($R^2 = 0.55$), the mean of the differences was $0.36 \pm 7.75\%$, and the limits of agreement ranged from -15.1 to 15.9%. The sign of the trend was similar in 85.1% of the paired data. However, the magnitude of the changes in $tS_{VC}O_2$ and tS_VO_2 were not always equivalent. Between 0 and 5% of the change in the $tS_{VC}O_2$ was coincident with only 44.7% of the tS_VO_2. A wide variation was found between both trends when the signs and magnitudes of the changes were taken into account.
Conclusions: When considering the sign and magnitude, the change over time of central venous O_2 saturations were not interchangeable in cardiac surgery patients. Clinical decisions based exclusively on $tS_{VC}O_2$ monitoring should be taken with caution.

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PALABRAS CLAVE
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Saturación de sangre venosa mezclada;
Cirugía cardíaca;
Monitorización hemodinámica;
Extracción de oxígeno;
Catéter de arteria pulmonar

Las tendencias en el tiempo de las saturaciones de oxígeno en la vena cava superior y la arteria pulmonar no son equivalentes en cirugía cardiaca

Resumen
Objetivo: Comparar los cambios de signo y magnitud de las tendencias (tSO_2) de las saturaciones venosas de arteria pulmonar (tS_VO_2) y de vena cava superior ($tS_{VC}O_2$) en pacientes sometidos a cirugía cardíaca.
Pacientes y métodos: Realizamos un estudio prospectivo y observacional en 34 pacientes sometidos a cirugía cardíaca. Las medidas hemodinámicas y las extracciones de sangre se realizaron a intervalos predefinidos. Se extrajeron muestras simultáneamente del puerto distal del catéter pulmonar (S_VO_2) y del introductor del mismo ($S_{VC}O_2$). Las tSO_2 se calcularon como la diferencia entre 2 medidas consecutivas. Los datos fueron procesados por test ANOVA, correlación de Pearson y análisis de Bland-Altman.
Resultados: Las tSO_2 de ambas variables mostraron una correlación positiva ($R^2 = 0{,}55$), siendo la diferencia de las medias de $0{,}36 \pm 7{,}75\%$ y los límites de discordancia desde $-15{,}1$ a 15,9%. La probabilidad de que un cambio direccional en $tS_{VC}O_2$ pueda ser seguido de un cambio similar en tS_VO_2, mostró que el signo de las mismas coincidió en el 85,1%. Sin embargo, la magnitud del cambio coincidió en un porcentaje menor, dependiendo del considerado. Entre 0 y 5% de cambio en la $tS_{VC}O_2$, se encontró coincidencia con la tS_VO_2 en el 44,7% de los casos.
Conclusiones: Considerando que el signo y magnitud de las tendencias de ambas SO_2 no son intercambiables, las decisiones terapéuticas basadas en la consideración de estos parámetros deben hacerse con precaución.

Introduction

There is strong evidence to suggest that absolute central venous saturation levels ($S_{VC}O_2$) do not match mixed venous oxygen saturation (S_VO_2) levels,[1–3] and clinicians should not base their decisions on the latter.[4] An alternative approach is to consider the changes over time or trend of these variables instead of their absolute value. Dueck et al.[5] found that $S_{VC}O_2$ ($tS_{VC}O_2$) trends could replace those of S_VO_2 (tS_VO_2), based purely on directional changes (rise/fall), without considering the magnitude of such changes. These findings, however, were not confirmed in other studies.[6,7]

The aim of our study was to compare changes in $S_{VC}O_2$ and S_VO_2 and the magnitude of such changes in patients undergoing heart surgery (HS).

Patients and methods

We carried out a prospective, observational study in the Hospital Universitario de Clínicas and the Sanatorio Americano in Montevideo. The study was approved by the Independent Ethics Committee of both hospitals, and patients were asked to give their informed consent. HS patients with indication for pulmonary artery catheter (PAC) were included; patients with tricuspid regurgitation or cardiac shunt were excluded. Prior to anesthesia induction, the left radial artery was catheterized and a PAC (7.5 G, Biosensors International Pvt Ltd., Singapore) was placed in the right internal jugular vein. During the immediate postoperative period the position of the catheter and the distal port of the introducer were confirmed by chest X-ray. Patients with PAC malposition were excluded. Hemodynamic measurements and blood samples were taken simultaneously: (a) following anesthesia induction; (b) immediately after surgery; (c) on transfer to the Intensive Care Unit; (d and e) at 12 and 36 h following transfer. Blood samples were taken simultaneously from the distal port of the PAC (S_VO_2), from the introducer ($S_{VC}O_2$), and from the radial artery. Each sample was measured twice, and the mean measurement was calculated (ABL® 700 series, Radiometer, Copenhagen, Denmark). Changes over time in both saturation levels (tSO_2) were taken to be the difference between 2 consecutive measurements.

Statistical analysis

Hemodynamic data were compared by one-way repeated measures ANOVA. *Post hoc* Newman–Keuls was used to evaluate differences between individual measurements, whenever necessary. The unpaired *t*-test with the Bonferroni correction was used to compare both saturation levels at different time periods. Paired SO_2 and tSO_2 samples were analyzed using the Pearson correlation coefficient and the Bland–Altman test. The sample size was sufficient for the purposes of the study ($\alpha = 0.05$, power 80%).

Results

Thirty-four patients were included in the study, 21 were men, and mean age was 64 ± 9 years. Of the total number of patients, 26 underwent coronary artery bypass graft,