Rev Esp Anestesiol Reanim. 2014;61(2):64–72

Revista Española de Anestesiología y Reanimación

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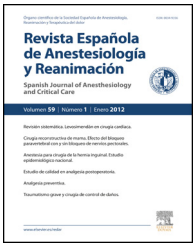

ORIGINAL ARTICLE

Cerebral oxygenation in patients undergoing shoulder surgery in beach chair position: Comparing general to regional anesthesia and the impact on neurobehavioral outcome

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Received 20 May 2013; accepted 5 August 2013
Available online 9 October 2013

KEYWORDS
Cerebral oxygenation;
Near-infrared spectroscopy;
Beach chair position;
Shoulder surgery;
Cerebral desaturation event;
Neurobehavioral outcome

Abstract
Background: Ischemic brain damage has been reported in healthy patients after beach chair position for surgery due to cerebral hypoperfusion. Near-infrared spectroscopy has been described as a non-invasive, continuous method to monitor cerebral oxygen saturation. However, its impact on neurobehavioral outcome comparing different anesthesia regimens has been poorly described.
Methods: In this prospective, assessor-blinded study, 90 patients undergoing shoulder surgery in beach chair position following general (G-group, $n = 45$) or regional anesthesia (R-group; $n = 45$) were enrolled to assess the prevalence of cerebral desaturation events comparing anesthesia regimens and their impact on neurobehavioral and neurological outcome. Anesthesiologists were blinded to regional cerebral oxygen saturation values. Baseline data assessed the day before surgery included neurological and neurobehavioral tests, which were repeated the day after surgery. The baseline data for regional cerebral oxygen saturation/bispectral index and invasive blood pressure both at heart and auditory meatus levels were taken prior to anesthesia, 5 min after induction of anesthesia, 5 min after beach chair positioning, after skin incision and thereafter all 20 min until discharge.
Results: Patients in the R-group showed significantly less cerebral desaturation events ($p < 0.001$), drops in regional cerebral oxygen saturation values ($p < 0.001$), significantly better neurobehavioral test results the day after surgery ($p < 0.001$) and showed a greater hemodynamic stability in the beach chair position compared to patients in the G-group.

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http://dx.doi.org/10.1016/j.redar.2013.08.002

Conclusions: The incidence of regional cerebral oxygen desaturations seems to influence the neurobehavioral outcome. Regional anesthesia offers more stable cardiovascular conditions for shoulder surgery in beach chair position influencing neurobehavioral test results at 24 h.
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PALABRAS CLAVE
Oxigenación cerebral;
Espectroscopia de infrarrojo cercano;
Posición sentada («silla de playa»);
Cirugía de hombro;
Episodio de desaturación cerebral;
Respuesta neuroconductual

Oxigenación cerebral en pacientes operados del hombro en posición sentada: comparación de anestesia general y regional e impacto en la respuesta neuroconductual

Resumen
Antecedentes: Se han registrado lesiones isquémicas cerebrales en pacientes sanos ocasionadas por hipoperfusión cerebral después de una intervención quirúrgica en posición sentada («silla de playa»). La espectroscopia de infrarrojo cercano se ha descrito como un método no invasivo continuo para supervisar la saturación de oxígeno en el cerebro. No obstante, apenas se ha descrito su impacto en el resultado neuroconductual que compara los distintos tipos de anestesia.
Métodos: En este estudio prospectivo con enmascaramiento doble se reclutaron 90 pacientes que habían sido operados del hombro en posición sentada con anestesia general (grupo G, n = 45) o regional (grupo R, n = 45), para evaluar la incidencia de episodios de desaturación en función de la anestesia suministrada y el impacto que esto suponía en su respuesta neurológica y neuroconductual. Se ocultaron a los anestesistas los valores de saturación regional de oxígeno cerebral. En la recopilación de los datos de referencia evaluados el día antes de la operación se incluían pruebas neurológicas y neuroconductuales, que se repitieron el día después de la misma. Se tomaron valores de referencia de saturación regional de oxígeno cerebral/índice biespectral y presión invasiva a nivel del corazón y el meato auditivo antes de la anestesia, 5 min antes de la anestesia, 5 min después de la colocación en posición sentada, después de la incisión y consecutivamente cada 20 min hasta el final.
Resultados: Los pacientes en el grupo R manifestaron muchos menos episodios de desaturación cerebral ($p < 0{,}001$), bajadas de los valores de saturación regional de oxígeno cerebral ($p < 0{,}001$), resultados mucho mejores en las pruebas neuroconductuales del día posterior a la operación ($p < 0{,}001$) y presentaron una mayor estabilidad hemodinámica en la posición sentada, en comparación con los pacientes del grupo G.
Conclusiones: La incidencia de desaturaciones regionales de oxígeno cerebral parece influir en la respuesta neuroconductual. La anestesia regional ofrece mayor estabilidad cardiovascular en las cirugías del hombro en posición sentada, de manera que influye en los resultados de las pruebas neuroconductuales después de 24 h.
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Background

Beach chair position is common for arthroscopic and open shoulder surgery facilitating shoulder joint access and optimal visualization due to the anatomic upright position of the shoulder.[1] In patients with normal preoperative regional cerebral oxygen saturation ($rScO_2$) values, changes have been shown during the beach chair position (BCP) following general anesthesia.[2,3] Rare but catastrophic case reports have been described in this position like visual loss, nerve injury, cerebral infarction and death.[2] The etiology of these complications remains unclear, but a correlation with the upright position and consecutive cerebral hypoperfusion and cerebral ischemia has been hypothesized.[1] Additionally, arthroscopic shoulder surgery is often performed using controlled hypotension protocols to minimize blood loss and possibly leading to further reduction of cerebral blood flow.[3] Therefore, a more cautious permissive hypotension management has been suggested for the beach chair position.[1,6,7]

The near-infrared spectroscopy (NIRS) is a non-invasive and continuous method to measure $rScO_2$. The technique has demonstrated to accurately recognize cerebral hypoperfusion leading to cerebral desaturation events (CDEs) that would remain undetected with the conventional monitoring with possible unfavorable neurological outcome.[4] Recently, studies have shown that NIRS can reliably indicate cerebral hypoperfusion during shoulder surgery in BCP.[3,5–11]

According to literature review and database searching, no previous study using NIRS for beach chair position has compared the effects of different anesthesia regimens assessing their impact on the number of CDEs and on neurobehavioral outcome using a wide spread controlled hypotension protocol.[12] Moreover, we also focused on the effects of the anesthesia regimen on hemodynamics, on the effects of intraoperative CDEs on post anesthesia care unit (PACU) bypassing/stay duration and on the influence of cardiovascular risk factors on CDEs.

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