

LETTER

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The prone position must accommodate changes in IAP in traumatic brain injury patients

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Dear Editor,

Recently, Bernon et al. evaluated in a retrospective study the safety and efficacy of prone position (PP) in patients treated for traumatic brain injury (TBI) and moderate-to-severe acute respiratory distress syndrome (ARDS) [1]. They analyzed changes in P_aO_2/FiO_2 and intracranial pressure in 10 patients during PP. Although P_aO_2/FiO_2 improved, PP was discontinued due to a raised intracranial pressure (ICP) in 50% of patients. Additionally, they found that all patients with $ICP > 17.5$ mmHg and 28% of patients with $ICP < 17.5$ mmHg prior PP had intracranial hypertension (ICH, defined as one or more ICP elevations > 25 mmHg) following PP. They concluded that monitoring of the brain compliance, ICP and the tolerance to venous return obstruction (Queckenstedt's maneuver) could be useful before decision of PP.

Severe ARDS makes the ventilator management of patients with TBI even more challenging. The European Society of Intensive Care Medicine strongly recommends to consider PP in patients with concomitant ARDS and TBI, if ICP is stable [2]. When PP is necessary, clinicians suggest to strictly monitor ICP, possibly with a multimodal neuromonitoring approach [1, 3] to early and promptly treat neurological complications. However, PP

may increase intracranial pressure (ICP) via a reduction of blood outflow from the brain.

Several factors may impair venous outflow from the brain, and elevated intra-abdominal pressure (IAP) is one of them. Significant increase in IAP closely corresponds to an increase in central venous pressure, jugular venous bulb pressure and low jugular venous bulb saturation in critically ill patients [4]. It was documented that increased IAP played an important role in developing intracranial complications during neurosurgical procedures in patients suffering from idiopathic ICH, TBI and during hydrocephalus therapy [5]. An incorrect PP can therefore increase intra-thoracic pressure via diaphragm elevation, causing impaired blood outflow from the brain leading to increase in ICP (Fig. 1). Hence, the elevated IAP following abdominal compression during PP plays a crucial role during ICP management, particularly in obese patients. Although we agree with the suggestions from Bernon et al. [1] regarding the need to close brain-monitoring in ARDS patients with TBI undergoing PP, we further suggest to include IAP monitoring and to carefully check the patient's position in order to avoid abdominal compression during PP. Further studies should be performed to explain the relationships between changes in IAP and risk of increase in ICP in patients with concomitant ARDS and TBI treated with PP.

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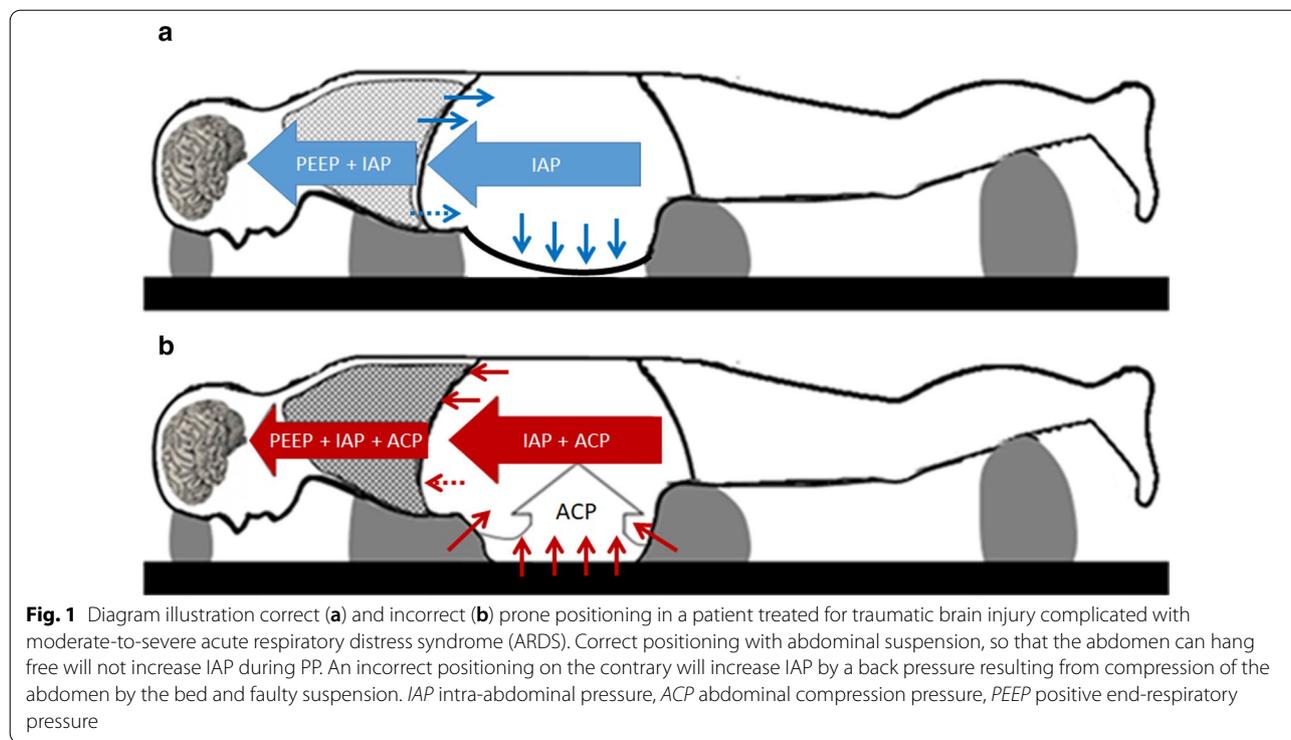
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Authors’ response

Prone positioning modalities are essential for good tolerance in patients with acute brain injury

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Dear Editor,

Dabrowski et al. published a letter in the journal about our work reporting data on the safety and efficacy of prone positioning (PP) in patients with acute brain injury and moderate-to-severe acute respiratory distress syndrome (ARDS) [1]. They suggest monitoring intra-abdominal pressure (IAP) in addition to brain compliance to evaluate the risk of impaired brain venous return during PP particularly in obese patients. In our cohort, intracranial hypertension (ICH, intracranial pressure-ICP > 25 mmHg) occurred in 14/27 patients (52%) leading to discontinue PP in 5/27 patients. Only 7/27 patients (26%) had a body mass index over 30 kg/m², 30% of whom (n = 3) had ICH during PP. The number of obese patients at risk of increased IAP was too small to conclude, and we agree with Dabrowski et al. that IAP plays

a critical role in venous return changes during PP. The pressure in the right atrium, which drives cerebral blood outflow, is influenced by cardiac output, intrathoracic pressure and to some extent by the venous pressure from other organs. PP is expected to improve thoracic compliance and thereby venous return; however, the increase in IAP may hinder this beneficial effect. For instance, during elective spine surgery the only frame that can reduce hemodynamic changes triggered by PP allows the abdomen to hang free [6] thereby preventing IAP elevation. This strategy has also been implemented in the intensive care unit with circular pillow during PP [7]. IAP release may therefore be transmitted to the right atrium and eventually to the brain, thereby improving cerebral outflow. Consequently, monitoring IAP could allow optimizing the positioning of patients with a high central venous pressure. In our opinion, head position remains one major determinant of cerebral blood outflow. It must remain on the axis in order to avoid compression of the jugular veins. The elevation of the head above the heart level is also important and allows to reduce intracranial pressure (ICP) in brain injured patients [8]. We agree that abdominal pressure release and monitoring should be considered during PP, but we would argue to test the tolerance to an obstacle to cerebral blood outflow before PP to identify patient at risk of IH. The evaluation of a protocol that standardize head position and abdomen release is therefore necessary to decrease the risk of IH

during PP sessions in patients with acute brain injury and ARDS.

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Authors' contributions

Each authors have made substantial contribution to conception of this paper. WD and CR designed of the work and drafted the manuscript. DSG, RB and MLNGM were involved in references collection, figure preparation and corrected the manuscript. All authors designed the study, drafted the manuscript, read and approved the final version. All authors meet key authorship requirements and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy are appropriately documented in the literature. All authors read and approved the final manuscript.

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