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EDITORIAL

Bioimpedance analysis in clinical anesthesia: insights from two recent studies

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Abbreviations
BIA Bioimpedance analysis
PA Phase angle

Two clinical studies using bioimpedance analysis (BIA) were recently published in the Journal of Anesthesia. The first study, conducted by Kusaka et al. [1], is titled "Effect of restrictive versus liberal fluid therapy for laparoscopic gastric surgery on postoperative complications: a randomized controlled trial", and the other study, by Bang et al. [2], is titled "Phase angle as a prognostic factor for postoperative outcomes in major abdominal surgery: a single-center prospective observational study". In the present editorial, we provide a brief explanation of the mechanism of BIA, and outline how it was utilized in the published studies.

BIA is a non-invasive method for estimating body composition. The human body consists of tissues with high water content, such as muscle and internal organs, and those with relatively low water content, such as fat and bone. When a weak alternating current is applied to the body, it preferentially flows through tissues rich in water and electrolytes, such as muscle. In contrast, it flows poorly through tissues with high electrical resistance, such as fat and bone. This difference in electrical properties is used to estimate the characteristics of individual tissues. In BIA, alternating currents at multiple frequencies are applied to the body, and electrical impedance—which is the combined measure of resistance and reactance—is measured. Low-frequency currents cannot pass through cell membranes and primarily flow through extracellular fluid. In contrast, high-frequency currents can pass through cell membranes and reach intracellular fluid. This difference enables the separate evaluation of extracellular and intracellular fluid volumes. Intracellular fluid volume is primarily associated with the quantity of water-rich tissues, such as muscle and organs. This volume is commonly used to estimate muscle mass. Fat mass is then estimated indirectly by subtracting fat-free mass—which includes muscle, bone, and other non-adipose tissues—from total body weight.

Additionally, when alternating current is applied to the body, the cell membrane acts as a capacitor, resulting in a phase shift between voltage and current. This phase difference is expressed as an angle, known as the phase angle (PA). A larger PA indicates better cell membrane integrity and intracellular water retention, reflecting physiological cell activity. Conversely, a small PA may indicate poor nutritional status or impaired cellular function.

Kusaka et al. employed BIA using the InBody720® (InBody Co., Ltd., Seoul, Korea) to compare and evaluate postoperative changes in body composition between restrictive and liberal fluid administration groups in patients undergoing laparoscopic gastric surgery. Interestingly, despite the large disparity in the median volume of perioperative fluid administration between the two groups (2950 mL vs. 800 mL in the liberal group and restrictive groups, respectively), fluid therapy did not lead to significant changes in body composition (i.e., total body water, extracellular water, and extracellular water / total body water as an indicator of edema, obtained from impedance analysis).

Bang et al.'s study focused on PA obtained using the InBody S10®. PA reflects hydration status, muscle mass, and strength—all closely associated with patient nutritional status and frailty. They demonstrated that low PA before surgery was associated with adverse postoperative outcomes in patients undergoing major abdominal surgery.

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BIA has been used in many recent studies that employed the InBody system series (InBody Co., Ltd., Seoul, Korea). However, smaller, more portable, and easier-to-use devices have recently become available, thereby expanding the applicability of BIA in clinical settings. Body composition estimation using BIA may serve as a valuable metric for evaluating nutritional therapy [3], fluid management in critically ill patients [4], frailty assessment [5], and the pharmacokinetics and pharmacodynamics [6] of anesthetic agents in clinical anesthesiology. The two studies presented in this editorial are expected to provide an important basis for future research.

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Declarations

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