Critical Care

CORRESPONDENCE

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Dynamic intra-abdominal organ volume changes in patients with sepsis

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Sepsis is characterized by life-threatening organ dysfunction due to a dysregulated systemic response to infection [1]. Previous studies have documented volumetric changes in single organs during sepsis [2, 3]. However, to our knowledge, no studies have simultaneously measured the volumes of multiple intra-abdominal organs and examined how these volumes change over time. Accordingly, we reviewed the data of 25 patients aged ≥ 16 years with sepsis who underwent at least one non-contrast computed tomography (CT) scan before, during, and after the onset of sepsis. We focused on four organs—the liver, kidneys, adrenal glands, and spleen—and evaluated temporal volume changes using a three-dimensional medical image analyzer (SYNAPSE VINCENT [FUJIFILM, Japan]).

Among 25 patients, the median age was 73 years [IQR: 64–78] and 68% were male. Peritonitis (36%) was the most common diagnosis, followed by pneumonia (20%), bloodstream infection (16%), and cholangitis (12%). The median SOFA and APACHE II scores at ICU admission were 5 (IQR: 3–8) and 20 (IQR: 18–24), respectively. The median times from the previous CT scan without sepsis before ICU admission and for ICU admission to the closest CT scan after sepsis recovery were 117 (interquartile range [IQR]: 37–170 days) and 56 days (IQR: 43–138 days), respectively.

Figure 1 shows the temporal changes in organ volumes pre-sepsis onset to after sepsis resolution. Compared with pre-sepsis onset, the liver, adrenal glands, and kidneys had significant volume increases during sepsis when evaluated by Wilcoxon signed-rank test with Bonferroni adjustment (significance at $p < 0.017$) (liver 16% [IQR: 0–30%], $p = 0.015$; adrenal glands 14% [IQR: 9–41%], $p < 0.01$; and kidneys 9% [IQR: 0–23%], $p < 0.01$, respectively). In contrast, the spleen showed no significant volume change (3% [IQR: − 11 to 23%], $p = 0.389$). After sepsis resolution, liver, adrenal glands, and kidneys volumes were significantly decreased compared with those at ICU admission (liver 16% [IQR: 2–32%, $p < 0.01$], adrenal glands 25% [IQR: 12–45%, $p < 0.001$], and kidneys 11% [IQR: 1–20%], $p < 0.01$, respectively). The liver and kidney volumes were decreased compared with the baseline levels pre-sepsis onset, while the adrenal gland volumes were significantly smaller than those pre-sepsis (− 5% [IQR: − 13 to − 1%], $p < 0.01$). The relative organ volumes at ICU admission and the fluid balance 24 h after ICU admission were not significantly correlated when evaluated by Kendall rank correlation.

We observed different temporal patterns of organ volume changes during sepsis, independent of fluid balance. Our findings are limited by the small sample size and it is uncertain whether sepsis-related organ size changes are associated with outcomes, including response to treatment and mortality.

A study has shown that the volumes of the adrenal glands returned to baseline values after sepsis resolution [2]. We performed the CT scans a median of 56 days after ICU admission, which may have

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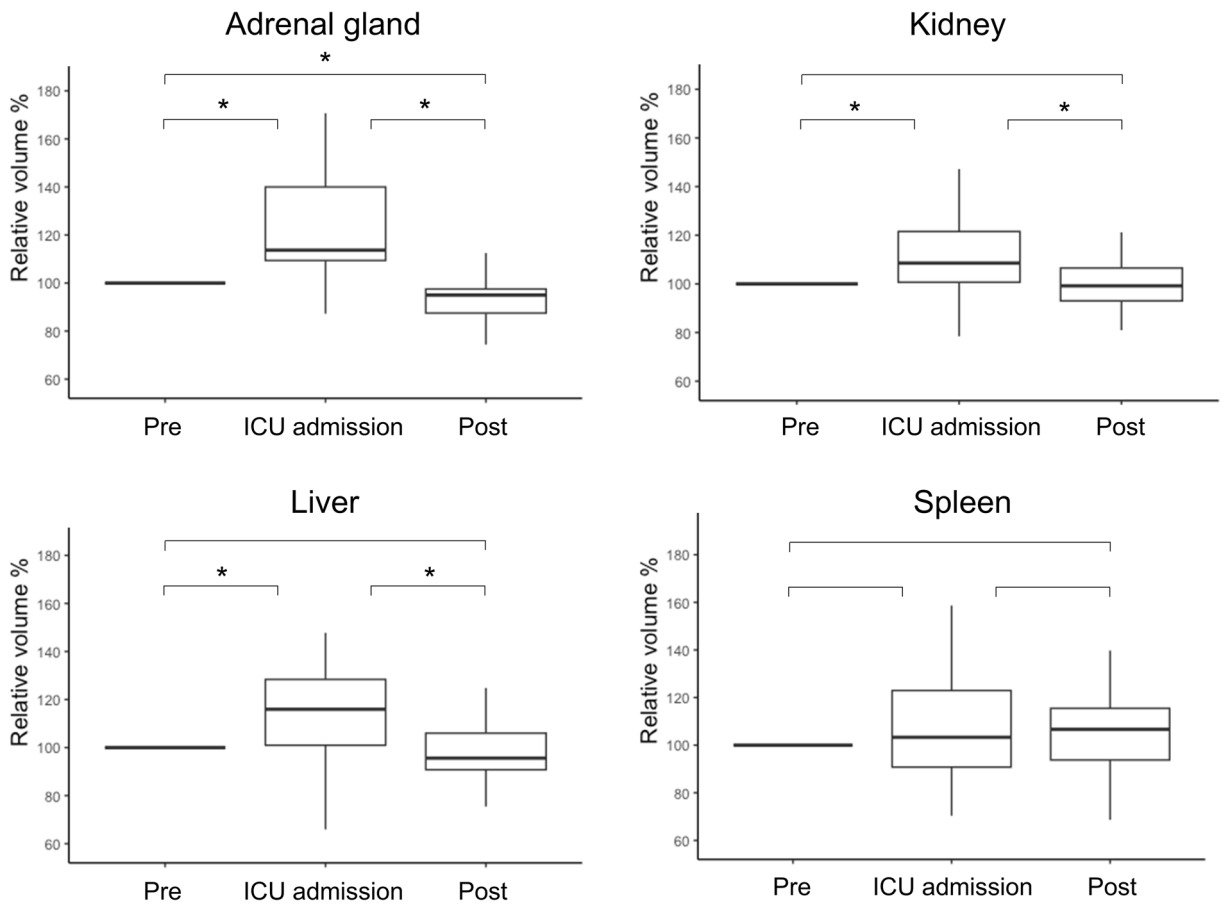

Fig. 1 Changes in intra-abdominal organ volumes from pre-sepsis onset to post-resolution. Relative volumes at ICU admission and post sepsis resolution were calculated by dividing individual values by their respective volumes prior to sepsis onset. The boxes represent the interquartile range, with the line inside each box indicating the median. *$p < 0.017$. ICU, intensive care unit

contributed to the discrepancy between our findings and those of a previous study, in which CT scans were performed approximately 100 days after ICU discharge sepsis resolution [2]. The adrenal glands may atrophy before returning to their baseline size during early sepsis recovery. The spleen did not undergo significant volumetric changes during sepsis. A study has demonstrated that splenic volume decreases as sepsis severity increases [3]. The spleen may possess factors that cause contraction, in addition to those that lead to enlargement in patients at sepsis onset.

Abbreviations

APACHE	Acute physiology and chronic health evaluation
CT	Computed tomography
ICU	Intensive care unit
IQR	Interquartile range
SOFA	Sequential organ failure assessment

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Not applicable.

Author contributions
TW, RI, and KD designed the study; ST collected the data; ST and RI analyzed the data; ST drafted the initial manuscript; and TW, RI. WG, and KD critically reviewed the manuscript. All authors have read and approved the final manuscript.

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Data availability
Data are available from the authors upon reasonable request and with permission from the Institutional Review Board of the University of Tokyo Hospital.

Declarations

Conflict of interest
The authors declare no competing interests.

Ethical approval and consent to participate
The retrospective cohort study was approved by the Research Ethics Committee of the University of Tokyo (number 2023347NI). The requirement for informed consent was waived because of the retrospective nature of the study design.

Consent for publication
Not applicable.

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