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Hyponatremia following high-volume D5W hydrodissection during thermal ablation

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To the Editor

During percutaneous thermal ablation such as radiofrequency ablation (RFA) and microwave ablation (MWA), a variety of protective maneuvers that include patient repositioning, hydrodissection, gas insufflation, balloon interposition, and applicator torquing have been employed to separate the lesion of interest from surrounding organs. Hydrodissection, typically the instillation of 5% dextrose in water (D5W) or another non-ionic fluid, has been shown to impart effective organ separation while permitting CT, ultrasound, and MRI guidance for ablation [1]. In clinical practice, high volumes of hydrodissection fluid are sometimes necessary to establish satisfactory interposition between the organs of interest secondary to tightly packed organs or fascial planes as well as free communication with the peritoneal cavity. Although D5W is isosmolar and is thought to be less likely to cause dilutional electrolyte abnormalities compared to sterile water [2], deleterious effects of very high-volume D5W instillation do occur. The present report describes a case in which profound electrolyte abnormalities were observed in a patient following hepatic MWA that employed high-volume D5W hydrodissection in order to protect the heart and stomach, which had been intimately touching the target liver lesion. A 64-year-old female with

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Conflict of interest statement

LJ, VK, and GMV declare that they have no conflicts of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

metastatic adrenocortical carcinoma underwent microwave ablation of two large metastatic liver lesions (Fig. 1). During the procedure, 5% dextrose in water was infused to separate the liver tumor from the heart and from the stomach (Fig. 2 and Fig. 3). Of note, adequate protective distraction of the lesion and heart was not attained until a total of 6500 mL of D5W was instilled. Following successful ablation, 3700 mL of the hydrodissection fluid was aspirated, for a net fluid retention of +2800 mL. Initial (30-minute) post-procedural serum sodium concentration was 121 mEq/L compared to the pre-procedural concentration of 142 mEq/L. The patient subsequently received continuous normal saline (NS) infusion at 125 mL/hr (2 mL/kg/hr); her serum sodium concentration was corrected to 135 mEq/L in approximately 11 hours. During and following the normalization of the patient's electrolytes, no neurologic deficits such as speech disturbance, motor impairment, and altered consciousness that may be precipitated by rapid serum sodium correction [3] were observed on this patient's hospital stay or on follow-up 14 days after discharge.

The hydrodissection technique, also known as artificial ascites, has been in practice for over a decade [4]. A nonionic, roughly isosmotic (252 mosmol/L) solution, D5W has been suggested as an ideal protective fluid for abdominal infusion prior to thermal ablation [2]. In contrast, the instillation of water, a hyposmotic fluid, is thought to be more prone than D5W to precipitate dilutional electrolyte abnormalities [2,5]. In the case of radiofrequency ablation, NS as a hydrodissection fluid may have conductive properties that theoretically add risk to the organ where protection is desired [5]; animal studies have demonstrated poor thermal insulation when NS is used for hydrodissection, likely due to conductive properties [2]. It is unclear whether the same caution is applicable to MWA. With MWA, ionic fluids may be less sensitive to heating up from ionic conduction compared with RFA due to the underlying mechanism of action [6]. In other words, compared to RFA, MWA may theoretically be less likely to heat up NS. Given that high volumes of hydrodissection are sometimes required in spaces between tight structures and fascial planes where fluid does not naturally gather, such as between the liver and the heart, electrolyte disturbances following hydrodissection are a concern but are unfortunately not well characterized. A retrospective analysis of 12 patients who underwent thermal ablation with hydrodissection noted a change in mean serum sodium concentration (reference normal, 135–144 mEq/L) from a pre-procedural value of 137 mEq/L (range, 133–141 mEq/L) to a post-procedural value of 135 mEq/L (range, 129–140 mEq/L) following the irrigation of a mean of 805 mL (range, 20–3000 mL) of D5W hydrodissection; the change was not statistically significant [7]. It is possible that high-volume hydrodissection has outcomes analogous to those of the better-described transurethral resection (TUR) syndrome, in which dilutional hyponatremia results from salt shifts and the absorption of irrigation fluid used in procedures such as endoscopic transurethral resection of the prostate [7,8]. The absorption of even 1 liter of fluid has been noted to significantly increase the likelihood of TUR syndrome [8].

Insight into the rate of abdominal fluid absorption may also be gained by comparing abdominal hydrodissection with peritoneal dialysis, as both procedures involve the instillation of fluids into the abdominal cavity. It is well established in peritoneal physiology that the rate of peritoneal membrane transport varies widely across individuals, and can be measured by the peritoneal equilibration test or a 24-hour dialysis collection [9]. Individuals who demonstrate high peritoneal membrane transport may rapidly absorb glucose from the

dialysate, thereby altering the osmotic equilibrium established by glucose, leading to a gradient and high free fluid absorption [9]. Analogously, it may be hypothesized that patients with high peritoneal membrane transport would rapidly absorb a glucose-based irrigation fluid such as D5W (placed in the abdominal cavity for organ protection during thermal ablation). This phenomenon, together with the lack of sodium in the hydrodissection fluid and potentially the hydrostatic pressure exerted by the fluid in a tight (intraperitoneal or fascial) space, leads to water absorption and favors the development of hyponatremia. Pre-procedural characterization of peritoneal membrane transport with an equilibration test could potentially play a role in certain patients to estimate the risk of high-volume hydrodissection. However, a more practical approach is currently practiced, where the electrolyte disturbances are managed with serial serum chemistries and prompt repletion, regardless of inter-patient variability in peritoneal membrane physiology. This patient's profound post-procedural hyponatremia was rapidly corrected with the help of NS infusion. Her serum sodium concentration normalized (increased) by a total of 15 mEq/L over 11 hours. Given that she developed hyponatremia acutely over the course of the procedure, rather than chronically over weeks, her risk of developing osmotic demyelination syndrome (also known as central pontine myelinolysis) from rapid correction is less likely. Evidence supports aggressive treatment in acute-onset hyponatremia to decrease the risk of life-threatening brain edema [10]. In contrast, individuals with chronic hyponatremia (1 week or longer), whose brains have had ample time for osmotic adaptation, are at highest risk for developing osmotic demyelination syndrome from rapid correction [11]. In these patients, serum sodium level should be corrected by no more than 4 to 6 mEq/L in a 24-hour period [10].

In summary, the instillation of high-volume D5W for hydrodissection in a patient undergoing thermal ablation may have precipitated metabolic derangements secondary to fluid and electrolyte shifts. Caution should be exercised in the application of large-volume hydrodissection during thermal ablation, including serial monitoring of serum electrolyte levels.

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Figure 1.
Pre-procedural CT image, showing the patient's liver lesion (outlined) abutting the stomach and the heart.

Figure 2. CT images highlighting the hydrodissection technique. Asterisk denotes the lesion to be ablated. Catheters have been placed into (a) the anterior perihepatic area and (b) the gastrohepatic area to instill D5W.

Figure 3.

CT images depicting the organ separation achieved during this procedure after instillation of 6500 mL of D5W. The liver lesion, into which 3 MWA antennas have been placed, is separated from (a) the heart and (b) the stomach by D5W.