J Anesth (2014) 28:132–135
DOI 10.1007/s00540-013-1670-0

SHORT COMMUNICATION

Preoperative oral rehydration solution intake volume does not affect relative change of mean arterial blood pressure and crystalloid redistribution during general anesthesia in low-risk patients: an observational cohort study

Sachiko Iwayama · Tsuneo Tatara · Toshihiro Osugi · Munetaka Hirose

Received: 16 February 2013 / Accepted: 23 June 2013 / Published online: 5 July 2013

Abstract Despite the implementation of liberal preoperative fasting routines, it is unclear whether preoperative oral rehydration solution intake volume affects blood pressure during general anesthesia. We enrolled 60 patients (American Society of Anesthesiologists status I/II) undergoing tympanoplasty. Patients drank 200–1,000 ml oral rehydration solution until 2–3 h before anesthesia induction. Anesthesia was induced by propofol and maintained with sevoflurane and remifentanil. Coinciding with anesthesia induction, 15 ml/kg Ringer's acetate solution was administered intravenously over 60 min followed by 1 ml/kg Ringer's acetate solution over the next 30 min. Mean arterial blood pressure (MAP) and whole-body bioelectrical resistance for extracellular fluid (R_e) during anesthesia were compared between retrospectively classified intake groups of oral rehydration solution. There were no differences in mean MAP during the 30–90 min period relative to baseline [0.67 (0.60–0.74), 0.65 (0.61–0.76), 0.64 (0.60–0.70), $P = 0.96$] and relative R_e at 90 min [0.945 (0.018), 0.944 (0.021), 0.943 (0.021), $P = 0.95$] between the small ($n = 14$), intermediate ($n = 29$), and large ($n = 17$) intake groups. The intake volume of preoperative oral rehydration solution does not affect the magnitude of hypotension during general anesthesia in low-risk patients undergoing minor surgery.

Keywords Dehydration · Fasting · Oral rehydration

Electronic supplementary material The online version of this article (doi:10.1007/s00540-013-1670-0) contains supplementary material, which is available to authorized users.

S. Iwayama · T. Tatara (✉) · T. Osugi · M. Hirose
Department of Anesthesiology, Hyogo College of Medicine, 1-1 Mukogawa-cho, Nishinomiya, Hyogo 663-8501, Japan
e-mail: ttatara@hyo-med.ac.jp

Overnight fasting before surgery is unpleasant for patients [1]. According to preoperative fasting guidelines that have been updated during the past decade, a fasting routine up to 2 h before anesthesia is recommended [2]. This routine has become popular in many countries [3–5].

One potential issue with preoperative oral rehydration is the fact that preoperative fasting guidelines set forth the amount of preoperative oral fluid intake without taking into account the patient's body weight [6]. Thus, patients with a higher body weight may suffer from preoperative dehydration given the low fluid intake per kilogram body weight.

It remains unclear whether low preoperative oral rehydration solution intake results in dehydration, thereby affecting blood pressure and fluid redistribution during general anesthesia. The aim of this study was to test the hypothesis that intake of small amounts of preoperative oral rehydration solution enhances the magnitude of hypotension during general anesthesia compared to the intake of large amounts of the solution. The primary outcome measure was mean arterial blood pressure (MAP) relative to baseline during anesthesia, and the secondary outcome measure was fluid redistribution as assessed by changes in whole-body bioelectrical resistance, which reflects fluid accumulation in the extracellular space during anesthesia [7–9].

The study was approved by the Ethics Review Board of Hyogo College of Medicine, and each patient provided written informed consent following an explanation of the study. We studied 60 consecutive American Society of Anesthesiologists physical status I or II patients aged 20–65 years who were scheduled for tympanoplasty under general anesthesia. Exclusion criteria included a history of cardiac, pulmonary, or renal disease, hypertension, diuretic medications, and conditions that may impair gastrointestinal motility and gastroesophageal reflex.

Patients scheduled for induction of anesthesia between 9:00 AM and 9:30 AM were instructed to drink 200 ml oral rehydration solution (OS-1; Otsuka Pharmaceutical Factory, Tokushima, Japan) at 7:00 AM (Online Resource 1). Patients scheduled for induction of anesthesia between 10:00 AM and 2:00 PM were instructed to drink 500 ml oral rehydration solution until 3 h before induction of anesthesia. Patients scheduled for induction of anesthesia later than 2:00 PM were instructed to drink 1,000 ml oral rehydration solution until 3 h before induction of anesthesia. The actual intake volume of oral rehydration solution was recorded for each patient.

After arriving at the operating room, noninvasive blood pressure was measured at 2.5-min intervals. In the same manner as described in our previous study [10], patients were given 2 μg/kg intravenous fentanyl followed by 2 mg/kg intravenous propofol over 6 min. After completion of the propofol infusion, a laryngeal mask was inserted and anesthesia was maintained with sevoflurane (1.0–1.5 %) and oxygen (50 %) in air, together with a continuous infusion of remifentanil at a rate of 0.10–0.15 μg/kg/min. Coinciding with the start of propofol administration, we infused 15 ml/kg Ringer's acetate solution intravenously over 60 min followed by 1 ml/kg Ringer's acetate solution over the next 30 min. Hypotension, defined as a systolic arterial blood pressure $\leq$75 mmHg, was treated with 4 mg intravenous ephedrine. A sample of collected urine was taken at the end of anesthesia induction for measurement of urine osmolality (pre-U_{osm}, in mOsm/kg). We also measured the osmolality (mOsm/kg) and volume (ml/kg) of urine produced during the study period.

We measured whole-body resistance and reactance every 5 min during the study period using a multifrequency bioimpedance analyzer (4200 Hydra; Xitron Technologies, San Diego, CA, USA) [10]. Whole-body resistance for extracellular fluid (R_e, in ohms) at each measurement time point and relative values of R_e to that at baseline were obtained for each patient. Based on the electrical properties of body tissues, relative change of the extracellular fluid volume is equal to relative $R_e^{-2/3}$ [7, 11].

Data regarding the amount of oral fluid intake before the induction of anesthesia (ml) were analyzed using a linear regression model, with time to induction (i.e., hours from 9:00 AM to the time anesthesia induction was initiated) as an independent variable. All patients were then retrospectively classified according to the amount of preoperative fluid intake (ml), with groupings based on small (i.e., <lower limit of the 95 % confidence band of the best-fit line; small intake group), intermediate (i.e., within lower and upper limits of the 95 % confidence band of the best-fit line; intermediate intake group), or large (i.e., >upper limit

Table 1 Patient characteristics by preoperative oral rehydration solution intake volume

Variable	Small intake (n = 14)	Intermediate intake (n = 29)	Large intake (n = 17)	P value
Gender (male/female)	6/8	10/19	11/6	0.14
Age (years)	44 (29–60)	52 (37–60)	46 (38–60)	0.44
Weight (kg)	59 (11)	57 (11)	59 (9)	0.78
Body mass index (kg/m^2)	22.1 (2.7)	21.9 (2.4)	21.4 (1.8)	0.67
ASA status (I/II)	7/7	16/13	10/7	0.89
Time to induction[a] (h)	5.6 (4.9–7.2)	3.1 (0.0–4.3)[d]	5.7 (2.5–7.8)	0.013
Oral rehydration[b] (ml/kg)	7.6 (6.0–9.8)	6.3 (3.8–11.1)	13.8 (9.3–17.4)[d,e]	<0.001
200/500/1,000 ml	2/9/0	13/10/2	0/7/9	<0.001
Baseline heart rate (bpm)	68 (60–78)	62 (53–70)	63 (55–72)	0.36
Baseline MAP (mmHg)	84 (11)	85 (11)	83 (12)	0.77
Pre-U_{osm} (mOsm/kg)	737 (252)	642 (175)	620 (177)	0.22
Post-U_{osm} (mOsm/kg)	221 (154–332)	202 (164–272)	243 (199–372)	0.40
Urine volume[c] (ml/kg)	2.4 (1.2–4.5)	3.0 (1.8–4.2)	2.1 (0.7–3.6)	0.57
Ephedrine use (times)	1.0 (0.0–3.0)	1.0 (0.0–2.5)	1.0 (0.0–2.0)	0.73

Data are presented as mean (SD), median (interquartile range), or number

ASA American Society of Anesthesiologists, *MAP* mean arterial blood pressure, *pre-U_{osm}* urine osmolality after induction of anesthesia, *post-U_{osm}* urine osmolality during the study period

[a] Hours from 9:00 AM to the start of anesthesia induction

[b] Amount of oral rehydration solution intake from 7:00 AM to the start of anesthesia induction

[c] Urine volume produced during the study period (i.e., 90 min)

[d] Compared to small intake group

[e] Compared to intermediate intake group

of the 95 % confidence band of the best-fit line; large intake group) amounts of fluid intake.

Data are expressed as mean (SD) or median (interquartile range). The continuous variables including amount of oral fluid intake (ml/kg), mean MAP during the 30- to 90-min period relative to baseline, and R_e values at 90 min relative to baseline were compared between the groups. One-way analysis of variance with the Student–Newman–Keuls post hoc test or the rank-sum test with Dunn's post hoc test was used to determine the significance of continuous variables. The χ^2 test was performed for analysis of categorical variables. $P < 0.05$ was considered significant.

The amount of oral fluid intake before anesthesia was positively correlated with time to anesthesia induction ($r^2 = 0.69$, $P < 0.0001$; Online Resource 2). Fourteen patients were classified in the small intake group, 29 were classified in the intermediate intake group, and 17 were classified in the large intake group. No significant differences were found between the groups with respect to patient characteristics including pre-U_{osm} and urine volume produced during the study period (Table 1). Preoperative intake volume of oral rehydration solution (ml/kg) for the large intake group was twofold higher than that for the small and intermediate groups (both $P < 0.05$).

Mean MAP during the 30- to 90-min period relative to baseline was comparable between the small, intermediate, and large intake groups [0.67 (0.60–0.74), 0.65 (0.61–0.76), 0.64 (0.60–0.70), $P = 0.96$; Fig. 1a]. Values of relative R_e at 90 min were similar for the small, intermediate, and large intake groups [0.945 (0.018), 0.944 (0.021), 0.943 (0.021), $P = 0.95$; Fig. 1b].

The major finding of the present study was that MAP and R_e relative to baseline during general anesthesia were similar for retrospectively classified intake groups of oral rehydration solution. Despite the large intake volume of oral rehydration solution (ml/kg) for the large intake group compared to other intake groups (Table 1), pre-U_{osm} was comparable across groups. Given that pre-U_{osm} for the three groups was consistent with urine osmolality reference values for healthy individuals with normal hydration (476–880 mOsm/kg) [12], hydration status was normal in all groups with no significant difference between groups.

Increased fluid transfer from the intravascular space to the interstitial space during crystalloid volume loading may decrease plasma volume expansion and thus attenuate recovery from hypotension. However, this was not the case when we tested groups provided with different amounts of oral solution per kilogram body weight. Indeed, we found no significant differences between the small and large intake groups for relative MAP (Fig. 1a) and relative R_e (Fig. 1b), which mainly reflects fluid volume changes in the interstitial space during general anesthesia [7–9, 13]. We believe these findings to be reasonable, provided the

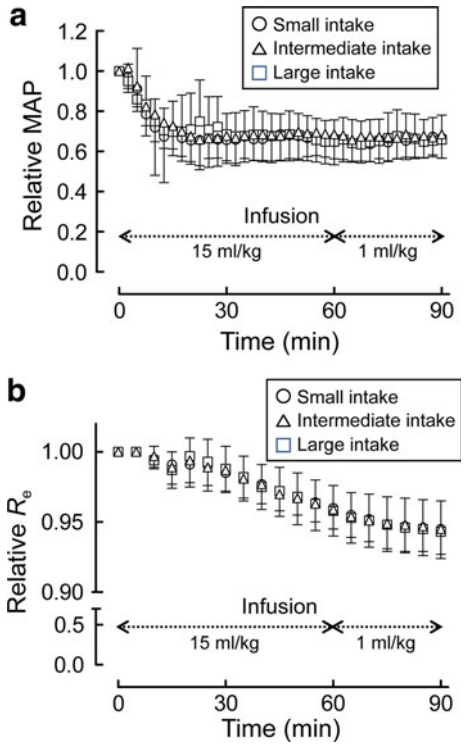

Fig. 1 Time course of mean arterial blood pressure (MAP) (**a**) and whole-body bioelectrical resistance for extracellular fluid (R_e) (**b**) relative to baseline during general anesthesia for small ($n = 14$), intermediate ($n = 29$), and large ($n = 17$) intake groups of preoperative oral rehydration solution. Data are presented as mean (SD)

assumption that for the small and large intake groups, preoperative oral rehydration proportionally hydrates the intravascular space and the interstitium before general anesthesia, leading to a normal hydration state. Moreover, the considerably large volume of crystalloid infusion over 60 min (i.e., 15 ml/kg) may have masked the effect of different volumes of oral rehydration solution intake on MAP during general anesthesia.

In contrast to preoperative intravenous hydration, it is cumbersome, not to mention difficult in daily clinical practice, to tightly control the rate of preoperative oral rehydration solution intake. Despite this, the mean MAP during the 30–90 min period relative to baseline and relative R_e at 90 min were comparable to those in a previous study we conducted with 60 patients who underwent overnight fasting and intravenous hydration (0.67 and 0.94, respectively) [10]. Moreover, given that minor surgeries are often scheduled in series, it is not uncommon for anesthesia induction to be delayed by as much as 3 h for the last scheduled patient undergoing surgery on a particular day. One concern we had was whether the resulting longer fasting time would accelerate hypotension during general anesthesia. However, our findings suggest

otherwise with low-risk patients undergoing minor surgery, consistent with a previous study showing no significant relationship between fasting time and decrease of MAP during propofol induction [14]. Thus, oral rehydration that does not account for body weight and unexpected longer fasting times is acceptable with respect to the magnitude of hypotension during general anesthesia.

One limitation of our study is that we did not perform a randomly controlled study for the amount of oral fluid intake (e.g., altering intake volume for preoperative oral rehydration) for ethical reasons, as the practice of liberal preoperative fasting has recently become widespread for minor surgery.

In conclusion, preoperative oral rehydration solution intake volume does not affect the magnitude of hypotension and crystalloid redistribution during general anesthesia in low-risk patients undergoing minor surgery.

Acknowledgments This study was supported by Grants-in-Aid for Researchers, Hyogo College of Medicine, 2011. The authors have no conflicts of interest to report.

References

1. Nygren J. The metabolic effects of fasting and surgery. Best Pract Res Clin Anaesthesiol. 2006;20:429–38.
2. Søreide E, Eriksson LI, Hirlekar G, Eriksson H, Henneberg SW, Sandin R, Raeder J. Pre-operative fasting: an update. Acta Anaesthesiol Scand. 2005;49:1041–7.
3. Breuer J-P, Bosse G, Seifert S, Prochnow L, Martin J, Schleppers A, Geldner G, Soreide E, Spies C. Pre-operative fasting: a nationwide survey of German anaesthesia departments. Acta Anaesthesiol Scand. 2010;54:313–20.
4. Taniguchi H, Sasaki T, Fujita H, Takamori M, Kawasaki R, Momiyama Y, Takano O, Shibata T, Goto T. Preoperative fluid and electrolyte management with oral rehydration therapy. J Anesth. 2009;23:222–9.
5. Itou K, Fukuyama T, Sasabuchi Y, Yasuda H, Suzuki N, Hinenoya H, Kim C, Sanui M, Taniguchi H, Miyao H, Seo N, Takeuchi M, Iwao Y, Sakamoto A, Fujita Y, Suzuki T. Safety and efficacy of oral rehydration therapy until 2 h before surgery: a multicenter randomized controlled trial. J Anesth. 2011;26:20–7.
6. Søreide E, Ljungqvist O. Modern preoperative fasting guidelines: a summary of the present recommendations and remaining questions. Best Pract Res Clin Anaesthesiol. 2006;20:483–91.
7. Tatara T, Tsuzaki K. Segmental bioelectrical impedance analysis improves the prediction for extracellular water volume changes during abdominal surgery. Crit Care Med. 1998;26:470–6.
8. Bracco D, Revelly J-P, Berger MM, Chioléro R. Bedside determination of fluid accumulation after cardiac surgery using segmental bioelectrical impedance. Crit Care Med. 1998;26:1065–70.
9. Bracco D, Berger MM, Revelly J-P, Schütz Y, Frascarolo P, Chioléro R. Segmental bioelectrical impedance analysis to assess perioperative fluid changes. Crit Care Med. 2000;28:2390–6.
10. Osugi T, Tatara T, Yada S, Tashiro C. Hydration status after overnight fasting as measured by urine osmolality does not alter the magnitude of hypotension during general anesthesia in low risk patients. Anesth Analg. 2011;112:1307–13.
11. De Lorenzo A, Andreoli A, Matthie J, Withers P. Predicting body cell mass with bioimpedance by using theoretical methods: a technological review. J Appl Physiol. 1997;82:1542–58.
12. Armstrong LE, Pumerantz AC, Fiala KA, Roti MW, Kavouras SA, Casa DJ, Maresh CM. Human hydration indices: acute and longitudinal reference values. Int J Sport Nutr Exerc Metab. 2010;20:145–53.
13. Tedner BT, Jacobson HS, Linnarsson D, Lins LE. Impedance fluid volume monitoring during intravenous infusion in healthy subjects. Acute Care. 1983–1984;10:200–6.
14. Morley AP, Nalla BP, Vamadevan S, Strandvik G, Natarajan A, Prevost AT, Lewis CM. The influence of duration of fluid abstinence on hypotension during propofol induction. Anesth Analg. 2010;111:1373–8.