CLINICAL STUDY

Safety of Hydroinfusion in Percutaneous Thermal Ablation of Hepatic Malignancies

Justin P. McWilliams, MD, Adam N. Plotnik, MBBS, MSc, FRANZCR, Eric Y. Sako, MD, Steven S. Raman, MD, Nelly Tan, MD, Surachate Siripongsakun, MD, Michael Douek, MD, and David S. Lu, MD

ABSTRACT

Purpose: Hydroinfusion is a commonly used ancillary procedure during percutaneous thermal ablation of the liver that is used to separate and protect sensitive structures from the ablation zone. However, risks of hydroinfusion have not been systematically studied. The purpose of the present study was to systematically examine the frequency and severity of local and systemic complications related to hydroinfusion.

Materials and Methods: From January 2009 to April 2012, 410 consecutive patients underwent percutaneous thermal hepatic tumor ablation. One hundred fifty patients in the study group underwent hydroinfusion and 260 in the control group did not. Patient charts and imaging studies of both groups were reviewed to compare incidences of complications that could potentially be caused by hydroinfusion, including pleural effusion, bowel injury, infection, electrolyte imbalance, and hyperglycemia.

Results: Pleural effusions were found to occur more commonly in the hydroinfusion group (45.3%) than in the control group (16.5%). Pleural effusions were significantly larger ($P < .001$) and more likely to be symptomatic (six of 150 patients; $P = .006$) in the hydroinfusion group than in the control group (one of 260 patients). Multiple patient and tumor characteristics were analyzed for association with development of major hydroinfusion-type complications (requiring therapy or extended/repeat hospitalization). Subcapsular location of tumor was the only variable to reach statistical significance ($P = .009$), with all major hydroinfusion-type complications (n = 10) occurring in patients with subcapsular tumors.

Conclusions: Hydroinfusion is a safe procedure overall. However, pleural effusions occur commonly after hydroinfusion, tend to be moderate or large in size, and are occasionally symptomatic.

ABBREVIATIONS

D5W = dextrose 5% in water, RF = radiofrequency

Thermal damage to surrounding organs, particularly bowel and diaphragm, is a major concern in image-guided percutaneous thermal ablation of liver tumors (1–5). To minimize or avoid thermal injury, various protective measures have been devised including infusion of chilled (5) or nonchilled saline solution (3), infusion of 5% dextrose (1), infusion of sodium hyaluronate solution (6), or injection of carbon dioxide (4) between the ablation zone and the susceptible organ, creating a layer of insulation from the heat and displacing the organ away from harm. Infusion of chilled dextrose 5% in water (D5W), known as hydroinfusion or hydrodissection, has become a popular means of thermal protection because of its low cost, ease of implementation, and compatibility with image-guided modalities (7).

Hydroinfusion with saline solution or D5W is minimally invasive and is considered a safe procedure (7–9). However, hydroinfusion does have potential complications (1). Because the procedure involves entering the peritoneal cavity with a needle, bleeding, infection, and bowel perforation are plausible adverse events. Infusion of fluid could lead to symptomatic pleural effusions. The absorption of D5W might predispose to electrolyte abnormalities and hyperglycemia.

The purpose of the present study was to determine if the aforementioned potential complications are seen more frequently in percutaneous liver ablation in patients

From the Department of Radiology, David Geffen School of Medicine at the University of California, Los Angeles, 757 Westwood Plaza, 2nd Floor, Suite 2125, Los Angeles, CA 90095. Received August 1, 2013; final revision received and accepted December 21, 2013. Address correspondence to J.P.M.; E-mail: jumcwilliams@mednet.ucla.edu

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who undergo D5W hydroinfusion compared with control patients who do not.

MATERIALS AND METHODS

Patient Population

A total of 410 consecutive patients who underwent image-guided percutaneous hepatic radiofrequency (RF) or microwave ablation between January 2009 and April 2012 were included in this institutional review board–approved retrospective case-control study. A total of 150 patients in the study group received hydroinfusion, and 260 patients in the control group did not. Baseline patient demographics and tumor data were collected in the hydroinfusion and control groups (Table 1).

Treatment Planning

A multidisciplinary team evaluated all patients who had evidence of hepatic malignancy through biopsy, imaging, and/or tumor markers, including tumor board for select cases. Percutaneous thermal ablation was considered for nonsurgical candidates with one or more lesions as large as 5 cm. Only one modality was used per procedure, with RF ablation generally being used for lesions smaller than 3 cm and microwave ablation being used for lesions larger than 3 cm.

For thermal protection, hydroinfusion was typically performed during ablation of peripherally located hepatic lesions (< 1 cm from liver capsule) if adjacent to the diaphragm, stomach, or bowel. The need for thermal protection was determined by one of four attending interventionalists on a case-by-case basis.

Hydroinfusion Technique

All percutaneous ablation treatments were performed under general anesthesia or monitored anesthesia care and performed by one of three attending interventional radiologists with 16, 15, 8, and 4 years of experience, respectively. Pretreatment computed tomography (CT) and ultrasound (US) were used to locate the tumors and determine their relationship to bowel, diaphragm, and other sensitive structures. If hydroinfusion was indicated, a 4-F or 5-F micropuncture set or Yueh needle was advanced into the peritoneal space under direct US guidance (model IU22 xMatrix; Philips, Bothell, Washington). In 34% of hydroinfusion cases, the catheter was placed between the liver and the adjacent organ of concern (eg, bowel, diaphragm). In the remaining cases, the catheter was placed in the peritoneal cavity for nontargeted instillation of fluid, most commonly into Morrison's pouch. By gravity drip, 500–2,000 mL of D5W was infused until satisfactory displacement of the adjacent organ was seen by CT. Displacement was considered satisfactory when the nontarget organ of interest was successfully displaced out of the expected ablation zone, which was determined based on ablation size data provided by the manufacturer. Therefore, position of ablation probes close to the liver surface, increased number of probes, and increased desired power level all demanded increased displacement.

Table 1. Baseline Patient Data and Treatment Characteristics

Characteristic	Hydroinfusion (n = 150)	Control (n = 260)	*P* Value
Age (y)	65.7 ± 11.8	64.7 ± 1.7	.38
Sex			
Male	93 (62)	189 (72.7)	.035
Female	57 (38)	71 (27.3)	.035
Tumor size (cm)	2.5 ± 1.1	2.3 ± 1.2	.098
Type of ablation			
RF	122 (81.3)	229 (88.1)	.055
Microwave	28 (18.7)	31 (11.9)	.055
Ablations per treatment	2.4 ± 1.5	2.4 ± 1.4	.7
Applicators per treatment	1.6 ± .6	1.7 ± .6	.7
Applicator approach through liver			
Anterior	37 (24.7)	69 (26.5)	.71
Anterolateral	40 (26.7)	62 (23.8)	.52
Lateral	52 (34.7)	85 (32.7)	.68
Posterolateral	20 (13.3)	48 (18.5)	.18
Posterior	1 (0.6)	5 (1.9)	.31
Type of tumor			
HCC	107 (71.3)	188 (72.3)	.83
Colorectal metastases	20 (13.3)	44 (16.9)	.33
Other	23 (15.3)	28 (1.8)	.18
Previous treatments			
None	60 (40)	92 (35.4)	.35
Ablation	67 (44.7)	139 (53.5)	< .001
Chemoembolization	34 (22.7)	55 (21.2)	.72
Surgery	13 (9.1)	45 (17.3)	.012
Yttrium-90	0	2 (0.8)	.28
Tumor location			
Dome	87 (58)	53 (20.4)	< .001
Other	63 (42)	207 (79.6)	< .001
Tumor location to capsule			
Subcapsular (< 1 cm)	145 (96.7)	106 (40.8)	< .001
Deep	5 (3.3)	154 (59.2)	< .001
Organ of concern			
None	8 (5.3)	193 (74.2)	< .001
Diaphragm	87 (58)	54 (2.8)	< .001
Stomach	21 (14)	6 (2.3)	< .001
Colon	26 (17.3)	1 (0.4)	< .001
Other	8 (5.3)	6 (2.3)	.1
Hydroinfusion approach			
Targeted	51 (34)	NA	–
Nontargeted	99 (66)	NA	–

Values presented as mean ± standard deviation where applicable. Values in parentheses are percentages.
HCC = hepatocellular carcinoma, NA = not applicable, RF = radiofrequency.