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CASE REPORT

# Ice Ball Crack During CT-Guided Renal Cryoablation Using 1.5-mm-Diameter Cryoprobes

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**Abstract** Ice ball fracture and massive hemorrhage are serious complications associated with renal cryoablation. When cracks occur in an ice ball, it is usually associated with adjacent renal parenchymal fracture, leading to massive hemorrhage. However, few studies have examined ice ball fracture under image-guided percutaneous renal cryoablation. We herein describe an 80-year-old male patient who had undergone CT-guided cryoablation for a left renal tumor using four cryoprobes (1.5 mm diameter each). Ice ball cracks were observed on CT images during cryoablation. However, there was no massive hemorrhage and further treatments were not necessary. This is the first report of ice ball cracks with a smaller diameter cryoprobe, which has not been considered to be associated with ice ball fracture.

**Keywords** Renal cryoablation · Complication · Ice ball crack

## Introduction

Renal cryoablation is a well-accepted less invasive nephron-sparing treatment for renal tumors. CT or MRI-guided percutaneous cryoablation under local anesthesia is minimally invasive and has been widely performed for patients who cannot receive general anesthesia due to other comorbidities [1]. Percutaneous cryoablation is a safe and feasible technique [2, 3], but there is a small risk of hemorrhage. Especially important will be an ice ball fracture, which is known to be the cause of massive hemorrhage related to the procedure. When cracks occur within an ice ball during cryoablation, the adjacent renal parenchyma will also fracture, and this will lead to massive hemorrhage [4]. The use of larger diameter cryoprobes (more than 1.5 mm) has been associated with ice ball fracture [5, 6], while the development of ice ball cracks and fracture in cryoablation using small diameter (< 1.5 mm) cryoprobes has not yet been reported in the past. We report herein a case with ice ball cracks while using a 1.5-mm cryoprobe but without massive hemorrhage.

## Case Report

An 80-year-old man was admitted to our hospital with an enlarged mass at the mid-pole of the left kidney that was 38 mm at its maximal diameter. Percutaneous CT-guided cryoablation was selected for the treatment of this tumor based on moderate renal dysfunction and the patient's strong request.

Transcatheter arterial lipiodol marking was performed, 3 days prior to cryoablation, in order to make it easier to visualize the tumor under non-contrast CT fluoroscopy.

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Lipiodol mixed with the same amount of contrast medium was injected into the feeding artery, and embolization was performed with crushed gelatin particles (Serescue®, Nippon Kayaku, Tokyo). Sufficient accumulation of lipiodol within the tumor was confirmed by cone-beam CT during the procedure. No complications occurred during this marking procedure.

Three days later, CT-guided cryoablation was performed following biopsy of the renal mass, which showed atypical cells consistent with necrosis of renal cell carcinoma. Four 1.5-mm cryoprobes (IceRod®, Galil Medical, Yokneam, Israel) were placed into the renal tumor under CT fluoroscopic guidance (Aquilion, Canon Medical Systems, Otawara, Japan), and 15–10–15-min freeze–thaw–freeze cycle cryoablation was performed. On the CT images at the end of the first freeze session, a crack was detected in the ice ball (Fig. 1). This crack disappeared, and no obvious hematoma was observed on CT images after the natural thawing cycle; therefore, the second freeze was performed. The crack appeared again after the second freeze session (Fig. 2), and thus, active thawing was avoided and needles were removed after 30 min of natural thawing. The following non-contrast CT scans did not show increase in the size of hematoma, and thus, conservative observation was selected. Another non-contrast CT scan was performed approximately 3 h after the procedure, which also did not show any increase in size of the left perinephric hematoma (Fig. 3). The patient's general condition remained stable and he had no significant back pain. His hemoglobin levels also remained stable. He was discharged 3 days after cryoablation without significant clinical symptoms. There has been no evidence for local tumor recurrence or metastatic disease on CT images 1 year after the ablation procedure.

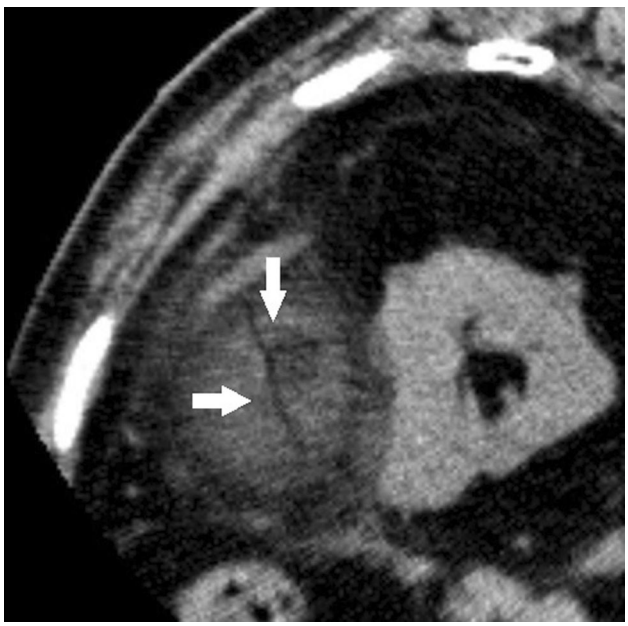

**Fig. 1** Axial CT images obtained after the first freeze session (prone position). Cracks were observed within the ice ball (arrow)

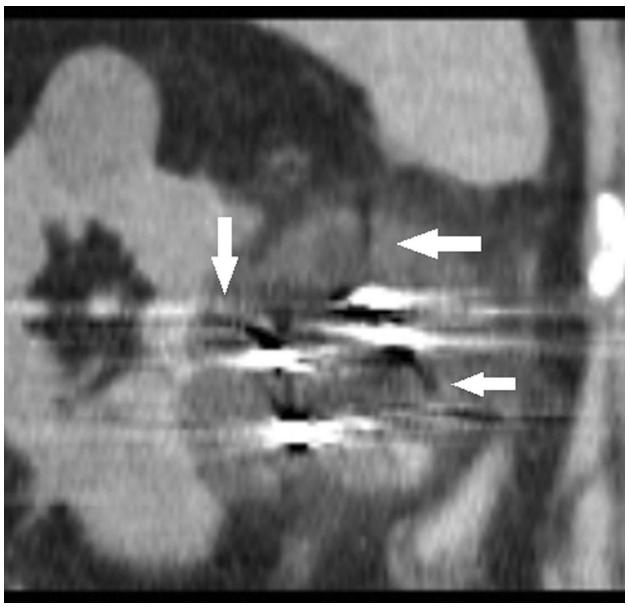

**Fig. 2** Coronal CT views after the second freeze session. Cracks (arrows) appeared again within the ice ball

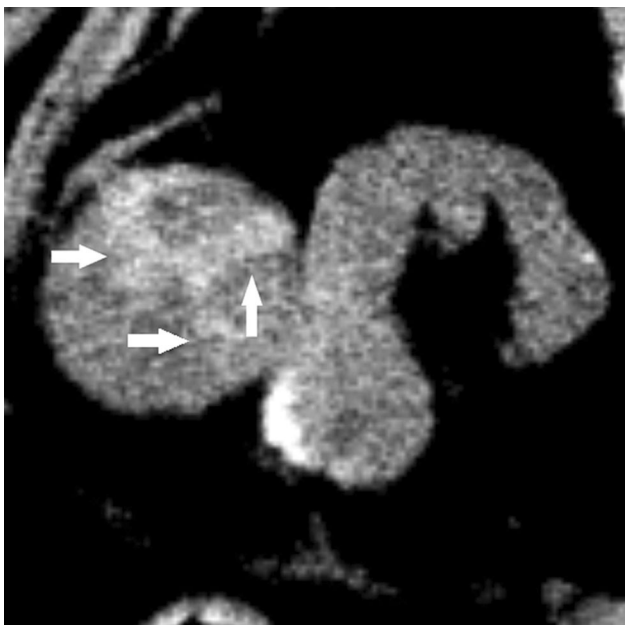

**Fig. 3** Non-contrast-enhanced trans-axial CT images obtained 3 h after cryoablation. A high-density area was identified and concordant with the cracks (arrow). However, there was no massive hemorrhage or fracture

## Discussion

Ice ball fracture is known to be a cause of massive hemorrhage during cryotherapy. In reviews of laparoscopic renal cryoablation, ice ball fractures occurred in 8–17% of cases [2, 3], some of which requiring blood transfusions or surgical managements. When cracks occur in an ice ball, the adjacent renal parenchyma will be also involved in the fracture, and this could lead to massive hemorrhage.

A previous study by Hruby et al. [5] searched for the potential risk factors for ice ball fracture during laparoscopic cryoablation, using a porcine model. They identified the following risk factors for ice ball fractures; a larger diameter (3.4 mm) cryoprobe, use of multiple cryoprobes, use of guillotine technique for upper pole cryoablation, initiating a second ice ball adjacent to the primary ice ball that had already formed, and the premature removal of cryoprobes before the complete thaw of the ice ball. Especially important will be the diameter of the probes, and those larger than 1.5 mm can be considered being a significant risk factor because no fracture has been reported with smaller cryoprobes [5]. Another study by Ortiz-Vanderdys et al. [6] conducted an experiment using an ex vivo model, and they have also shown that no fracture occurs with 1.5-mm cryoprobes. In contrast, the frequency of ice ball fracture has been reported to be lower with image-guided (CT or MRI) percutaneous cryoablation than with laparoscopic cryoablation [4]. The following reasons have been proposed for this lower rate of fracture, smaller diameter cryoprobes, less visibility of smaller cracks using imaging studies, and lack of exposure to ambient air during the procedure [4].

Our case is the first report of ice ball cracks noted during CT-guided cryoablation with 1.5-mm-diameter cryoprobes. There are a couple of possible explanations for the ice ball cracks that occurred in this present case. First, we used multiple needles placed too closely to one another. Second, the tumor was located nearby the upper pole of the kidney and stretching stress due to respiratory movements may have had some effects on the ice ball. It remains, however, unclear whether any of the above-mentioned mechanisms were truly responsible for the development of ice ball cracks in our case. We have to also keep in mind that cracks observed during laparoscopic cryoablation may not be the same as those we see on CT imaging. Further investigations are warranted to elucidate the true mechanisms behind this phenomenon.

In the present case, despite the fact that there were cracks within the ice ball, massive hemorrhage did not follow, as reported elsewhere. There are several potential explanations for this phenomenon, which include preoperative lipiodol marking, smaller cryoprobes, and natural thawing. Lipiodol marking was performed with transcatheter arterial method, and this aimed for better visualization on CT fluoroscopy [7]. This marking procedure with embolization using gelatin particles may have helpful preventing massive hemorrhage due to a decrease in blood flow into the tumor. Usage of smaller cryoprobes may have had some advantages. Furthermore, the removal of cryoprobes after the complete disappearance of the ice ball followed by natural thawing may have had benefit in avoiding hemorrhage. We did not use active thawing and waited to remove cryoprobes until cracks and ice ball findings disappeared on CT images because it is known that the premature removal of cryoprobes before complete thawing of the ice ball is considered to be a risk factor for fracture [4].

In conclusion, this is the first report of ice ball cracks during CT-guided cryoablation using a 1.5-mm cryoprobe. It is important to note that ice ball cracks may occur even with small diameter cryoprobes, and thus, caution is needed. Even if ice ball cracks appear, massive hemorrhage may be avoided by careful managements.

#### Compliance with Ethical Standards

**Conflict of interest** No authors have any conflict of interest related to this manuscript.

**Ethical Approval** Formal consent is not required for this type of study.

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

## References

1. Atwell TD, Farrell MA, Leibovich BC, Callstrom MR, Chow GK, Blute ML, et al. Percutaneous renal cryoablation: experience treating 115 tumors. J Urol. 2008;179(6):2136–40.
2. Georgiades CS, Hong K, Bizzell C, Geschwind JF, Rodriguez R. Safety and efficacy of CT-guided percutaneous cryoablation for renal cell carcinoma. J Vasc Interv Radiol. 2008;19(9):1302–10.
3. Gupta A, Allaf ME, Kavoussi LR, Jarrett TW, Chan DY, Su LM, et al. Computerized tomography guided percutaneous renal cryoablation with the patient under conscious sedation: initial clinical experience. J Urol. 2006;175(2):447–52.
4. Schmit GD, Atwell TD, Callstrom MR, Kurup AN, Fleming CJ, Andrews JC, et al. Ice ball fractures during percutaneous renal cryoablation: risk factors and potential implications. J Vasc Interv Radiol. 2010;21(8):1309–12.
5. Hruby G, Edelstein A, Karpf J, Durak E, Phillips C, Lehman D, et al. Risk factors associated with renal parenchymal fracture during laparoscopic cryoablation. BJU Int. 2008;102(6):723–6.
6. Ortiz-Vanderdys CG, Etafy MH, Saleh FH. Ex vivo model for renal fracture in cryoablation. Urology. 2012;80(4):953.e15–9.
7. Hongo F, Yamada Y, Ueda T, Nakmura T, Naya Y, Kamoi K, et al. Preoperative lipiodol marking and its role on survival and complication rates of CT-guided cryoablation for small renal masses. BMC Urol. 2017;17(1):10.