SHORT COMMUNICATION

CT-guided radiofrequency liver tumour ablation: use of a two-step coaxial system with a fine guide needle-wire unit for high-risk cases

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CT-guided radiofrequency ablation using two-step coaxial system

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Received 5 December 2009

Revised 16 January 2010

Accepted 25 January 2010

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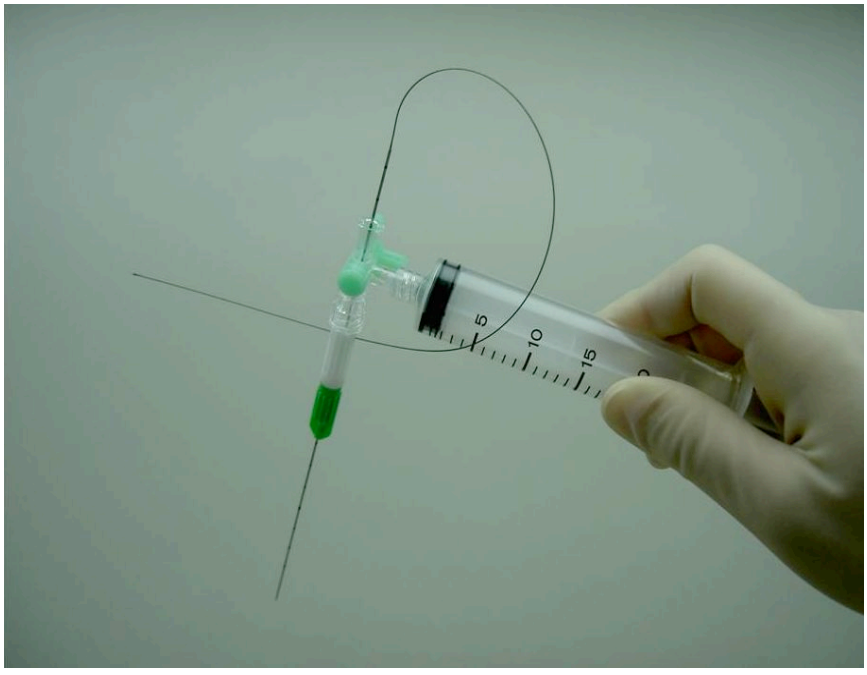
Abstract

Background: Accurate radiofrequency (RF) needle targeting to liver lesions under CT guidance is technically difficult and generally requires multiple needle manipulations, which carries potential risk. It is not suited to precariously located lesions or patients who have difficulty holding their breath.



Purpose: To develop a novel two-step coaxial system to facilitate CT-guided RF ablation in difficult cases.

Materials and methods: The study group comprised 11 patients with 12 hepatic lesions. The coaxial system consisted of two parts: (1) a 21-gauge pencil-tip guide needle-wire (GNW) unit comprising a 150 mm-long needle segment and a 250 mm-long wire segment; and (2) a 140 mm-long outer cannula with its stylet, which accepts a 17-gauge RF electrode needle. The GNW was inserted until its root was confirmed to be positioned correctly. The cannula with the stylet was then advanced along the GNW.

Results: Lesions were successfully accessed using the GNW, even in patients who could not hold their breath, and manipulation was feasible within the limited space of the CT gantry. The light GNW also facilitated step-by-step CT-guided angular manipulations, unlike heavy RF electrodes that are unstable during hands-free use unless deeply inserted. This system enabled sequential ablations of large tumors by ensuring three different roots in advance, using the GNW. Insertion of the cannula along the GNW was simple.

Conclusion: The two-step coaxial system enabled CT-guided RF tumour ablation to be performed in cases conventionally contraindicated because of the high risk of serious complications.

Percutaneous RF tumour ablation is commonly performed with CT guidance when lesions cannot be adequately delineated by sonography [1]. Accurate needle targeting to the centre of liver lesions is essential to obtain coagulation necrosis covering safe tumour-free margins. This is technically difficult with CT guidance, so multiple needle manipulations are generally required, which carries potential risk. This technique is not suitable for deeply situated, precariously located lesions and for patients who have difficulty holding their breath. Such situations are common in our clinical practice.

A two-step approach: firstly, initial use of a fine needle to ensure a proper root; secondly, subsequent exchange of a cannula for the RF needle provides safe needle access to the lesion. This technique requires a long needle (needle length is more than

twice the depth of the lesion) and makes it difficult to manoeuvre within the CT gantry space. Here, we describe a novel two-step coaxial system that uses a fine GNW that can be easily manipulated under CT guidance.

Materials and methods

The two-step coaxial system was used to treat 13 lesions in 11 patients with hepatocellular carcinoma (10 lesions) and liver metastases (two lesions). This system was employed for these patients either because the needle access routes were close to the heart, the lungs, the large portal triad or the gallbladder, or because the patient had difficulty holding their breath.

The procedure was carried out in patients whose haemocoagulation parameters met the following criteria: platelet count >40,000/mm^3 and prothrombin time >40% of control.

The coaxial system consists of two parts: (1) a 21-gauge pencil-tip GNW comprising a 150 mm-long needle segment and a 250 mm-long wire segment; and (2) a 15-gauge 140 mm-long cannula with a bevelled-tip stylet, able to accept the GNW (Coax: Hakko, Tokyo, Japan) (Figure 1). The cannula accepts a 17-gauge RF electrode needle (Cool-tip: Radionics, Burlington, MA, or LeVeen expandable needle: Boston Scientific, Natick, MA). The wire segment of the GNW was constructed by running a wire through the needle lumen and then gluing it in place. The GNW has a hub that can be fixed to any part of the needle segment and is detachable; a hole in the hub allows the wire segment to be fixed during needle placement (Figure 2). The needle segment of the GNW and the cannula are graduated in centimetres.

The needle entry site, the degree of inclination required to direct the needle and the distance from the body surface to the lesion margin were determined by initial CT localisation images. These images were obtained using a metallic marker positioned on the body surface of each patient.

Our aim was to position the cannula tip 10 mm proximal to the lesion margin. The appropriate distance from the cannula tip to the electrode needle tip was calculated using the formula given in Figure 3. The required position for the electrode needle shaft to meet the entrance of the hub of the cannula was marked in advance of the procedure using a piece of tape.

After the patient's skin had been cleaned and the entry site anesthetised and incised, the GNW was inserted in a stepwise manner until the root of the GNW was confirmed to be appropriate. This was achieved either under conventional helical 5 mm CT imaging or interrupted CT-fluoroscopy guidance. For patients who could not hold their breath, the GNW was advanced during end-expiration. The cannula with the stylet was then

advanced along the GNW until the graduations on the cannula reached the required distance in relation to the surface of the lesion. The RF electrode needle was then inserted into the cannula so that the tape mark was aligned with the entrance of the hub. The position of the RF electrode tip was then checked using CT images and any minor adjustments were made before the RF ablations were performed.

Once RF ablation was complete, the electrode needle was slowly withdrawn. If blood flowed over the cannula, additional RF coagulation was performed to control the bleeding. Immediate follow-up contrast-enhanced CT was performed to check the area for ablation necrosis.

Results and discussion

The GNW was easy to manoeuvre within the limited CT gantry space. It could be advanced and withdrawn safely in multiple exploratory movements, and successfully used to access lesions. It was also easy to perform step-by-step CT-guided angular manipulations, in contrast to the use of RF electrodes, which are heavy and unstable during hands-free use unless deeply inserted. This system enabled sequential ablations of large tumors by ensuring three different roots in advance using GNW. We found that the cannula was easily advanced along the GNW.

The cannula tip was positioned 10 mm proximal to the tumour margin because this facilitated the subsequent placing of the electrode tip. The position of the cannula tip also served to indicate whether the ablation margin had reached the tumour-free margin of 10 mm on immediate follow-up CT.

In conclusion, our two-step coaxial system using a fine GNW enabled safer and less stressful placement of the RF needle than the conventional method allows. It can also be applied to CT-guided RF ablations and other interventions, such as biopsy, in cases conventionally contraindicated because of high risk.

References

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Figure 1. Illustration of the two-step coaxial system. 1) The GNW unit with a movable hub. 2) The cannula (a) with a stylet (b) that accepts the GNW.

Figure 2. GNW manipulation. 1) The wire segment remains within the aperture of the hub. 2) A three-way stopcock and a syringe were connected to the hub for manipulation of the unit inside the CT gantry space. 3) The cannula with the stylet was then advanced

along the GNW.

Figure 3. For a 30 mm active-tip electrode, the planned distance from the cannula tip to the electrode needle tip is 10 mm + tumour diameter + (30 mm – tumour diameter) / 2.