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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ABSTRACT. Accurate radiofrequency (RF) needle targeting to liver lesions under CT guidance is technically difficult and generally requires multiple needle manipulations, which carries potential risk. This approach is hardly applicable for precariously located lesions or for patients who have difficulty holding their breath. The aim of this study was to develop a novel two-step coaxial system to facilitate CT-guided RF ablation in difficult cases. The study group comprised 11 patients with 12 hepatic lesions. The coaxial system consisted of two parts: 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 a 140-mm-long outer cannula with its stylet, which accepts a 17-gauge RF electrode needle. The GNW was inserted until the route of the GNW was confirmed to be positioned correctly. The cannula with the stylet was then advanced along the GNW. 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, which are unstable during hands-free use unless deeply inserted. Therefore, this system enabled sequential ablations of large tumours by ensuring three different routes in advance by using the GNW. Insertion of the cannula along the GNW was simple. In conclusion, the two-step coaxial system enabled CT-guided RF tumour ablation to be performed in cases conventionally contraindicated owing to high risk of serious complications.

Received 5 December 2009
Revised 16 January 2010
Accepted 25 January 2010

DOI: 10.1259/bjr/21804442

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Percutaneous radiofrequency (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 tumour-free safety margins, and this is technically difficult with CT guidance; thus, multiple needle manipulations are generally required, which carries potential risk. As a consequence, this technique is not suitable for deeply situated, precariously located lesions or for patients who have difficulty holding their breath. We commonly encounter such situations in our clinical practice.

A two-step approach — the initial use of a fine needle to ensure a proper route and the subsequent exchange with a cannula for the RF needle — will provide safe needle access to the lesion. This technique, however, requires a long needle (needle length is more than twice the depth of the lesion) and is difficult to manoeuvre within the CT

gantry space. Here, we describe a novel two-step coaxial system that uses a fine guide needle wire (GNW) unit that can be easily manipulated under CT guidance.

Methods and materials

The two-step coaxial system was used to treat 13 lesions in 11 patients with hepatocellular carcinoma (10 lesions) and liver metastases (2 lesions). This system was employed for these patients because the needle access routes were close to the heart, 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 two criteria: a platelet count $>40\,000\text{ mm}^3$ and a prothrombin time $>40\%$ of control.

The coaxial system consists of two parts: a 21-gauge pencil-tip GNW comprising a 150-mm-long needle segment and a 250-mm-long wire segment; and a 15-gauge 140-mm-long cannula with a bevelled tip stylet,

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

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 LeVein 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 obtained with 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 anaesthetised and incised, the GNW was inserted in a stepwise manner under conventional helical 5-mm CT imaging or interrupted CT fluoroscopy guidance until the route of the GNW was confirmed to be appropriate. For patients who could not hold their breath, the GNW was advanced during end-expiration. The cannula with

(a)

(b)

(c)

Figure 2. Guide needle wire (GNW) unit manipulation. (a) The wire segment remains within the aperture of the hub. (b) A three-way stopcock and a syringe were connected to the hub for manipulation of the unit inside the CT gantry space. (c) 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.

the stylet was then advanced along the GNW until the graduations on the cannula reached the required distance with regards 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 minor adjustments were made if needed 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 at this point to control the bleeding. Immediate follow-up contrast-enhanced CT was performed to check the area of ablation necrosis.

Results and discussion

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

Positioning of the cannula tip 10 mm proximal to the tumour margin was chosen because this facilitated the subsequent placing of the electrode tip. In addition, the position of the cannula tip indicated whether the ablation margin reached the tumour-free margin of 10 mm on immediate follow-up CT.

Conclusion

Our two-step coaxial system using a fine GNW enabled safer and less stressful placement of the RF needle than the conventional method; therefore, this approach can 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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