Pleural Puncture that Excludes the Ablation Zone Decreases the Risk of Pneumothorax after Percutaneous Microwave Ablation in Porcine Lung

Kyungmouk Steve Lee, MD, Haruyuki Takaki, MD, PhD, Hooman Yarmohammadi, MD, Govindarajan Srimathveeravalli, PhD, Kerith Luchins, DVM, Sébastien Monette, DMV, MVSc, Sreejit Nair, MD, Sirish Kishore, MD, and Joseph P. Erinjeri, MD, PhD

ABSTRACT

Purpose: To test the hypothesis that the geometry of probe placement with respect to the pleural puncture site affects the risk of pneumothorax after microwave (MW) ablation in the lung.

Materials and Methods: Computed tomography–guided MW ablation of the lung was performed in 8 swine under general anesthesia and mechanical ventilation. The orientation of the 17-gauge probe was either perpendicular (90°) or parallel (< 30°) with respect to the pleural puncture site, and the ablation power was 30 W or 65 W for 5 minutes. After MW ablation, swine were euthanized, and histopathologic changes were assessed. Frequency and factors affecting pneumothorax were evaluated by multivariate analysis.

Results: Among 62 lung MW ablations, 13 (21%) pneumothoraces occurred. No statistically significant difference was noted in the rate of pneumothorax between the perpendicular and the parallel orientations of the probe (31% vs 14%; odds ratio [OR], 2.8; $P = .11$). The pneumothorax rate was equal for 65-W and 30-W ablation powers (21% and 21%; OR, 1.0; $P = .94$). Under multivariate analysis, 2 factors were independent positive predictors of pneumothorax: ablation zone inclusive of pleural insertion point (OR, 7.7; $P = .02$) and time since intubation (hours) (OR, 2.7; $P = .02$).

Conclusions: Geometries where the pleural puncture site excluded the ablation zone decreased pneumothorax in swine undergoing MW ablation in the lung. Treatment planning to ensure that the pleural puncture site excludes the subsequent ablation zone may reduce the rate of pneumothorax in patients undergoing MW ablation in the lung.

ABBREVIATIONS

MW = microwave, OR = odds ratio

The most common complication after percutaneous thermal ablation in the lung is pneumothorax. Pneumothorax may occur in 11%–63% of patients; a few of these patients require chest tube placement that may result in prolonged hospitalization (1–7). In radiofrequency (RF) ablation of pulmonary tumors, risk factors for pneumothorax include emphysema, small tumor size, absence of prior pulmonary surgery, and traversal of major fissure by the probe (1–5). Prior studies of RF ablation showed that contact of the ablation zone with the pleura can lead to delayed or recurrent pneumothorax and that tract ablation should be avoided (8,9). Microwave (MW) ablation can be used at much higher energy than RF ablation and results in larger tumor ablation volumes, higher intratumoral temperatures, and less susceptibility to heat sink effect (10,11). However, there have been reports of intractable pneumothorax and the formation

From the Department of Radiology (K.S.L., H.T., H.Y., G.S., S.N., S.K., J.P.E), Research Animal Resource Center Memorial (K.L.), and Laboratory of Comparative Pathology (S.M.), Memorial Sloan-Kettering Cancer Center, 1275 York Avenue, H-118, New York, NY 10065. Received October 10, 2014; final revision received January 11, 2015; accepted January 12, 2015. **Address correspondence to** J.P.E.; E-mail: erinjerj@mskcc.org

None of the authors have identified a conflict of interest.

© SIR, 2015

J Vasc Interv Radiol 2015; 26:1052–1058

http://dx.doi.org/10.1016/j.jvir.2015.01.016

of bronchopleural fistula after MW ablation in the lung (12,13). It is unknown how the MW energy deposition directly on the pleura affects the risk of pneumothorax. The purpose of this study was to test the hypothesis that the geometry of probe placement with respect to the pleural puncture site affects the risk of pneumothorax after percutaneous computed tomography (CT)–guided MW ablation in a porcine lung model.

MATERIALS AND METHODS

Animals

All experiments were performed with approval from the Institutional Animal Care and Use Committee of our institution and in accordance with the Guide for Care and Use of Laboratory Animals issued by the National Research Council. Eight swine (Yorkshire female) weighing 35–45 kg were used in this study.

Experimental Setup

The swine received sedation (tiletamine/zolazepam and xylazine), anesthesia (isoflurane), and preemptive analgesics (buprenorphine and carprofen). After endotracheal intubation, mechanical ventilation was initiated without positive end expiratory pressure (ventilatory pressure, 18–22 cm H_2O; tidal volume, 5–10 mL/kg). Under CT guidance (LightSpeed 16; GE Healthcare, Milwaukee, Wisconsin), a 17-gauge MW ablation probe (Certus 140 PR 15 Probe; NeuWave Medical, Madison, Wisconsin) was percutaneously inserted into the porcine lung by a single operator in either the perpendicular or the parallel orientation. The needle orientation was defined as "perpendicular" if the angle between the needle and the pleural puncture site was 90° (**Fig, a**). The needle orientation was defined as "parallel" if the angle between the needle and the pleural puncture site was $< 30°$ (**Fig, d**). For each ablation, a single pleural puncture was made during the insertion of the MW probe. If there was any adjustment of the probe position with respect to the pleura, the pleural puncture site remained constant, and only minor angle changes were made. The tip of the ablation probe did not violate any lung fissures, and all ablations were performed away from any major bronchus. There was no violation of the instructions for use of the MW ablation device.

Randomization was performed with regard to probe orientation and lung laterality during MW ablation. The first lung to be ablated was randomized—in four swine, the right lung was ablated first; in four swine, the left lung was ablated first. The probe orientation was also randomized—in four swine, the perpendicular orientation was used as the initial ablative approach; in four swine, the parallel orientation was used as the initial approach. For the first four swine, MW ablations were performed for 5 minutes at 30 W; for the second four swine, ablations were performed for 5 minutes at 65 W. During each ablation, the maximum temperature of the probe was recorded. Immediately after each ablation, CT images were acquired to evaluate the size of the ablation zone. CT images of the entire chest were obtained immediately after and 5 minutes after ablation to identify any pneumothorax. When a pneumothorax occurred, an 8-F chest tube was placed percutaneously into the thorax under CT guidance. The chest tube was connected to a drainage system and placed onto continuous low wall suction. If a pneumothorax developed in one lung, no further ablations were performed in that lung, and the contralateral lung was used for subsequent ablations. The animals were euthanized with an overdose of pentobarbital after the procedure.

Measurements

Based on the CT images, the following measurements were obtained: dimensions of the ablation zone (long axis and short axis), distance from the emitting point of the MW probe to the pleural puncture site (the emitting point was 1 cm from the tip of the probe), distance from the emitting point to the nearest adjacent pleura, length of pleural contact with the ablation zone, and whether or not the ablation zone includes the pleural puncture site. The time elapsed since endotracheal intubation was recorded. The number of ablations performed in each lung was also documented.

Histopathologic Examination

At the conclusion of the MW ablation session, the swine was euthanized using intravenous injections of pentobarbital and phenytoin. Subsequently, gross dissection was performed, and lungs were removed en bloc. Gross photographs of the ablated lung and pleura were obtained. The ablation zone and surrounding pleura were harvested from the lungs, fixed by immersion in 10% neutral buffered formalin, routinely processed for histology, embedded in paraffin, sectioned at 4-μm thickness, and stained with hematoxylin and eosin.

Statistical Analysis

To determine the factors predicting pneumothorax after MW ablation, univariate logistic regression was performed for both categorical variables (perpendicular or parallel geometry, ablation zone includes pleural puncture site yes/no, presence of pneumothorax) and continuous variables. The factors significant in the univariate model underwent a multivariate logistic regression. P values $< .05$ were considered statistically significant. Statistical analysis was performed using SAS software version 9.4 (SAS Institute, Cary, North Carolina).

RESULTS

There were 62 percutaneous CT-guided MW ablations performed in the porcine lung (**Table 1**). The ablations

Download English Version:

https://daneshyari.com/en/article/4237790

Download Persian Version:

https://daneshyari.com/article/4237790

Daneshyari.com