Combination Radiofrequency Ablation and Intravenous Radiolabeled Liposomal Doxorubicin: Imaging and Quantification of Increased Drug Delivery to Tumors

**Purpose:** To identify, with noninvasive imaging, the zone of radiopharmaceutical uptake after combination therapy with radiofrequency (RF) ablation and intravenous administration of technetium 99m (99mTc) liposomal doxorubicin in a small-animal tumor model, and to quantify and correlate the uptake by using imaging and tissue counting of intratumoral doxorubicin accumulation.

**Results:** At both SPECT/CT and planar scintigraphy, increased uptake of 99mTc-liposomal doxorubicin was visibly apparent in the ablated tumors. Results of quantitative analysis with both imaging and tissue counting confirmed significantly greater uptake in the RF ablation–treated tumors (P < .001). Intratumoral doxorubicin accumulation correlated closely with imaging (r = 0.9185–0.9871) and tissue-counting (r = 0.995) results.

**Conclusion:** Study results show that increased delivery of intravenous liposomal doxorubicin to tumors combined with RF ablation can be depicted and quantified with noninvasive imaging.
Figure 2: Increased uptake of \(^{99m}\text{Tc}\)-liposomal doxorubicin in RF-ablated tumors. (a) Transaxial (left) and coronal (right) SPECT/CT images acquired at three time points after intravenous administration of \(^{99m}\text{Tc}\)-liposomal doxorubicin in rat with two tumors. Right tumor (arrows) was also treated with RF ablation. Left tumor (arrowheads) was not ablated. Color map represents SPECT pixel values from 0 to an arbitrary maximal value of 100, indicating percent relative \(^{99m}\text{Tc}\) activity. (b) Posterior scintigraphic images acquired at four time points after intravenous administration of \(^{99m}\text{Tc}\)-liposomal doxorubicin in different rat with two tumors. Left tumor (arrow) was also treated with RF ablation. Right tumor (arrowhead) was not ablated. (c) Graph illustrates percentages of injected \(^{99m}\text{Tc}\) activity per cubic centimeter of tumor tissue at three time points, as determined at SPECT/CT analysis of single tumors in seven rats treated with combined RF ablation-intravenous \(^{99m}\text{Tc}\)-liposomal doxorubicin and three rats treated with intravenous \(^{99m}\text{Tc}\)-liposomal doxorubicin only. (d) Graph illustrates percentages of injected \(^{99m}\text{Tc}\) activity per cubic centimeter of tumor tissue at three time points, as determined at SPECT/CT analysis of rats with two tumors each, one of which was treated with RF ablation after intravenous \(^{99m}\text{Tc}\)-liposomal doxorubicin. (e) Graph illustrates percentages of injected \(^{99m}\text{Tc}\) activity per whole tumor at four time points, as determined at scintigraphic analysis of rats with two tumors each, one of which was treated with RF ablation after intravenous \(^{99m}\text{Tc}\)-liposomal doxorubicin. In c–e, center points indicate means and error bars indicate 95% confidence intervals. \(P\) values were calculated at two-way ANOVA after logarithmic transformation of raw data.