

Literature Survey

Bipolar/multipolar tumor ablation

RFITT Power System

09 April 2014

List of contents

2014	4
Bipolar radiofrequency ablation of spinal tumors: predictability, safety, and outcome	4
Histopathologic Comparison of Monopolar Versus No-Touch Multipolar Radiofrequency Ablation to Treat Hepatocellular Carcinoma within Milan Criteria	5
2013	6
Clinical effectiveness of bipolar radiofrequency ablation for small liver cancers.....	6
2012	7
Bipolar Radio Frequency Ablation of Spinal Neoplasms in Late Stage Cancer Disease - <i>A Report of Three Cases</i>	7
CT-guided Bipolar and Multipolar Radiofrequency Ablation (RF Ablation) of Renal Cell Carcinoma: Specific Technical Aspects and Clinical Results.....	8
2011	9
Efficiency Analysis of Bipolar and Multipolar Radiofrequency Ablation in an In Vivo Porcine Kidney Model Using Three-Dimensional Reconstruction of Histologic Section Series.....	9
2010	10
The efficacy of bipolar and multipolar radiofrequency ablation of lung neoplasms — results of an ablate and resect study	10
2009	11
Intraoperative Radiofrequency Ablation of Lung Metastases and Histologic Evaluation	11
Ex Vivo Evaluation of a Bipolar Application Concept for Radiofrequency Ablation.....	12
2008	13
Multipolar Hepatic Radiofrequency Ablation Using up to Six Applicators: Preliminary Results.....	13
Wide-bore 1.5 Tesla MR imagers for guidance and monitoring of radiofrequency ablation of renal cell carcinoma: initial experience on feasibility	14
Fluid-Modulated Bipolar Radiofrequency Ablation: An Ex-Vivo Evaluation Study	15
Large (≥5.0 cm) HCCs: Multipolar RF Ablation with Three Internally Cooled Bipolar Electrodes — Initial Experience in 26 Patients	16
Radiofrequency Ablation with Internally Cooled versus Perfused Electrodes for the Treatment of Small Hepatocellular Carcinoma in Patients with Cirrhosis.....	17
2007	18
Bipolar Radiofrequency Ablation Using Internally Cooled Electrodes in Ex Vivo Bovine Liver (Prediction of Coagulation Volume From Applied Energy)	18
Image-guided multipolar radiofrequency ablation of liver tumours: initial clinical results	19
Internally Cooled Bipolar Radiofrequency Ablation: Is a Lower Power Output More Effective?	20

In Vivo Efficiency of Multipolar Radiofrequency Ablation with Two Bipolar Electrodes: A Comparative Experimental Study in Pig Kidney	21
Radiofréquence bipolaire et cimentoplastie dans le traitement des métastases osseuses.....	22
Nouvelles techniques interventionnelles radiologiques dans le traitement des douleurs d'origine cancéreuse : infiltration, alcoolisation, vertébroplastie, cimentoplastie, radiofréquence bipolaire Algoradiologie interventionnelle de la douleur cancéreuse	23
2006	24
Bipolar radiofrequency ablation of liver metastases during laparotomy. First clinical experiences with a new multipolar ablation concept	24
Multipolar radiofrequency ablation of large hepatic metastases of endocrine tumors	25
Bipolar and multipolar radiofrequency ablation with resistance-controlled power output: Standardized ex-vivo kidney tissue evaluation	26
Technical characterization of a new bipolar and multipolar radiofrequency device for minimally invasive treatment of renal tumors.....	27
Multipolar radiofrequency ablation with internally cooled electrodes: experimental study in ex-vivo bovine liver with mathematical modeling	28
Radiofrequency Ablation of Osteoid Osteoma: Initial Results with a Bipolar Ablation Device	29
Magnetic Resonance Imaging for Assessment of Radiofrequency Lesions in Kidney Tissue Immediately after Ablation: An Experimental Study	30
Hepatic Radiofrequency Ablation Using Multiple Probes: Ex Vivo and In Vivo Comparative Studies of Monopolar versus Multipolar Modes	31
2005	32
Multipolar radiofrequency ablation of hepatic tumors: Initial experience	32
2004	33
Multipolar radiofrequency ablation: First clinical results	33

2014

Bipolar radiofrequency ablation of spinal tumors: predictability, safety, and outcome

Gazis A, Beuing O, Franke J, Jöllenbeck B, Skalej M

The Spine Journal, Volume 14, Issue 4, 1 April 2014, Pages 604–608

BACKGROUND: Bone metastases are often the cause of tumor-associated pain and reduction of quality of life. For patients that cannot be treated by surgery, a local minimally invasive therapy such as radiofrequency ablation can be a useful option. In cases in which tumorous masses are adjacent to vulnerable structures, the monopolar radiofrequency can cause severe neuronal damage because of the unpredictability of current flow.

PURPOSE: The aim of this study is to show that the bipolar radiofrequency ablation provides an opportunity to safely treat such spinal lesions because of precise predictability of the emerging ablation zone.

STUDY DESIGN: Prospective cohort study of 36 patients undergoing treatment at a single institution.

Patient sample: Thirty-six patients in advanced tumor stage with primary or secondary tumor involvement of spine undergoing radiofrequency ablation.

OUTCOME MEASURES: Prediction of emerging ablation zone. Clinical outcome of treated patients.

METHODS: X-ray-controlled treatment of 39 lesions by bipolar radiofrequency ablation. Magnetic resonance imaging was performed pre- and postinterventionally. Patients were observed clinically during their postinterventional stay.

RESULTS: The extent of the ablation zones was predictable to the millimeter because it did not cross the peri-interventional planned dorsal and ventral boundaries in any case. No complications were observed.

CONCLUSIONS: Ablation of tumorous masses adjacent to vulnerable structures is feasible and predictable by using the bipolar radiofrequency ablation. Damage of neuronal structures can be avoided through precise prediction of the ablation area.

Histopathologic Comparison of Monopolar Versus No-Touch Multipolar Radiofrequency Ablation to Treat Hepatocellular Carcinoma within Milan Criteria

Seror O, N’Kontchou G, Tran Van Nhieu J, Rabahi Y, Nahon P, Laurent A, Trinchet J C, Cherqui D, Vicaut E, Beaugrand M, Sellier N

J Vasc Interv Radiol 2014 (published online 12 February 2014)

PURPOSE: To compare histopathologically the completeness of radiofrequency (RF) ablation to treat hepatocellular carcinoma (HCC) with monopolar or multipolar technique.

MATERIALS AND METHODS: Thirty-five consecutive patients (mean age, 59 y) with cirrhosis and HCC (n = 59) within Milan criteria received RF ablation and subsequently underwent liver transplantation (LT) for tumor progression or liver failure. Data were extracted retrospectively from a prospective database. Thirty nodules were treated with a monopolar device with internally cooled (n = 17) or perfused (n = 13) electrodes, and 29 were treated with a multipolar technique with internally cooled electrodes based on the “no-touch” concept. This consisted of inserting two or three straight electrodes around the nodule to avoid intratumor puncture to the greatest extent possible. Effectiveness of the three devices was compared by histopathologic examination of explants. Fisher exact and χ^2 tests and multivariate logistic regression analysis were performed.

RESULTS: Mean sizes of nodules ablated (25, 22, and 21.6 mm) and median times from ablation to LT (11, 7.5, and 8.4 months) for patients treated with the monopolar internally cooled electrode device (MoICD), monopolar perfused electrode device (MoPED), and multipolar internally cooled electrode device (MulCD), respectively, were similar ($P = .8$ and $P = .9$, respectively). Pathologic examination showed complete necrosis for eight of 17 and six of 13 nodules treated with the MoICD and MoPED, respectively, versus 26 of 29 treated with the MulCD ($P = .0019$). In multivariate analysis, RF technique remained the predictive factor for complete necrosis ($P = .005$).

CONCLUSIONS: Ablation of small HCCs with multipolar RF ablation based on the no-touch concept improves the rate of complete necrosis during pathologic examination compared with monopolar techniques.

2013

Clinical effectiveness of bipolar radiofrequency ablation for small liver cancers

Osaki Y, Ikeda K, Izumi N, Yamashita S, Kumada H, Hatta S, Okita K

Journal of Gastroenterology, July 2013, Volume 48, Issue 7, pp 874-883

BACKGROUND: Radiofrequency ablation (RFA) is minimally invasive and can achieve a high rate of cure of liver cancer. This study was conducted to evaluate the efficacy and safety of a bipolar RFA device (CelonPOWER System) in the treatment of Japanese liver cancer patients.

METHODS: The study was a multicenter, single-group, open-label trial. The indications for RFA were based on the Japanese guidelines for the management of liver cancer. The subjects had a Child-Pugh classification of A or B, and the target tumors were defined as nodular, numbering up to 3 lesions, each of which was 3 cm or less in diameter, or solitary lesions up to 4 cm in diameter. To test for the non-inferiority of the CelonPOWER System, this system was compared with the Cool-tip RF System, which has already been approved in Japan, in terms of the complete necrosis rate (CNR).

RESULTS: The CNR obtained with the CelonPOWER System was 97.8 % (88/90 patients). The CNR obtained with the Cool-tip RF System was 86.2 % (50/58 patients), confirming the non-inferiority of the CelonPOWER System ($p < 0.001$, Fisher's exact test based on binomial distribution). Throughout the treatment and follow-up periods, there were no adverse events regarding safety that were uniquely related to the CelonPOWER System and there were no cases of device failure.

CONCLUSIONS: The CelonPOWER System was confirmed to be an effective and safe RFA device. It could become extensively used as a safe next-generation RFA device, reducing the physical burden on patients.

2012

Bipolar Radio Frequency Ablation of Spinal Neoplasms in Late Stage Cancer Disease - A Report of Three Cases

Gazis A, Beuing O, Jöllenbeck B, Franke J, Skalej M

SPINE Volume 37, Number 1, pp E64–E68, 2012

STUDY DESIGN: Case report.

OBJECTIVE: To avoid neuronal damage by using the bipolar radio frequency ablation of spinal tumors.

SUMMARY OF BACKGROUND DATA: Radio frequency ablation of tumorous masses is an established procedure and is increasingly used as pain therapy of unresectable spine tumors. Ablation of lesions adjacent to vulnerable structures remains a challenging task because flow of current is insufficiently controlled by monopolar probes. Using this technique, a prediction of the induced necrosis accurate to the millimeter is not feasible.

METHODS: Three patients with metastases of the spine were treated using the bipolar radio frequency ablation.

RESULTS: In all 3 cases collateral damage of neuronal structures could be avoided even though tumorous masses touched the cauda equina or were very close to vulnerable structures, respectively. The induction of necrosis was predictable to the millimeter.

CONCLUSION: Ablation of tumorous masses adjacent to neural structures by bipolar technique, is feasible and predictable. Spinal cord damage can be avoided by exact planning of the induced necrosis.

CT-guided Bipolar and Multipolar Radiofrequency Ablation (RF Ablation) of Renal Cell Carcinoma: Specific Technical Aspects and Clinical Results

C. M. Sommer C M, Lemm G, Hohenstein E, Bellemann N, Stampfl U, Goezen A S, Rassweiler J, Kauczor H U, Radeleff B A, Pereira P L

Cardiovasc Intervent Radiol (published online: 28 Aug 2012)

PURPOSE: This study was designed to evaluate the clinical efficacy of CT-guided bipolar and multipolar radiofrequency ablation (RF ablation) of renal cell carcinoma (RCC) and to analyze specific technical aspects between both technologies.

METHODS: We included 22 consecutive patients (3 women; age 74.2 ± 8.6 years) after 28 CT-guided bipolar or multipolar RF ablations of 28 RCCs (diameter 2.5 ± 0.8 cm). Procedures were performed with a commercially available RF system (Celon AG Olympus, Berlin, Germany). Technical aspects of RF ablation procedures (ablation mode [bipolar or multipolar], number of applicators and ablation cycles, overall ablation time and deployed energy, and technical success rate) were analyzed. Clinical results (local recurrence-free survival and local tumor control rate, renal function [glomerular filtration rate (GFR)]) and complication rates were evaluated.

RESULTS: Bipolar RF ablation was performed in 12 procedures and multipolar RF ablation in 16 procedures (2 applicators in 14 procedures and 3 applicators in 2 procedures). One ablation cycle was performed in 15 procedures and two ablation cycles in 13 procedures. Overall ablation time and deployed energy were 35.0 ± 13.6 min and 43.7 ± 17.9 kJ. Technical success rate was 100 %. Major and minor complication rates were 4 and 14 %. At an imaging follow-up of 15.2 ± 8.8 months, local recurrence-free survival was 14.4 ± 8.8 months and local tumor control rate was 93 %. GFR did not deteriorate after RF ablation (50.8 ± 16.6 ml/min/1.73 m² before RF ablation vs. 47.2 ± 11.9 ml/min/1.73 m² after RF ablation; not significant).

CONCLUSIONS: CT-guided bipolar and multipolar RF ablation of RCC has a high rate of clinical success and low complication rates. At short-term follow-up, clinical efficacy is high without deterioration of the renal function.

2011

Efficiency Analysis of Bipolar and Multipolar Radiofrequency Ablation in an In Vivo Porcine Kidney Model Using Three-Dimensional Reconstruction of Histologic Section Series

Neuhaus J, Blachut L, Rabenalt R, Stein T, König F, Wehner M, Liatsikos E, Stolzenburg J

JOURNAL OF ENDOUROLOGY Volume 25, Number 5, May 2011

BACKGROUND AND PURPOSE: Radiofrequency ablation (RFA) was established for minimally invasive treatment of small kidney tumors in multimorbid patients. Bipolar and multipolar RFA may allow the treatment of larger tumors. Safe tumor coagulation depends on total energy supplied and proper electrode placing. To investigate the influence of energy on ablation size and shape in intact kidneys, we used cooled bipolar and multipolar RFA in an in vivo pig model.

MATERIALS AND METHODS: Twenty-five male pigs were treated with percutaneous bipolar (one electrode) or multipolar (two electrodes) RFA with various energy transfer under laparoscopic visual control. The animals were sacrificed 4 to 5 hours after RFA. Volume and shape of the coagulation zone was analyzed by threedimensional reconstruction of hematoxylin and eosin and diaminobenzidine stained paraffin serial sections. Heat-induced cellular activation was addressed by immunohistologic detection of apoptosis marker proteins heat shock protein 70 (Hsp70) and caspase-3 (Casp3).

RESULTS: Multipolar RFA led to significant larger tissue ablation than bipolar RFA. Increasing energy, however, did not result in significant enlargement of the coagulation volume. Shape control was better in bipolar RFA. Hsp70 and activated Casp3 immunoreactivity were increased close to the central coagulation zone and occasionally in the caliceal system.

CONCLUSIONS: RFA causes minimal tissue damage beyond the primary coagulation zone, indicating that RFA is a safe, minimally invasive method for treatment of renal tumors. The ablation of larger volumes necessitates further improvement of multipolar RFA. These findings may be of general interest, because treatment failure correlates with mass size in monopolar RFA and cryoablative techniques as well.

2010

The efficacy of bipolar and multipolar radiofrequency ablation of lung neoplasms — results of an ablate and resect study

Schneider T, Reuss D, Warth A, Schnabel P, von Deimling A, Herth F, Dienemann H, Hoffmann H

European Journal of Cardio-thoracic Surgery 2011 Jun;39(6):968-73. Epub 2010 Oct 18

OBJECTIVE: Radiofrequency ablation (RFA) has obtained increasing attention as an interventional approach for the local treatment of primary and secondary lung neoplasms. The local effect of the procedure is usually controlled by radiologic means. The objectives of this 'ablate and resect' study were to investigate the efficacy of bipolar and multipolar RFA by histologic evaluation and to compare the two techniques.

METHODS: In a total of 32 subjects with histologically proven non-small-cell lung cancer or pulmonary metastases from an extrathoracic primary tumor, bipolar, or multipolar RFA was performed during open thoracotomy. Curative resection (lobectomy or wedge resection including mediastinal lymph node dissection) was performed subsequently. The extent of cell death and early histologic findings following RFA were determined by histology and immunohistochemistry (nicotinamide adenine dinucleotide (NADH) and monoclonal anti-mitochondrial antibodies MAB 1273).

RESULTS: Intra-operative bipolar and multipolar RFA is a safe procedure, and there was no bleeding or thermal damage of the lung tissue. Routine histologic staining could not identify tumor cell death. However, immunohistochemistry was able to verify cell death in the ablated tumor tissue. Complete tumor cell necrosis was determined in 12 tumors (37.5%); and scattered vital tumor tissue was detected in 16 tumors (50%). Incomplete ablation with a ratio of >20% vital tumor tissue was found in four tumors (12.5%), particularly surrounding vascular structures within the tumor tissue or in marginal zones of the tumor tissue. The local efficacy of bipolar and multipolar RFA was comparable, and incomplete ablations were found only in adenocarcinoma.

CONCLUSIONS: Bipolar and multipolar RFA in an open thoracotomy setting is a technically feasible and safe procedure. Early immunohistochemical findings after RFA showed complete tumor cell necrosis in 38% of cases. The high rate of viable tumor cells remaining after ablation casts doubt on RFA as a curative concept. This approach should be reserved for palliative indications. Patients fulfilling the criteria for curative resection should not be denied surgery.

2009

Intraoperative Radiofrequency Ablation of Lung Metastases and Histologic Evaluation

Schneider T, Warth A, Herpel E, Schnabel P, von Deimling A, Eberhardt R, Herth F, Dienemann H, Hoffmann H

Ann Thorac Surg 2009;87:379–84

BACKGROUND: Radiofrequency ablation (RFA) has received high interest in the treatment of primary and secondary lung neoplasms. Clinical experience continues to accumulate; however, the biologic effects after ablation remain poorly understood. This study evaluated the safety and feasibility of RFA in an open thoracotomy setting and investigated the early histopathologic changes after RFA.

METHODS: The study enrolled 18 subjects with multiple pulmonary metastases from a solid primary tumor. RFA was performed at an open thoracotomy setting, followed by wedge resection of the ablated tumor.

RESULTS: No intraoperative complications during the RFA procedure occurred. Immunostaining revealed a complete ablation in 7 patients (39%). The grade of ablation was greater than 90% in 9 patients (50%), and less than 90% in 2 (11%). No correlation was found between the grade of ablation and the applied energy and the diameter of the lesion.

CONCLUSIONS: Intraoperative RFA in an open thoracotomy setting appears to be a safe and feasible technique. Tumor devitalization sufficient for local control was achieved in 89% in our series. Ablation was incomplete in 11%, subject to the methods used in this study. This result appears to be inferior to metastasectomy by surgical resection.

Ex Vivo Evaluation of a Bipolar Application Concept for Radiofrequency Ablation

Zurbuchen U, Frericks B, Roggan A, Lehmann K, Bössenroth D, Buhr H, Ritz J

ANTICANCER RESEARCH 29: 1309-1314 (2009)

BACKGROUND: Bipolar radiofrequency ablation (RFA) can avoid complications such as thermal tissue damage, a possible consequence of monopolar RFA. However, basic studies about the dosage/effect relationship of bipolar systems are missing. This is systematic research on ex vivo beef livers to find which capacity parameters produce high energy in the tissue and achieve large lesion volumes.

MATERIALS AND METHODS: The active lengths 20, 30 and 40 mm of a bipolar, internally cooled applicator were studied. The tissue was fresh ex vivo beef liver. Five measurements each for each active applicator with a power between 10 and 50 W were conducted.

RESULTS: The best power for the 20 mm applicator was 15 W, since the highest achieved volume was $5,599 \pm 1,760 \text{ mm}^3$ and the highest amount of energy introduced to the tissue was $15 \pm 3 \text{ kJ}$. The best power for the 30 mm applicator was 20 W (volume $14,538 \pm 1,220 \text{ mm}^3$, energy $24 \pm 1 \text{ kJ}$). For the 40 mm applicator, the best power was 20 W, (volume $20,562 \pm 896 \text{ mm}^3$, energy $24 \pm 0 \text{ kJ}$).

CONCLUSION: The results of this study help clinicians determine which active length is required for the applicator and which presetting should be selected to achieve a defined coagulation volume size.

2008

Multipolar Hepatic Radiofrequency Ablation Using up to Six Applicators: Preliminary Results

Bruners P, Schmitz-Rohde T, Günther R W, Mahnken A

Fortschr Roentgenstr 2008, 180: 216-222

PURPOSE: To evaluate the clinical feasibility and safety of hepatic radiofrequency (RF) ablation using a multipolar RF system permitting the simultaneous use of up to six electrodes.

MATERIALS AND METHODS: Ten patients (3 female, 7 male, mean age 61) suffering from 29 hepatic metastases (range: 1 - 5) of different tumors were treated with a modified multipolar RF system (CelonLab Power, Celon Medical Instruments, Teltow, Germany) operating four to six needle-shaped internally cooled RF applicators. The procedure duration, applied energy and generator output were recorded during the intervention. The treatment result and procedure-related complications were analyzed. The achieved coagulation volume was calculated on the basis of contrast-enhanced CT scans 24 hours after RF ablation.

RESULTS: Complete tumor ablation was achieved in all cases as determined by the post-interventional lack of contrast enhancement in the target region using four applicators in five patients, five applicators in one patient and six applicators in four patients. A mean energy deposition of 353.9 +/- 176.2 kJ resulted in a mean coagulation volume of 115.9 +/- 79.5 cm (3). The mean procedure duration was 74.9 +/- 21.2 minutes. Four patients showed an intraabdominal hemorrhage which necessitated further interventional treatment (embolization; percutaneous histoacryl injection) in two patients.

CONCLUSION: Multipolar RF ablation of hepatic metastasis with up to six applicators was clinically feasible. In our patient population it was associated with an increased risk of intraabdominal bleeding probably due to the multiple punctures associated with the use of multiple applicators.

Wide-bore 1.5 Tesla MR imagers for guidance and monitoring of radiofrequency ablation of renal cell carcinoma: initial experience on feasibility

Boss A, Rempp H, Martirosian P, Clasen S, Schraml C, Stenzl A, Claussen C D, Schick F, Pereira P L

Eur Radiol, Vol 18, No 7, Jul 2008: 1449-1455

This study was conducted to test and demonstrate the feasibility of magnetic resonance (MR)-guided radiofrequency (RF) ablation of renal cell carcinoma (RCC) using a 1.5 T whole-body scanner equipped with a wide-bore superconductive magnet. Two patients with contrast-enhancing renal masses were treated with multipolar RF ablation (Celon ProSurge). Applicator navigation and near realtime ablation monitoring were performed in a wide-bore 1.5 T scanner using adapted fluoroscopic and diagnostic sequences. In addition to T2-weighted imaging for ablation monitoring, perfusion-weighted images acquired with an arterial spinlabeling technique (FAIR-TrueFISP) were applied. Results were compared to a previous study on 12 patients performed at 0.2 T. Navigation and monitoring of RF ablation using the wide-bore system operating at 1.5 T were clearly improved compared to former experiences on a 0.2 T MR unit. Fluoroscopic and diagnostic images for MR guidance could be acquired with distinctly higher image quality and shorter acquisition time resulting in higher accuracy of applicator placement and shorter treatment time. Spin-labeling perfusion imaging exhibited good image quality, potentially providing additional clinically important information. MR-guided RF ablation of RCC can safely be performed in a 1.5 T wide-bore scanner offering higher image quality, shorter acquisition time, and new monitoring modalities not feasible at 0.2 T.

Fluid-Modulated Bipolar Radiofrequency Ablation: An Ex-Vivo Evaluation Study

Bruners P, Mueller H, Guenther W, Schmitz-Rode T, Mahnken A H

Acta Radiol 2008 (3): 258-266

BACKGROUND: The effect of radiofrequency ablation (RFA) can be modulated by fluid injection.

PURPOSE: To evaluate the potential of different fluids to modulate the effect of bipolar RFA in an ex-vivo liver model.

MATERIAL AND METHODS: A bipolar RFA system with an internally cooled needle-shaped applicator (20-mm active tip) was used to induce coagulation lesions in ex-vivo porcine liver. Prior to the ablation procedure, 1-ml samples of seven different fluids were injected (0.9% saline, gadopentetate dimeglumine, ioxithalamate, 10% hydroxyethyl starch, 5% glucose, 95% ethanol, distilled water). Each fluid was used for five RF ablations. During the procedure, applied energy, impedance, and time were recorded. Additionally, temperature was measured at a fixed distance of 0.5 and 1.0 cm from the RF probe. Generator output was set to 20 W, as recommended by the vendor. Five ablation procedures without fluid injection served as the reference standard. The lesion diameters were measured, and volume and an efficiency index (coagulation volume/procedure duration) calculated and compared (ANOVA, Student-Newman-Keuls test).

RESULTS: In comparison to the reference standard, fluid injection resulted in an enlargement of mean coagulation volume for all fluids. In comparison to RF ablation alone ($1.42 \pm 0.33 \text{ cm}^3$), significant increase ($P < 0.001$) of lesion size was found using gadopentetate dimeglumine, hydroxyethyl starch, glucose, and ethanol. The largest lesions were generated using preinjection of hydroxyethyl starch. Most energy could be applied after injection of glucose. Comparing the efficiency index, no statistically significant differences were found.

CONCLUSION: Besides the modulation of the electrical conductivity, the increase in thermal conductivity also contributes to the enhancement of RFA by the injection of the tested fluids. Further studies are needed to evaluate this effect for larger injection volumes under in-vivo conditions.

Large (≥ 5.0 cm) HCCs: Multipolar RF Ablation with Three Internally Cooled Bipolar Electrodes — Initial Experience in 26 Patients

Seror O, Kontchou G, Ibraheem M, Ajavon Y, Barrucand C, Ganne N, Coderc E, Trinchet J C, Beaugrand M, Sellier N

Radiology, Vol 248, No 1, July 2008

PURPOSE: To prospectively evaluate the safety and effectiveness of percutaneous multipolar radiofrequency (RF) ablation for the treatment of large (≥ 5.0 cm in diameter) hepatocellular carcinomas (HCCs).

MATERIALS AND METHODS: Twenty-six patients (four women, 22 men; median age, 72 years) with cirrhosis (Child-Pugh class A disease, 22 patients; Child-Pugh class B disease, four patients) and at least one 5.0–9.0-cm-diameter HCC without invasion of the portal trunk or main portal branches were treated with multipolar RF ablation performed by a single operator. The procedure was performed with three separate bipolar linear internally cooled electrodes with ultrasonographic guidance. Twenty-seven of the 33 tumors treated had a diameter of 5.0 cm or greater (median diameter, 5.7 cm; range, 5.0–8.5 cm); 12 of these 27 tumors were infiltrative, and four invaded segmental portal vein branches. Ten patients had a serum α -fetoprotein level higher than 400 $\mu\text{g/L}$. Results were assessed by using computed tomography. Primary effectiveness, complications, tumor progression, and survival rates were recorded. Probabilities of survival were calculated by using the Kaplan-Meier method.

RESULTS: One to two RF ablation procedures per patient (mean, 1.15 ± 0.43 [standard deviation]) led to the complete ablation of 22 (81%) of the 27 tumors (18 tumors after one and four tumors after two procedures), including three tumors that showed segmental portal vein invasion. All patients experienced postablation syndrome, and one experienced subcapsular hematoma and a segmental liver infarct, but no major complication occurred. After a mean follow-up of 14 months (range, 3–34 months), local and distant tumor progression and actual survival rates were 14% (three of 22), 24% (five of 21), and 65% (17 of 26), respectively. The probabilities of 1- and 2-year survival, respectively, were 68% (95% confidence interval: 49%, 86%) and 56% (95% confidence interval: 51%, 81%).

CONCLUSION: HCCs larger than 5.0 cm (but smaller than 9.0 cm)—even those that are infiltrative and those that involve a segmental portal vein—can be completely and safely ablated with multipolar RF ablation.

Radiofrequency Ablation with Internally Cooled versus Perfused Electrodes for the Treatment of Small Hepatocellular Carcinoma in Patients with Cirrhosis.

Seror O, N'kontchou G, Tin-Tin-Htar M, Barrucand C, Ganne N, Coderc E, Trinchet JC, Sellier N, Beaugrand M.

J Vasc Interv Radiol. 2008 May;19(5):718-724.

PURPOSE: To compare the results of radiofrequency (RF) ablation with internally cooled electrodes (ICEs) versus perfused electrodes (PEs) in patients with cirrhosis with small (≤ 3 cm) hepatocellular carcinoma ineligible for resection.

MATERIALS AND METHODS: Patients treated with RF ablation over two consecutive periods were analyzed retrospectively. From 2000 to 2002, 45 patients were treated with 17-gauge ICEs, and from 2002 to 2004, 44 patients were treated with 15-gauge PEs. The two groups were similar in age, sex, Child-Pugh stage, serum α -fetoprotein (AFP) level, and size and number of tumors (54 tumors in each group). Results were assessed by contrast medium-enhanced CT.

RESULTS: In both groups, 52 of 54 tumors (96.3%) were completely ablated. Eight of 54 tumors (14.8%) treated with ICEs and 39 of 54 tumors (72.2%) treated with PEs required multiple RF applications ($P < .00005$). In the respective groups, one of 54 tumors (1.8%) and seven of 54 tumors (12.9%) required multiple RF sessions ($P = .03$). Complication rates were similar. The 2-year probabilities of local and distant (ie, separated from the ablation zone) tumor progression in the ICE and PE groups were 11% and 15%, respectively ($P = .65$), and 31% and 64% ($P = .01$), respectively. On multivariate analysis, serum AFP level greater than 100 ng/mL ($P = .006$) and the use of a PE ($P = .003$) were risk factors for distant tumor progression.

CONCLUSIONS: RF ablation with the use of a PE requires more applications and sessions and is associated with a higher risk of distant tumor progression compared with the use of an ICE.

2007

Bipolar Radiofrequency Ablation Using Internally Cooled Electrodes in Ex Vivo Bovine Liver (Prediction of Coagulation Volume From Applied Energy)

Clasen S, Schmidt D, Dietz K, Boss A, Kröber SM, Schraml C, Fritz J, Claussen CD, Pereira PL

Investigative Radiology, Vol. 42, No. 1, Jan 2007, 29-36

OBJECTIVE: We sought to evaluate the relationship between parameters of bipolar radiofrequency (RF) ablation using internally cooled electrodes.

MATERIALS AND METHODS: Bipolar RF ablations ($n = 24$) were performed in ex vivo bovine liver using an internally cooled applicator with 2 electrodes located on the same shaft. The power-output was systematically varied (20–75 W). On the basis of our experimental data, mathematical functions were fitted and the goodness of-fit was assessed by the parameter R^2 .

RESULTS: The duration to induce an increase of tissue resistance and the amount of applied energy increased with a decreased poweroutput. The maximum short-axis was 4.5 cm (20 W) and required an application of 64 kilojoules (kJ). The volume of coagulation can be determined as a function of the duration of energy application ($R^2 = 0.954$) and the amount of applied energy ($R^2 = 0.945$).

CONCLUSION: The amount of applied energy and the duration of energy application can predict the volume of induced coagulation and may be useful to control internally cooled bipolar RF ablation.

Image-guided multipolar radiofrequency ablation of liver tumours: initial clinical results

Terraz S, Constantin C, Majno PE, Spahr L, Mentha G, Becker CD

Eur Radiol (2007) 17: 2253-2261

The local effectiveness and clinical usefulness of multipolar radiofrequency (RF) ablation of liver tumours was evaluated. Sixty-eight image-guided RF sessions were performed using a multipolar device with bipolar electrodes in 53 patients. There were 45 hepatocellular carcinomas (HCC) and 42 metastases with a diameter ≤ 3 cm (n=55), 3.1–5 cm (n=29) and >5 cm (n=3); 26 nodules were within 5 mm from large vessels. Local effectiveness and complications were evaluated after RF procedures. Mean follow-up was 17 ± 10 months. Recurrence and survival rates were analysed by the Kaplan-Meier method. The primary and secondary technical effectiveness rate was 82% and 95%, respectively. The major and minor complication rate was 2.9%, respectively. The local tumour progression at 1- and 2-years was 5% and 9% for HCC nodules and 17% and 31% for metastases, respectively; four of 26 nodules (15%) close to vessels showed local progression. The survival at 1 year and 2 years was 97% and 90% for HCC and 84% and 68% for metastases, respectively. Multipolar RF technique creates ablation zones of adequate size and tailored shape and is effective to treat most liver tumours, including those close to major hepatic vessels.

Internally Cooled Bipolar Radiofrequency Ablation: Is a Lower Power Output More Effective?

Clasen S, Geng A, Herberts T, Boss A, Schmidt D, Schraml C, Fritz J, Kröber SM, Claussen CD, Pereira PL

Fortschr Roentgenstr 2007, 179: 282-288

[German language]

PURPOSE: Evaluation of bipolar radiofrequency (RF) ablation using internally cooled electrodes in an ex-vivo experiment.

MATERIALS AND METHODS: Bipolar RF ablations (n = 154) were performed in ex-vivo bovine liver. Both electrodes with a total length of the active tip of 4 cm were located on the same shaft of an internally cooled applicator. The power output was systematically varied between 20 and 100 watts (W). The energy application was continuous or modulated depending on the tissue resistance. In relationship to the maximum power output, the volume of coagulation was assessed.

RESULTS: In continuous energy application the induced volume of coagulation was increased at lower power outputs up to 33.7 cm³ (20 watts). Parallel to an increased volume of coagulation, the required duration of energy application was increased up to a maximum of 51.6 minutes. Modulation of the power output as a function of the tissue resistance enabled application of a wide range of power outputs (40–75watts) leading to a comparable extent of coagulation with a maximum of 14.9 cm³ (10min.), 16.8 cm³ (15min.), and 19.1 cm³ (20 min.).

CONCLUSION: Continuous application of RF energy leads to an inverse relationship between volume of coagulation and power output. Modulation of the power output as a function of the tissue resistance enables application of a wider range of power outputs compared to continuous application of RF energy.

In Vivo Efficiency of Multipolar Radiofrequency Ablation with Two Bipolar Electrodes: A Comparative Experimental Study in Pig Kidney

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J Vasc Interv Radiol 2007; 18:1553–1560

PURPOSE: To compare in vivo efficacy of multipolar radiofrequency (RF) ablation with two internally cooled electrodes to that of monopolar RF ablation with internally cooled single and cluster needles to induce coagulation in in vivo porcine kidneys.

MATERIALS AND METHODS: Twenty-four coagulations were created in the kidneys of 12 pigs by means of laparotomy by using a monopolar or multipolar RF system. In the monopolar mode, RF was applied to a single internally cooled probe (group A) or to a cluster probe (group B) for 12 minutes. In the multipolar mode, RF was applied to two bipolar probes with 2-cm interprobe spacing up to 50 kJ (group C). Technical parameters and the dimensions, shapes, and coefficients of variation of the coagulations were compared among the three groups.

RESULTS: The minimum transverse diameters of the RF-induced coagulations in groups B ($3.5 \text{ cm} \pm 0.5$) and C ($3.8 \text{ cm} \pm 0.6$) were significantly larger than that in group A ($2.6 \text{ cm} \pm 0.3$). The mean coagulation volumes produced in the multipolar group ($25.1 \text{ cm}^3 \pm 5.2$) were greater than those produced in the monopolar groups ($11.6 \text{ cm}^3 \pm 3.7$ and $18.1 \text{ cm}^3 \pm 5.8$) ($P < .05$). The mean ratio of transverse diameter to vertical diameter of the coagulations was larger in groups B and C (1.2 ± 0.2 and 1.0 ± 0.1 , respectively) than in group A (0.8 ± 0.2) ($P < .05$). In addition, the coefficients of variation for groups A, B, and C were 0.33, 0.30, and 0.21, respectively. The procedure time was longer with the multipolar technique ($27.2 \text{ minutes} \pm 4.9$) than with the monopolar technique with a single or cluster probe (12 minutes).

CONCLUSIONS: Multipolar RF ablation showed at least equivalent or better in vivo efficiency for creating a larger coagulation than monopolar RF ablation with single or cluster electrodes, but with a longer procedure time and at slightly greater complexity.

Radiofréquence bipolaire et cimentoplastie dans le traitement des métastases osseuses

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J Radiol 2007;88:1242-7 (Éditions Françaises de Radiologie)

[French language]

Combined bipolar radiofrequency and cementoplasty of bone metastases

Bone metastases are the most common cause of pain in cancer patients. Pain management in cancer patients, often revealing the disease and always present at advanced stages, is an important and difficult task. Pain is not always properly controlled by high doses of specific medication, radiation therapy or chemotherapy. When these therapies do not provide adequate pain relief, percutaneous neurolysis, infiltrations, alcoholizations and cementoplasty may be considered. More recently RF ablation has been proposed. On weight-bearing bones, RF can be combined with acrylic cement injection. The authors present here this very effective new technique which is complementary to classical pain management techniques.

Nouvelles techniques interventionnelles radiologiques dans le traitement des douleurs d'origine cancéreuse : infiltration, alcoolisation, vertébroplastie, cimentoplastie, radiofréquence bipolaire Algoradiologie interventionnelle de la douleur cancéreuse

B Kastler, F-G Barral, P Sarlieve, S Aubry, M Jacamon, G Hadjidekov, J-M Lerais, Z Boulahdour, N Saille, L Laborie, G Cadel, J Puget, R Kovacs, D Michalakis, H Haj Hussein, J-F Litzler, P Manzoni, M De Billy, F Tiberghien, M Braun, A Blum, H Boulahdour, R Aubry, B Fergane

Doul. et Analg. (2007) Numéro 1: 1–16

[French language]

New interventional and metabolic techniques in the management of cancer pain: neurolysis, infiltration, alcoholization, percutaneous vertebroplasty, cementoplasty, and radiofrequency ablation. Interventional radiology in cancer pain management. Abstract: Bone invasion by metastatic tumours is the most common cause of pain in cancer patients. The management of cancer pain, pain that often reveals the disease and is always present at advanced stages, is an important and difficult task. High doses of specific medications, chemotherapy and radiation therapy do not always succeed in effectively controlling pain. When these treatments do not provide adequate relief, neurolysis, infiltration, alcoholization, percutaneous vertebroplasty, cementoplasty, and radiofrequency ablation are elegant and efficient complementary alternative pain management methods. The authors helped to develop these new techniques, which rely on CT guidance, and offer their expertise in how to apply them.

2006

Bipolar radiofrequency ablation of liver metastases during laparotomy. First clinical experiences with a new multipolar ablation concept

Ritz JP, Lehmann KS, Reissfelder C, Albrecht T, Frericks B, Zurbuchen U, Buhr HJ

International Journal of Colorectal Disease, Vol 21, No 1 / Jan 2006: 25-32

BACKGROUND AND OBJECTIVE: Radiofrequency ablation (RFA) is a promising method for local treatment of liver malignancies. Currently available systems for radiofrequency ablation use monopolar current, which carries the risk of uncontrolled electrical current paths, collateral damages and limited effectiveness. To overcome this problem, we used a newly developed internally cooled bipolar application system in patients with irresectable liver metastases undergoing laparotomy. The aim of this study was to clinically evaluate the safety, feasibility and effectiveness of this new system with a novel multipolar application concept.

PATIENTS AND METHODS: Patients with a maximum of five liver metastases having a maximum diameter of 5 cm underwent laparotomy and abdominal exploration to control resectability. In cases of irresectability, RFA with the newly developed bipolar application system was performed. Treatment was carried out under ultrasound guidance. Depending on tumour size, shape and location, up to three applicators were simultaneously inserted in or closely around the tumour, never exceeding a maximum probe distance of 3 cm. In the multipolar ablation concept, the current runs alternating between all possible pairs of consecutively activated electrodes with up to 15 possible electrode combinations. Post-operative follow-up was evaluated by CT or MRI controls 24–48 h after RFA and every 3 months.

RESULTS: In a total of six patients (four male, two female; 61–68 years), ten metastases (1.0–5.5 cm) were treated with a total of 14 RF applications. In four metastases three probes were used, and in another four and two metastases, two and one probes were used, respectively. During a mean ablation time of 18.8 min (10–31), a mean energy of 48.8 kJ (12–116) for each metastases was applied. No procedure-related complications occurred. The patients were released from the hospital between 7 and 12 days post-intervention (median 9 days). The post-interventional control showed complete tumour ablation in all cases.

CONCLUSIONS: Bipolar radiofrequency using the novel multipolar ablation concept permits a safe and effective therapy for the induction of large volumes of coagulation in the local treatment of liver metastases.

Multipolar radiofrequency ablation of large hepatic metastases of endocrine tumors

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Eur J Gastroenterol Hepatol 2006, 18: 89–92

Radiofrequency ablation (RFA) is a reliable method of creating thermally induced coagulation necrosis. Local recurrence after RFA of hepatic metastases is directly dependent on tumour size related to the free margin of ablation. To produce larger coagulation volumes a bipolar radiofrequency device was developed that allows the simultaneous activation of three active needles. This technique was used at laparotomy in a patient with liver metastases of an endocrine tumour. Coagulation size up to 12cm in diameter could be created. The postoperative recovery of the patient was uncomplicated. No local recurrence was seen after 13 months of follow-up with computed tomography scan. The use of simultaneously operated multiple radiofrequency electrodes in a multipolar mode expands the treatment options for patients with large and unresectable intrahepatic metastases.

Bipolar and multipolar radiofrequency ablation with resistance-controlled power output: Standardized ex-vivo kidney tissue evaluation

Haecker A, Vallo S, Weiss C, Grobholz R, Stein T, Knoll T, Michel MS

Journal of Urology, Vol. 175, 1122-1126, March 2006

PURPOSE: We investigated a newly developed bipolar and multipolar RF ablation system with an internally cooled electrode and resistance controlled power output in a standardized model of perfused ex vivo kidney tissue.

MATERIALS AND METHODS: RF energy was applied at different power levels (20, 30 and 60 W) for 1, 3, 5 and 9 minutes. Each treatment parameter was repeated 5 times. For the 20/30 W levels a bipolar electrode with an active conducting part of 20/30 mm was selected. At 60 W 2 bipolar electrodes with an active conducting part (30 mm each) were connected. Lesion volumes and shapes were calculated by measuring the maximum vertical, long axis and short axis diameters of the macroscopic lesion.

RESULTS: Lesion volume increased significantly with the treatment time and generator power applied ($p < 0.0001$). Lesion size in multipolar ablated zones was larger than that in bipolar ablated zones. A reliable dose-effect relationship existed between the generator power/applied treatment time and ablated tissue lesion size. All lesions were elliptical.

CONCLUSIONS: Bipolar and multipolar RF ablation with an internally cooled electrode and tissue resistance control represent an interesting advance in RF technology. The development of lesion size and volume is predictable, while a uniform lesion shape can be achieved in perfused ex vivo kidney tissue. Further in vivo trials are required to test whether complete and reliable tumor tissue ablation is possible with this system.

Technical characterization of a new bipolar and multipolar radiofrequency device for minimally invasive treatment of renal tumors

Haecker A, Vallo S, Weiss C, Stein T, Alken P, Knoll T, Michel MS

British Journal of Urology, Vol. 97, 822-828, 2006

OBJECTIVE: To investigate the technical characteristics of a newly developed device for bipolar and multipolar radiofrequency ablation (RFA) of kidney tissue with a resistance-controlled power output.

MATERIALS AND METHODS: The standardized model of the isolated perfused ex vivo porcine kidney was used. Two different applicators (20 and 30 mm active length) were selected for bipolar RFA, and one pair of applicators (2 x 30 mm active length) for multipolar RFA. RF energy was applied at different power levels (20, 30, 60 W) depending on the total active length of the electrodes. Treatment times were 1, 3, 5 and 9 min. The ablation cycles were recorded in continuous digital real-time and displayed on a monitor showing pre-set power, actual applied power, applied energy, tissue resistance, and impedance. Lesion sizes were measured macroscopically. A coagulation coefficient (coagulated tissue volume per applied energy unit) was calculated.

RESULTS: There was a dosage-effect relationship between the generator power/treatment time and the sizes of the lesions. With increasing treatment time, less tissue volume was coagulated per unit of applied energy. The actual applied energy was lower than that calculated theoretically. The resistance and impedance values for the 30-W applicator were lower than those of the 20-W applicator.

CONCLUSIONS: The technical features of this RFA device, with internally cooled bipolar and multipolar applicators and a resistance-controlled power output, represents an innovative improvement in RF technology. In vivo studies are needed to confirm the expected advantages and the suitability of this device for complete and reliable ablation of renal tumours.

Multipolar radiofrequency ablation with internally cooled electrodes: experimental study in ex-vivo bovine liver with mathematical modeling

Clasen S, Schmidt D, Boss A, Dietz K, Kröber S, Claussen C, Pereira P

Radiology 2006, 238(3):881-890

PURPOSE: To evaluate the size and geometry of thermally induced coagulation by using multipolar radiofrequency (RF) ablation and to determine a mathematic model to predict coagulation volume.

MATERIALS AND METHODS: Multipolar RF ablations ($n = 80$) were performed in ex vivo bovine livers by using three internally cooled bipolar applicators with two electrodes on the same shaft. Applicators were placed in a triangular array (spacing, 2–5 cm) and were activated in multipolar mode (power output, 75–225 W). The size and geometry of the coagulation zone, together with ablation time, were assessed. Mathematic functions were fitted, and the goodness of fit was assessed by using r^2 .

RESULTS: Coagulation volume, short-axis diameter, and ablation time were dependent on power output and applicator distance. The maximum zone of coagulation (volume, 324 cm³; short-axis diameter, 8.4 cm; ablation time, 193 min) was induced with a power output of 75 W at an applicator distance of 5 cm. Coagulation volume and ablation time decreased as power output increased. Power outputs of 100–125 W at applicator distances of 2–4 cm led to a reasonable compromise between coagulation volume and ablation time. At 2 cm (100 W), coagulation volume, short-axis diameter, and ablation time were 66 cm³, 4.5 cm, and 19 min, respectively; at 3 cm (100 W), 90 cm³, 5.2 cm, and 22 min, respectively; at 4 cm (100 W), 132 cm³, 6.1 cm, and 27 min, respectively; at 2 cm (125 W), 56 cm³, 4.2 cm, and 9 min, respectively; at 3 cm (125 W), 73 cm³, 4.9 cm, and 12 min, respectively; and at 4 cm (125 W), 103 cm³, 5.5 cm, and 16 min, respectively. At applicator distances of 4 cm (>125 W) and 5 cm (>100 W), the zones of coagulation were not confluent. Coagulation volume ($r^2 = 0.80$) and RF ablation time ($r^2 = 0.93$) were determined by using the mathematic model.

CONCLUSION: Multipolar RF ablation with three bipolar applicators may produce large volumes of confluent coagulation ex vivo. A compromise is necessary between prolonged RF ablations at lower power outputs, which produce larger volumes of coagulation, and faster RF ablations at higher power outputs, which produce smaller volumes of coagulation.

Radiofrequency Ablation of Osteoid Osteoma: Initial Results with a Bipolar Ablation Device

Mahnken A, Tacke JA, Wildberger J, Günther RW

Journal of Vascular and Interventional Radiology (2006), 1465-1470

PURPOSE: To report the initial results with percutaneous radiofrequency (RF) ablation of osteoid osteomas with a bipolar ablation device.

MATERIALS AND METHODS: Twelve patients (seven male patients and five female patients; mean age, 17.3 years; age range, 6–36 y) with clinically and radiologically suspected osteoid osteoma were treated with computed tomography–guided percutaneous bipolar RF ablation. The procedure was performed with the patients under general anesthesia. After localization of the nidus, an 11-gauge hollow drill was introduced into the nidus through a 9-F introducer sheath. A bipolar 18-gauge RF probe with a 9-mm active tip was inserted through the introducer sheath and connected to the RF generator. Energy application was started at 2 W and subsequently increased to a maximum of 5 W. The procedure was terminated if a resistance of 900 Ω was reached.

RESULTS: Mean duration of energy deposition was 8.3 ± 4.0 minutes, with a mean energy application of 1.8 ± 2.9 kJ (range, 0.3–7 kJ). In one patient, the intervention had to be repeated twice to achieve total pain relief. Eleven of 12 patients (92%) remained free of symptoms at a follow-up time of 15.1 ± 9.5 months (range, 5–31 months). One patient had recurrence of pain 16 months after the procedure and was treated surgically. No complications occurred. Patients resumed normal activity within 24 hours.

CONCLUSIONS: Percutaneous bipolar RF ablation is an efficient and safe treatment of osteoid osteoma. Short-term efficacy of bipolar RF ablation may rival the results of monopolar RF ablation. Further studies are needed to address the long-term efficacy of this technique

Magnetic Resonance Imaging for Assessment of Radiofrequency Lesions in Kidney Tissue Immediately after Ablation: An Experimental Study

Haecker A, Risse F, Peters K, Fink C., Weiss C, Huber P E, Alken P, Michel M S, Jenne J W

Journal of Endourology, Vol 20, No 5, May 2006: 312-317

BACKGROUND AND PURPOSE: Radiofrequency ablation (RFA) is an attractive minimally invasive treatment option for small renal masses. The purpose of this study was to investigate the morphologic imaging appearance of RF lesions immediately after the ablation of kidney tissue using standard clinical MR sequences, as well as to investigate the correlation between MR and gross lesion size.

MATERIALS AND METHODS: Ablations were performed 17 times in a standardized model of ex-vivo perfused porcine kidneys using a resistance-controlled RF device (250 W, 470 kHz) and a nonexpandable bipolar applicator inserted into the center of healthy renal parenchyma. The RF current was applied for 9 minutes at 20 W. Imaging was performed after ablation using standard clinical MR sequences: morphologic T1/T2-weighted images and an isotropic post-contrast T1 high-resolution measurement (VIBE). Maximum lesion diameters were measured in three directions and were compared with the measurements of the gross lesions. Histologic (hematoxylin - eosin and nicotinamide adenine dinucleotide staining) and statistical analyses were performed.

RESULTS: The gross pathologic examination showed a firm, white-yellow ablation zone sharply demarcated from the untreated tissue. The histologic examination confirmed cellular viability outside but not in the treatment zone. The RF lesions were hyperintense on T1-weighted images and hypointense on T2-weighted images. The lesion size measured in the VIBE images correlated best with the macroscopic lesion size (N = 16).

CONCLUSIONS: Morphologic MR T1 and T2 sequences of RF lesions immediately after ablation produce reliable and consistent imaging characteristics. The post-contrast, high-resolution sequence (VIBE) enables the extent of the lesion to be determined accurately. The potential uses of this imaging strategy in clinical practise warrant further investigation on human renal-cell carcinoma.

Hepatic Radiofrequency Ablation Using Multiple Probes: Ex Vivo and In Vivo Comparative Studies of Monopolar versus Multipolar Modes

Lee JM, Han JK, Lee JY, Kim SH, Choi JY, Lee MW, Choi SH, Eo H, Choi BI

Korean J Radiol 2006;7:106-117

OBJECTIVE: We wanted to compare the efficiency of multipolar radiofrequency ablation (RFA) using three perfused-cooled electrodes with multiple overlapping and simultaneous monopolar techniques for creating an ablation zone in ex vivo bovine livers and in in vivo porcine livers.

MATERIALS AND METHODS: In the ex vivo experiments, we used a 200 W generator (Valleylab, CC-3 model) and three perfused-cooled electrodes or internally cooled electrodes to create 30 coagulation zones by performing consecutive monopolar RFA (group A, n = 10), simultaneous monopolar RFA (group B, n = 10) or multipolar RFA (group C, n = 10) in explanted bovine livers. In the consecutive mode, three ablation spheres were created by sequentially applying 150 watts radiofrequency (RF) energy to the internally cooled electrodes for 12 minutes each for a total of 36 minutes. In the simultaneous monopolar and multipolar modes, RF energy was concurrently applied to the three perfused-cooled electrodes for 20 minutes at 150 watt with instillation of 6% hypertonic saline at 2 mL/min. During RFA, we measured the temperatures of the treated area at its center. The changes in impedance, the current and liver temperature during RFA, as well as the dimensions of the thermal ablation zones, were compared among the three groups. In the in vivo experiments, three coagulations were created by performing multipolar RFA in a pig via laparotomy with using same parameter as the ex vivo study.

RESULTS: In the ex vivo experiments, the impedance was gradually decreased during the RFA in groups B and C, but in group A, the impedance was increased during RFA and this induced activation by the pulsed RF technique. In groups A, B and C, the mean final-temperature values were $80\pm 10^{\circ}\text{C}$, $69\pm 18^{\circ}\text{C}$ and $79\pm 12^{\circ}\text{C}$, respectively ($p < 0.05$). The multipolar mode created a larger volume of ablation than did the other modes: $37.6\pm 4.0\text{ cm}^3$ (group A); $44.9\pm 12.7\text{ cm}^3$ (group B); and $78.9\pm 6.9\text{ cm}^3$ (group C) ($p < 0.05$). In the in vivo experiment, the pig well tolerated the RFA procedure and no major complications occurred during the 4 days of the follow-up period. The mean volume of coagulations produced by multipolar RFA in the pig liver was $60.5\pm 17.9\text{ cm}^3$.

CONCLUSION: For the multiple probe RFA, the multipolar mode with hypertonic saline instillation was more efficient in generating larger areas of thermal ablation than either the consecutive or simultaneous monopolar modes.

2005

Multipolar radiofrequency ablation of hepatic tumors: Initial experience

Frericks B, Ritz JP, Roggan A, Wolf KJ, Albrecht T

Radiology 2005, 237:1056-1062

Institutional review board approval and patient informed consent were obtained. Use of a multipolar radiofrequency (RF) ablation device in patients with hepatic malignancy was prospectively evaluated with regard to feasibility, achieved ablation zone size and shape, technical effectiveness,

and complications. Nineteen malignant liver tumors were treated with the multipolar resistance-controlled RF ablation system, with which up to three internally cooled bipolar coagulation electrodes can be operated simultaneously. Postinterventional imaging was performed with dynamic contrast material–enhanced magnetic resonance (MR) imaging and MR imaging–based three-dimensional planimetry. Complete tumor destruction was achieved in 18 of 19 tumors. Mean ablation zone volume was $52 \text{ mL} \pm 45$ (standard deviation). Thirteen patients were treated with a percutaneous approach; six, with an intraoperative approach. Maximum ablation size was $91 \times 62 \times 79 \text{ mm}$ with the percutaneous and $73 \times 98 \times 74 \text{ mm}$ with the intraoperative approach. Of the 18 completely evaluable ablation zones, 13 were concentric, two were moderately eccentric, two were eccentric, and one was wedge-shaped. The multipolar RF ablation device achieves large ablation zones and has high technical effectiveness in treating hepatic tumors.

2004

Multipolar radiofrequency ablation: First clinical results

Tacke J, Mahnken A, Roggan A, Günther RW

Fortschr Roentgenstr 2004, 176: 1-6

Common systems of radiofrequency ablation (RFA) are monopolar devices which require grounding pads on the thighs in order to close the electrical circuit. Bipolar RFA does not require grounding pads, because both electrodes are located on one probe and alternating current circuit is confined within the target tissue. In this paper we report on the first clinical application of a new ablation device which enables both, bipolar (1 probe) and multipolar (up to 3 internally cooled probes simultaneously) radiofrequency ablation. We report on bi- and multipolar applications in liver tumors (9 patients), osteoid osteoma (2 patients) and renal cell cancer (1 patient).