RESEARCH ARTICLE

Analysis of Radiofrequency Ablation of Small Renal Tumors in Patients at High Anesthetic and Surgical Risk: Urologist Experience with Follow-up Results in the Initial Six Months

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Abstract

<u>Background:</u> To evaluate the results of various types of radiofrequency ablation (RFA) treatment of renal tumors in patients with excessive anesthetic and surgical risk. <u>Materials and Methods:</u> Data for RFA performed in in high risk patients were retrospectively evaluated. Other RFA applications in patients with no anesthetic and/or surgical risk were excluded. RFA was by ultrasound or CT guided percutaneous (USG/CT-PRFA) and retroperitoneally or transperitoneally laparoscopic (R/T-LRFA) techniques under general or local anethesia. Follow-up data of enhanced CT or MRI after 1, 3 and 6 months were analysed for twelve RFA applications. <u>Results:</u> The RFA applications included 4 (40%) left-sided, 5 (50%) right-sided and 1 (10%) bilaterally RFA (simultaneously 1 right and 2 left). The localizations of tumors were 2 (16.6%) upper, 5 (41.6%) mid and 5 (41.6%) lower pole. The RFA applications included 9 (75%) USG-PRFA, 1 (8.3%) CT-PRFA, 1 (8.3%) T-LRFA and 1 (8.3%) R-LRFA. The mean age was 65.3±8.5 (52-76) years. The mean tumor size was 29.6±6.08 (15-40) mm. No complications related to the RFA were encountered in any of the cases. Failure (residual tumour) was determined in 8.3% (1/12) of USG-RFA application. The success rate was thus 91.7% (11/12). Other 1st, 3rd and 6th months follow-up data revealed no residua and recurrence. <u>Conclusions:</u> RFA application appears to be safe as a less invasive and effective treatment modality in selected cases of small renal tumors in individuals with excessive anesthetic and also surgical risk.

Keywords: Endourology - small renal mass - radiofrequency ablation - excessive anesthetical - surgical risk

Introduction

Currently, more frequently use of imaging modalities in the observation of disorders resulted in an increased incidence and incidentally diagnosis of small renal masses (SRMs), which are commonly with slow growth, low tumor stage and limited to the kidney (Campbell et al., 2009; Ljungberg et al., 2010; Iannuccilli et al., 2012). For a long time, radical nephrectomy (RN) was accepted as the gold standard treatment for all stages of renal tumors (Huang et al., 2006; Lucas et al., 2008). This management seems to be an overtreatment for some of localized renal tumors, thus the use of nephron-sparing surgery (NSS) increased in the treatment of SRMs as a result of the technological developments and advances in surgical techniques. In the following time, partial nephrectomy (PN) is accepted as the new gold standard in the treatment of SRMs (Campbell et al., 2009; Ljungberg

et al., 2010; Breau et al., 2011). Although NSS provides similar functional and oncological results to RN, it has also increased rate of perioperative complications and morbidity especially in elderly patients with multiple comorbidities and high surgical risk (Fergany et al., 2000; Gill et al., 2007; Breau et al., 2011).

Since more SRMs are diagnosed in elderly patients with medical comorbidities, NSS has increased perioperative risk, and the advancements occured in imaging modalities, the use of ablative treatment techniques including radiofrequency ablation (RFA) increased in the treatment of SMRs (Wingo et al., 2008; Ljungberg et al., 2010; Iannuccilli et al., 2012). These minimally invasive, more conservative and nephron-sparing treatment modalities provide some advantages, such as not requiring surgical approach and pedicule clamping, not causing transient ischemia related renal injury, shorter hospital stay, lower complication rate, and offering curative and nephron-

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sparing treatment to the patients who are not appropriate candidates for NSS (Matsumoto et al., 2005; Pasticier et al., 2006; Gill et al., 2007; Tracy et al., 2010; Kim et al., 2012, Laguna et al., 2012; Karam et al., 2013).

In this study, we aimed to analyse the results of various types of RFA applications in only the patients who had the excessive anesthetical and also surgical risk and thus could not undergo any curative surgical treatment alternatives, genereal anesthesia, or the anesthesia with a long duration and to present the urologists' experience in RFA treatment with the follow-up data of initial six months in this specific indication.

Materials and Methods

The data of patients who had a SRM with the suspicion of renal cell carcinoma on imaging modalities, had the excessive anesthetical and also surgical risk and thus could not undergo any curative surgical treatment alternatives and/or general anesthesia, and underwent RFA application with a local or general anesthesia in a short duration were retrospectively evaluated. Other RFA applications that were performed in patients with no anesthetical and/or surgical risk were excluded from the study. All SRMs were preoperatively diagnosed by the imaging modalities of contrast- enhanced CT or MRI. Although a curative surgical treatment was planned in these patients, some reasons including solitary kidney tumors, bilateral renal tumors, advanced age, coexistent morbidities that significantly increase the risk of anesthesia, no ability for the application of general anesthesia or the anesthesia with a long duration and no ability for the application of a curative surgery or the surgery with a long duration as a result of high surgical and anesthetical risk, and patient preference caused to prefer RFA as a curative treatment. All patients were preoperatively informed, and an informed consent form was obtained. Commonly, posterior and posterolateral tumors were managed by percutaneous technique, and anteriorly and medially located tumors were treated by the laparoscopic approach. RFA application was performed by using RITA model 1500X radiofrequency generator and Starbust Talon radiofrequency probe, which can ablate all parts of the tumor by peripherally openning arms and has the features

of self-contained cooling and providing impedance controlled intermittent pulse (Figure 1). Maximal duration of the ablation was 12 minutes, and the ablation cycle was repeated when the targeted temprature was suboptimal.

In percutaneous RFA (PRFA) application, the patient was positioned in a modified lateral position based on tumor location. PRFA was performed in the guidance of ultrasound (USG-PRFA) or CT (CT-PRFA) under general or local anesthesia with sedation. After the determination of the location, borders and the relation with adjacent structures of tumor by the guidance of USG or CT, a perioperative renal biopsy was commonly performed. Subsequently, RFA needle with appropriate tip to the tumor size was inserted into the tumor ,and the side arms was opened under direct visualisation of radiological modalities, and the tumor was completely ablated (Figure 2). When it was supposed that an incomplete ablation was present in some patients related to the tumor location and size, synchronous repeated ablation was performed to completely ablate the tumor by repositioning of the RFA needle. Nevertheless, the repated placement of RFA needle in an appropriate area was more difficult because of the hyperechogenity of ablation side, which disrupted the clearence of perioperative radiological view (Figure 3).

In laparoscopic RFA (L-RFA) application, transperitoneal (TL-RFA) (Figure 4) and retroperitoneal (RL-RFA) (Figure 5) approaches were used. Both techniques were performed by using 3 ports under general anesthesia. The Gerato fascia and perirenal fatty tissue were dissected, and the tumor was exposed. After the visualisation of tumor by laparsocopic view and synchronous external USG imaging, RFA needle was directly placed into the tumor from the nearest abdominal wall and through the hole of laparoscopic port.

Figure 2. A USG-Guided RFA Application Under Local Anesthesia

Figure 3. The Demonstration of Increasing Echogenity of Tumor Field During the Ablation Period and More Hyperechoic USG View of the Ablated Tumor Tissue

Figure 1. The Demonstration of RITA Model RFA Generator, Starbust Talon RFA Probe, and Self-Contained Cooling and Impedance Controlled RFA Needle
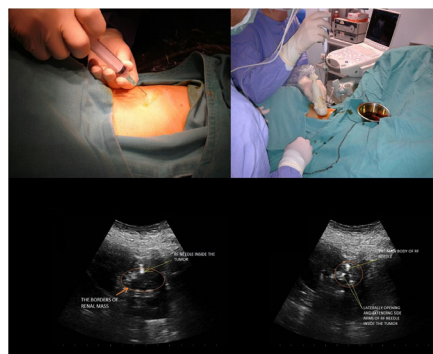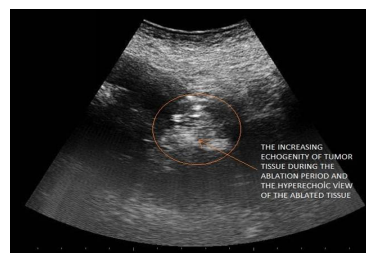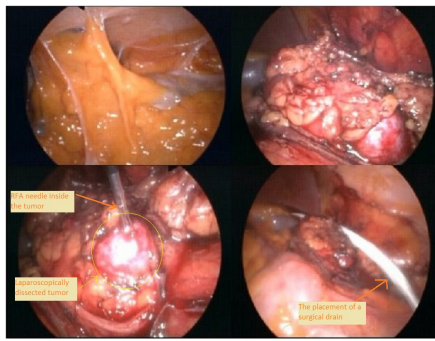
Figure 4. A Transperitoneal Laparoscopic Tranperitoneal RFA Application

Figure 5. The demonstration of the Placement of RFA Probe throuh a Laparoscopic Port Hole, the RFA Needle Inside the Tumor, and Peripheral Extention of the Ablation in a Retroperitoneal Laparoscopic RFA Appliction

A periperative renal biopsy was commonly performed. We could not use an intraoperative laparoscopic USG because of not being present. When an incomplete ablation was supposed, synchronous repeated ablation was perpormed to completely ablate the tumor by repositioning of the RFA electrode. After the completion of ablation, it was seen that the surface of tumor was also ablated.

In the follow up protocol, an enhanced CT or MRI was performed at 1st, 3rd and 6th month. At 1st month control, the determination of an enhancing tumor field was accepted as the presence of residual tumor and incomplete ablation, which meaned that the failure of RFA application. Subsequent RFA application was performed in these cases. The presence of being ablated, unenhancing, necrotic tumor field was evaluated as the successfull RFA procedure. Recurrence was defined as the determination of enhancing tumor field at the subsequent controls in patients with no residua at first control.

Results

The data of twelve RFA applications were performed in only the patients with excessive anesthetical and surgical risk. 4 symptomatic tumors presented flanc pain and 6 non-symptomatic tumors were incidentally diagnosed by radiological analysis that was used to evaluate other disorders. The mean age was 65.3±8.5 (52-76) years. The mean tumor size was 29.6±6.08 (15-40) mm. Nine patients had unilateral tumor, and one 1 patient had bilaterally localized, 3 synchronous tumors (1 right and 2 left sided one). The distribution of the localization of tumors were 2 (16.6%) upper, 5 (41.6%) mid and 5 (41.6%) lower pole. The anesthesia type included 9 general and 1 local anesthesia. PRFA applications consisted of 9 (75%)

USG- PRFA and 1 (8.3%) CT- PRFA. LRFA applications contained 1 (8.3%) T-LRFA and 1 (8.3%) R-LRFA. The majority of RFA applications consisted of USG-PRFA application. The RFA applications included 4 (40%) left-sided, 5 (50%) right-sided and 1 (10%) bilaterally (simultaneously 1 right and 2 left sided). Technical success was achieved in 11 of 12 (91.7%) initial RFA applications. All of the pre-RFA biopsies demonstrated renal cell carcinoma. No perioperative and postoperative RFA related complications was seen. The data of 1st, 3rd and 6th months' follow-up results revealed that incomplete tumor ablation was observed in 1 of 10 PRFA, but all of the LRFA applications had no residual tumor at 1st month control. In overall, the failure rate of the initial RFA was 8.3% (1/12), and it was occurred in only 1 USG-RFA application. In this case, USG-RFA was repeated and the patient was subsequently followed according to the same protocol. The 1st month control of secondary RFA application showed no residual tumor, futhermore other controls revealed also no tumor reccurrence. In overall, tumor reccurrence was not observed in 3rd and 6th month controls of all patients.

Discussion

In 1997, Zlotta et al. initially described the clinical application of RFA in the treatment of SRMs (Zlotta et al., 1997). RFA provides an anti-tumor effect, which occurs as a result of the coagulation necrosis that performs irreversible tissue damage (Campbell et al., 2007). In current RFA systems, the ablative temperature is provided by alternation of radiofrequency energy to the heat, and a coagulative necrosis that radiates outwards from the needle occurs (Hacker et al., 2006; Okhunov et al., 2012). RFA has some advantages, such as less complication rates, shorter hospital stay and recovery period, not requiring pedicule clamping and causing ischemic renal damage, the applicability as a curative and nephron sparing approach in patients who are not appropriate candidates for surgical treatment. These factors increased the routinely use of RFA in clinical practice. Nevertheless, the most important disadvantage is incomplete tumor ablation and the residua (Matsumoto et al., 2005; Ljungberg et al., 2010; Iannuccilli et al., 2012; Laguna et al., 2012).

In this study, we aimed to analyse the results of various types of RFA applications in only the patients who were with SRMs, had the high anesthetical and also surgical risk and thus could not undergo any curative surgical treatment alternatives, genereal anesthesia, or the anesthesia with a long duration and to present the urologists' experience in RFA treatment with the follow-up data of initial six months in this specific. In our study, different RFA techniques including USG-PRFA (9/12), CT-PRFA (1/12), R-LRFA (1/12) and T-LRFA (1/12) were used, and it was seen that the majority of RFA applications consisted of USG-PRFA application (75%). The amounts of various RFA groups were not appropriate for comparing their results, thus we just presented the overall results. The techical success rate of initial RFA application, which was accepted as the absence of an enhancing area inside the ablated tumor field, has been previously reported 90-100%. In our

sample, the success rate at initial RFA was found 91.7%, which is similar to previous literature. The failure occurred in only 1 case of USG-PRFA, but no failure was seen in LRFA applications. After the application of a second RFA in this case, the subsequent first month control showed no enhancing, viable, residual tumor. Therefore, the overall success rate was accepted as 100%, which was comparable to the previous literature (Arima et al., 2007; Breen et al., 2007; Mylona et al., 2009; Salas et al., 2010; Altunrende et al., 2011; Iannuccilli et al., 2012; Karam et al., 2013). The presence of incomplete ablation at initial RFA only in USG-PRFA application was supposed that the preferred technique could influence the RFA results. Repeatability in the same RFA session or after the determination of the failure at the follow-up period is a significant advantage of RFA.

Some factors, such as tumor size, tumor localization, the use of appropriately sized needle, influence the results of RFA application. Tumor size is one of the most important factor that may affect the RFA results. Because of a higher tumor size causes an increased incidence of incomplete ablation. In the literature, it was reported that the success rate at initial RFA in SRMs≤3 cm was 85.7%. When the tumor size increased, the success rate at first RFA sesssion significantly decreased, and the requirement of subsequent treatments increased. Therefore, the tumor size is an important factor in the determination of appropriate case for RFA application, and RFA provides better complete ablation results at first RFA session in the tumors ≤3 cm (Mylona et al., 2009; Best et al., 2012; Laguna et al., 2012). In our study, the distribution of tumor size showed 3 tumors >3 cm and 7 tumors ≤3 cm. The smallest one was 15 mm in diameter, and the biggest tumor was 40 mm in diameter. Although incomplete ablation occurred in only 1 patient who were with a 35 mm, unilateral, left renal tumor and treated by PRFA in the guidance of USG, complete ablation was obtained in all of the other PRFA and LRFA applications regardless of tumor size and RFA technique. In this case, the complete ablation of the tumor was provided by a second USG-PRFA application. Furthermore, it was interesting that the complete ablation was achieved in a patient who was with bilaterally tumors (right 4 cm, left 3 and 2.8 cm) and managed by simultaneous, multiple session of USG-PRFA. The sesond important factor is tumor location. It has been reported that different locations of the tumors could affect the complete ablation rates at initial RFA. Because some tumor locations, such as medial localization, adjacence to the vessels and other abdominal structures, and intraparanchimally localization, can make the clearly demonstration of the tumor, appropriately placement of RFA needle inside the tumor and sufficiently ablation of all parts of the tumor difficult (Gervais et al., 2005; Chen et al., 2009; Kim et al., 2012; Iannuccilli et al., 2012). In our study, there were 2 (16.6%) upper, 5 (41.6%) mid and 5 (41.6%) lower pole tumors. Eleven of 12 (91.7%) tumors were exophytic, and only 1 (8.3%) tumor was intraparanchimal. While medial location was present in only 2 of 12 (16.7%) tumors, 10 (83.3%) tumors peripherally localized. Although one of 2 medially localized tumors was also close to the pedicule, all of the

medially located tumors were completely ablated by LRFA (1 R-LRFA, 1 T-LRFA). It was determined that the failure occurred in only 1 patient who were with exophytic, mid pole tumor and treated by USG- PRFA. The complete ablation was provided by a second USG-PRFA session in this patient. Nevertheless, it was interesting that incomplete tumor ablation was not seen especially in 2 patients who were with medially located tumors and treated by LRFA application. Therefore, we supposed that LRFA could be the treatment of primary choice for the tumors, which was centrally located, adjacent to the other abdominal structures and renal pedicule, and difficult to target by radiological imaging modalities.

It is the fact that completely ablated tumors at initial RFA can relapse during the follow-up period, and it has been notified that the reccurrence rate was between 0% and 11.1%. The tumor reccurrence evaluated by using contrast enhanced CT or MRI and was accepted as the determination of an enhancing tumor field at subsequent controls in patients who had a successful initial RFA application. We did not prefer to evaluate tumor reccurrence by a routine post-RFA biopsy in patients who had no suspicion of the reccurrence on radiological imaging modalities because of the difficulty of the application of routine biopsy, biopsy related complications and unnecessarily increased cost. Nevertheless, the contribution of a confirmatory post-RFA biopsy to the diagnosis of the reccurrence can not be ignored in patients with suspected findings of recurrence on radiological analyses. In our follow up protocol including 3rd and 6th month controls, it was seen that no tumor (0%) reccurrences occurred, and this result was also in correlation with the literature (Gervais et al., 2005; Park et al., 2006; Zagoria et al., 2007; Ferakis et al., 2010; del Cura et al., 2010; Kim 2012). Although RFA is a less invasive treatment than surgical treatment options, various complications, such as pain, bleeding, hematuria, infection, urinary fistula, damage of adjacent structures can be occurred in RFA (Aron and Gill, 2005; Kwan and Matsumoto, 2007; Park et al., 2009; Ji et al., 2011; Atwell et al., 2012). In our study, no RFA related complications was detemined in the application and follow up period.

In conclusion, although surgical management is still accepted as the gold-standard treatment for SRMs, RFA has become an effective and safe treatment alternative especially for T1 stage renal masses. Recent advancements in imaging modalities and technological and technical developments have resulted in similar functional and oncological outcomes of RFA to the surgical management. RFA is an increasingly popularity, ablative treatment modality, which presents some advantages of lower surgical and anesthetical complication rates, shorter recovery time and hospital stay, no renal ischemia, and a curative, nephrone sparing treatment choice to the patients who are not appropriate candidate for the surgery or do not prefer the surgical teratment. Thus, RFA can be a good choice of treatment with its lower surgical risk and similar oncological and functional results comparable with the surgical treatment of SRMs. However, our study showed that RFA seemed to be a safe, effective, well tolarated and minimal invasive treatment in also the selected cases of small renal tumors with excessive anesthetical and also

surgical risk. The long-term efficacy of RFA as a first line treatment in SRMs is still on debate. More detailed, comprehensive and prospective studies with long term follow-up data is required for the routinely use of RFA as a first line treatment in SRMs.

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