The standard approach for the treatment of kidney (renal) cancer is radical or partial nephrectomy (removal of the kidney).

Radiofrequency ablation (RFA), a less invasive approach, is an option for the treatment of small tumours, and in cases where surgery is contraindicated.

Its safety and efficacy compare favourably with those of other approaches.

The persistence of residual tumour is a disadvantage of earlier versions of the technology. The use of more powerful radiofrequency (RF) generators may reduce such persistence, but definitive evidence is unavailable.

Experience with this application of the technology is limited. Longer follow-up of patients is required to provide an adequate comparison with nephrectomy.

Radiofrequency ablation (RFA) is one of several less invasive approaches that have been investigated for the treatment of kidney cancer. In RFA, an electric current from a radiofrequency (RF) generator delivers energy into the tumour, via an electrode. Tissue impedance leads to heat generation, production of lethal temperatures, and ablation of tissue.

The procedure is typically performed percutaneously under computed tomography (CT) or ultrasound guidance, as a same-day procedure, with the patient under sedation. A laparoscopic approach is considered for anterior tumours and for those that are close to other organs. Larger tumours, typically those more than 3 cm to 4 cm in diameter, may require more than one treatment session.

Health Canada has licensed several systems for the RF coagulation and ablation of soft-tissue lesions. These are the RF 2000™ and RF 3000® RF generators, manufactured by Boston Scientific Corporation (San Jose CA), the Cool-tip™ RF ablation system from Valleylab™ (Boulder CO), and the RITA® RF generator, by RITA Medical Systems, Inc. (Fremont CA). These are used with various electrodes. In the US, RF systems have received 510(K) approval from the Food and Drug Administration for the ablation of soft tissue, and have been used in the treatment of other organs, for example, for cancers of the liver and of the lungs.

RFA has been used most often for adults with small kidney tumours. Indications include comorbidities that preclude surgery, a single kidney, and multifocal renal cell carcinoma. Initial experience occurred with patients without metastatic disease, but RFA has now been used in patients with limited metastases and documented slow disease progression.
**Current Practice**

The standard approach to the treatment of renal carcinoma is surgical. Laparoscopic radical nephrectomy is an established procedure for the management of patients with localized tumours, and laparoscopic partial nephrectomy is emerging as a nephron-sparing option.8

**The Evidence**

The evidence of benefit for the technique comes from several case series, recent examples of which are listed in Table 1. Several groups have shown high success rates for the ablation of small tumours, particularly for those that are not centrally located in the kidney (exophytic or parenchymal). In the study by Gervais et al.,7 a multivariable analysis gave results that are consistent with the findings from other investigators. The results show that small tumour size and non-central location are predictors of success. An analysis of their findings reveals that the use of 4.2 cm or 5.8 cm as exclusion criteria for tumour size would include 90% or 99% of all tumours respectively for which complete necrosis can be achieved.

**Table 1: Results of studies on RFA of kidney tumours**

<table>
<thead>
<tr>
<th>Study</th>
<th>Numbers of Patients and Tumours</th>
<th>Mean Tumour Size</th>
<th>Exophytic or Parenchymal Location</th>
<th>Success Rate*</th>
<th>Mean Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gervais7 (2005)</td>
<td>85 patients; 100 tumours</td>
<td>3.2 cm</td>
<td>68%</td>
<td>&lt;3 cm; 52 of 52, 100%; 3 cm to 5 cm, 36 of 39, 92%; &gt;5 cm; 2 of 8, 25%</td>
<td>28 months</td>
</tr>
<tr>
<td>Matsumoto9 (2005)</td>
<td>91 patients; 109 tumours</td>
<td>2.4 cm</td>
<td>58%</td>
<td>107 of 109, 98% at 6 weeks; 35 of 36, 97% at 19.4 months</td>
<td>All patients had &gt;6 months follow-up; and 60 of these were followed for &gt;12 months</td>
</tr>
<tr>
<td>Veltre10 (2004)</td>
<td>13 patients; 18 tumours</td>
<td>2.4 cm for 17 tumours; 1 tumour 7.5 cm</td>
<td>89%</td>
<td>85%</td>
<td>12 months</td>
</tr>
<tr>
<td>Zagoria11 (2004)</td>
<td>22 patients; 24 tumours</td>
<td>3.5 cm</td>
<td>38%</td>
<td>100%</td>
<td>7 months</td>
</tr>
<tr>
<td>Hwang12 (2004)</td>
<td>17 patients; 24 tumours (8 percutaneous, 9 laparoscopic procedures)</td>
<td>2.2 cm</td>
<td>42%</td>
<td>23 of 24, 96%</td>
<td>13 months</td>
</tr>
<tr>
<td>Farrell13 (2003)</td>
<td>20 patients; 35 tumours (2 treated intraoperatively)</td>
<td>1.7 cm</td>
<td>63%</td>
<td>100%</td>
<td>9 months</td>
</tr>
<tr>
<td>Mayo-Smith14 (2003)</td>
<td>32 patients; 32 tumours</td>
<td>2.6 cm</td>
<td>91%</td>
<td>100%</td>
<td>9 months</td>
</tr>
<tr>
<td>Su15 (2003)</td>
<td>29 patients; 25 tumours</td>
<td>2.2 cm</td>
<td>80%</td>
<td>100%</td>
<td>9 months</td>
</tr>
</tbody>
</table>

* On the basis of CT follow-up findings.
In some series, incomplete tumour destruction has been reported. Rendon et al. treated four patients after surgical exposure of the tumour followed immediately by nephrectomy; and six patients were treated with percutaneous ablation followed by nephrectomy after seven days. Pathological examination showed residual viable tumour cells in 5% of the volume in four of five tumours in the first group, and three of six tumours in the delayed group. In a series by Michaels et al., 15 patients were treated with RFA before partial nephrectomy. The pathological examination of all 20 resected tumours showed evidence of viable tumour cells. In a series of eight patients treated before open surgery, there was necrosis in seven of eight tumours. The necrosis varied from 15% to 90% (mean 60%).

In these studies, lower power RF generators were used (50 watts, 90 watts, and 150 watts). Hwang et al. suggested that using a higher power generator might result in more consistent energy deposition and higher cell death. In their series, 23 of 24 tumours ablated using a 200 watt generator lacked contrast uptake on CT after a minimum follow-up of two years. The results suggested an improved performance but were not definitive, because of the absence of histopathological results. Gervais et al. commented that a case in their series illustrated the limitations of imaging for the detection of residual tumour. The local progression of cancer after the ablation was linked to the presence of residual malignant tissue that could not be distinguished from an artefact on the CT scan.

Adverse Effects

Complications associated with RFA and cryoablation were assessed by Johnson et al. in a multicentre study that included 271 cases (133 RFA, 139 cryoablation). Of 30 complications (11 for RFA), 26 were attributable to the procedure. Five of the complications were major. Three of these occurred after RFA: ileus, obstruction secondary to scarring from tissue damage, and urine leakage. The authors compared their findings with those of earlier studies on percutaneous renal biopsies and laparoscopic urological procedures. They concluded that kidney ablation procedures have a low complication profile when used to treat small renal tumours. The complication rate was similar to those of other laparoscopic and percutaneous procedures. Among the 85 patients in the series of Gervais et al., the most common complication was hemorrhage. Two patients required blood transfusion, and two patients had neuropathic pain. There were also individual cases of ureteral stricture, ureteral urgency, burns, and an asymptomatic, non-malignant abdominal wall mass.

Cost

The cost of an RF generator ranges from C$20,000 to C$30,000, and disposable single-use electrodes typically cost C$600 to C$1,000. Lotan and Cadeddu give the cost per RFA procedure at a centre in Dallas TX as US$4,454, which is cheaper than the costs for laparoscopic or open nephrectomy (respectively US$7,013 and US$7,767). The estimated costs per procedure of RF liver ablation in Ontario are C$1,554. The costs of professional fees, radiology, and surgical supplies are all higher in the US study, which includes some items that are excluded in the Ontario estimate.

Concurrent Developments

Some work has been done on the application of high intensity focused ultrasound (HIFU) in the treatment of kidney tumours. Reviews conclude that this procedure is promising, but that it should be regarded as experimental, and should be reserved for selected patients in well designed clinical studies. The use of stereotactic radiosurgery has also been investigated.

Rate of Technology Diffusion

RFA has been used in the treatment of other types of cancer and for other conditions. The availability of RFA equipment can be expected to increase. The rate of diffusion may be influenced by developments in the technology, by the limited data on longer term patient outcomes, and by specialists’ judgments about the merits of this approach compared with those of other minimally invasive techniques.
Implementation Issues

RFA is emerging as a useful alternative to nephrectomy in the management of some types of kidney cancer. It appears to be useful for smaller, non-central tumours, and for cases where surgery is contraindicated. Several points need to be noted by those implementing the technique. A disadvantage is the possibility of residual cancer that cannot be detected by diagnostic imaging during follow-up. There are no results from randomized trials, and the period of follow-up for patients who have had the procedure is short. Only with longer follow-up evaluations (five years to 10 years) will relevant comparison with radical and partial nephrectomy be possible.3

There may be an issue with ensuring the standardization of RFA. Veltri et al. comment that the procedure has been performed with different ablation systems and techniques, with varying versions of electrodes, and differing power and time settings.10 Implementation will also be influenced by the need for appropriate training in the use of the procedure, and consideration of the known benefits, costs, and disadvantages of alternative approaches for the management of kidney tumours.

References


Cite as: Hailey D. Radiofrequency ablation in the treatment of kidney cancer [Issues in emerging health technologies issue 80]. Ottawa: Canadian Coordinating Office for Health Technology Assessment; 2006.

***************

CCOHTA appreciates comments from its reviewers.

Reviewers: Edward D. Matsumoto MD MEd, McMaster University, Hamilton ON; David Valenti BSc MDCM, McGill University Health Centre, Montreal QC.

This report and the French version entitled L’ablation par radiofréquence dans le traitement du cancer du rein are available on CCOHTA's web site.

Production of this report is made possible by financial contributions from Health Canada and the governments of Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Nunavut, Ontario, Prince Edward Island, Québec, Saskatchewan, and Yukon. The Canadian Coordinating Office for Health Technology Assessment takes sole responsibility for the final form and content of this report. The views expressed herein do not necessarily represent the views of Health Canada or any provincial or territorial government.