Image-guided ablation

Second edition
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>3</td>
</tr>
<tr>
<td>Introduction</td>
<td>4</td>
</tr>
<tr>
<td>The procedure</td>
<td>5</td>
</tr>
<tr>
<td>Requirements</td>
<td>6</td>
</tr>
<tr>
<td>Equipment</td>
<td>6</td>
</tr>
<tr>
<td>Staff support</td>
<td>6</td>
</tr>
<tr>
<td>Sessional/logistic support</td>
<td>7</td>
</tr>
<tr>
<td>Time support</td>
<td>8</td>
</tr>
<tr>
<td>Training</td>
<td>8</td>
</tr>
<tr>
<td>Cancer Reform Strategy and extended waiting time standards</td>
<td>9</td>
</tr>
<tr>
<td>Case selection</td>
<td>10</td>
</tr>
<tr>
<td>The National Institute for Health and Care Excellence (NICE)</td>
<td>10</td>
</tr>
<tr>
<td>MDT</td>
<td>10</td>
</tr>
<tr>
<td>Service provision</td>
<td>11</td>
</tr>
<tr>
<td>Referrals</td>
<td>11</td>
</tr>
<tr>
<td>Numbers of centres</td>
<td>11</td>
</tr>
<tr>
<td>Baseline and follow-up imaging</td>
<td>12</td>
</tr>
<tr>
<td>Patient information</td>
<td>12</td>
</tr>
<tr>
<td>Audit and research</td>
<td>13</td>
</tr>
<tr>
<td>Audits</td>
<td>13</td>
</tr>
<tr>
<td>Research</td>
<td>13</td>
</tr>
<tr>
<td>References</td>
<td>14</td>
</tr>
</tbody>
</table>
This publication is intended to inform radiologists, oncologists, all members of the medical profession involved in the care of patients with cancer, hospital trusts, commissioners of healthcare, strategic health authorities and government departments about the current status of a rapidly developing, minimally invasive cancer therapy, image-guided ablation (IGA), which includes radiofrequency ablation (RFA), microwave ablation, and image-guided cryoablation. The demand for these cancer therapies is currently outstripping our ability to deliver them in a timely fashion, and there is concern that many patients undergo unnecessary surgery because of such issues.

The Royal College of Radiologists is grateful to the original authors, Drs Fergus Gleeson and Mark Anderson (Consultant Clinical Radiologists, Churchill Hospital, Oxford), Dr David Breen (Consultant Clinical Radiologist, Southampton University Hospital) and Mr Zahir Soonawalla (Consultant Hepatobiliary Surgeon) for writing the paper, and to Dr Alice Gillams for updating this guidance. The previous edition, Image-guided ablation, has been withdrawn.

Dr Pete Cavanagh
Vice-President of the Faculty of Clinical Radiology
The Royal College of Radiologists
Introduction

There are several minimally invasive ablative therapies which include radiofrequency ablation (RFA), microwave ablation (MW), high-intensity focused ultrasound (HIFU), laser-induced interstitial thermotherapy (LITT), cryoablation, irreversible electroporation (IRE) and percutaneous ethanol injection. This is an evolving field with proponents (and potentially, applications) for each technique. The technology continues to improve. High-power MW systems have been introduced. IRE is a new ablative technology, very much in the early stages of development. HIFU produces well-controlled but very focal areas of ablation. RFA is the most commonly performed ablative therapy and is now recognised as part of standard clinical treatment. It is also the modality that has the best available evidence base in the literature on which recommendations can be based; because of this, the report will focus on RFA, but will, where possible, produce generic recommendations applicable to all methods of ablation.

Ablative therapy is most commonly performed in patients with primary and metastatic liver and lung tumours and in early renal cell carcinoma. It may also be carried out in patients with benign and metastatic bone tumours, nodal metastases, adrenal tumours and thyroid nodules. It is mostly performed by radiologists percutaneously, using ultrasound, computed tomography (CT) or magnetic resonance imaging (MRI) guidance. Some hepatobiliary surgeons use ablation as an adjunct to liver resection, but the open approach carries a significant morbidity and small mortality and therefore the percutaneous route is preferable.

This document will provide an overview of the requirements for the provision of an ablative service, including patient referral base, teamworking, equipment, staff, time, training, facilities, outpatient and inpatient requirements, follow-up, patient information leaflets, research and audit.
Radiofrequency ablation (RFA) is a minimally invasive ablative treatment that produces cell death by coagulative necrosis through conductive heating. Radiofrequency through a high frequency alternating current produces ionic agitation resulting in frictional heating that causes coagulative necrosis. The radiofrequency current is delivered through a probe consisting of a partly insulated needle, with an active unshielded tip. The tip may be of variable length, the most common being 3 cm, and may either be a single straight tip or an array of expandable tines that when deployed form an umbrella- or basket-shape embracing the tumour. The probes have different mechanisms for providing feedback to the operator of the power being delivered, the temperature at the tip(s) and the resistance (impedance) of the adjacent tissues. The RF generator can also control the temperature at the tip(s), preventing charring of tissues, which can limit the ablation zone. The amount of ionic agitation and subsequent heat production is relative to the distance from the unshielded tip, with the volume of tissue destruction produced dependent on the number of probes placed, their distribution and the size of the unshielded electrode.

For larger tumours, multiple needle placements may be made to produce overlapping areas of tissue destruction. After the procedure the probes are removed, with the probe tracts being ablated (cauterised), reducing the possibility of tumour seeding and haemorrhage. Adjunctive interventional manoeuvres such as hydrodissection (instillation of collateral fluid to displace adjacent, temperature-sensitive structures), pre-embolisation or post-procedural chemoembolisation have extended the scope and applicability of these procedures.

The procedure may be performed under deep conscious sedation or general anaesthetic. The procedure may be performed either as a day case or requiring an overnight admission (the most common practice in the UK) with discharge the following day. Antibiotic prophylaxis is routinely administered before the procedure and continued for a variable period of 24 to 72 hours afterwards. Analgesia is required during the recovery period but may be self-administered as an outpatient and the post-procedural pain is usually limited in severity and duration.

There are recognised complications of the procedure, both generic and unique to the area being ablated. The risk of certain complications also varies according to the size and position of the lesion, its proximity to other structures and the experience of the operator. For the most part, RFA is an extremely successful method of providing focal tumour ablation and in skilled hands has a low and acceptable rate of complications. A multicentre study on over 2,000 patients undergoing hepatic RFA reported a mortality of less than 0.5%, and major and minor complication rates of 2% and 5% respectively.\(^1\) Mortality was secondary to massive haemorrhage, bowel perforation, liver failure and septic shock. Major complications were haemorrhage, gallbladder perforation, bowel perforation and hepatic abscess. Complications following ablation of primary liver cancer are higher than following ablation of metastatic disease. Pulmonary RFA in primary lung cancer on the background of emphysema has a higher complication rate, with complications requiring admission in over 10%, a pneumothorax incidence of 40% and a higher mortality rate of up to 4% in some reports.\(^2\) Pulmonary RFA in metastatic disease is generally well tolerated and while pneumothorax is common, only 10% of patients require chest tube insertion, and most pneumothoraces resolve within 12 hours allowing the drain to be removed and the patient discharged. Renal RFA appears safe, with most series reporting a zero mortality rate and a combined major and minor complication rate of less than 5%.\(^3\)
**Requirements**

**Equipment**

RFA probes and a radiofrequency generator are required. There are a number of different manufacturers, each having slightly different generators and probes. The generators have a variety of methods of enabling the operator to assess the adequacy of tissue damage being produced by the ablation treatment. The probes are also varied in design, some being water cooled and some measuring the local tip temperature whereas others measure the degree of impedance in order to determine treatment completion. The probe types are linked to the different generators. There is no evidence to suggest that any one particular probe is significantly better than any other.

**Recommendation**

The probes and generators chosen will in part be dependent on operator preference and the financial arrangement made by the institution and the supplier. It is often possible to negotiate arrangements on the cost and number of probes used, and the cost of the generator. It is probably beneficial to have more than one type of probe and generator available in any institution, both to enable competition among the equipment suppliers and to provide training using more than one probe. It is also possible that an operator may favour a particular type of probe for a particular lesion, but another probe for others.

**Staff support**

There are significant numbers of staff required to provide a successful and busy RFA practice. The service is most likely to run efficiently and successfully if a team of individuals, both medical and non-medical are involved.

Secretarial/clerical support is necessary to liaise with patients and referring clinicians, request scans performed elsewhere for review, book pretreatment and follow-up scans, arrange patient anaesthetic pre-assessment, book CT, MR or treatment sessions, retrieve medical notes and deal with correspondence. In institutions where there are large numbers of tertiary referrals, a clerical co-ordinator may be helpful in this regard. Facilities for the electronic transfer of images from referring centres have greatly facilitated the prompt initial assessment of tertiary referrals and accommodation into the local patient pathway.

Nursing staff are required, as with any form of interventional procedure. They may help with patient queries about the procedure, are essential to providing assistance during the procedure and may be involved in significant proportions of patient aftercare, including discharge and follow-up. Their role may vary among institutions. A busy service may consider the feasibility of a specialist nurse who develops expertise in this field and helps run the RFA service.

Radiographers familiar with both RFA and cross-sectional interventional procedures, particularly those performed with CT, are essential to enable accurate probe localisation.

Both cross-sectional and interventional radiologists perform RFA, and there are merits in each case. Independent of the specialisation, all individuals require adequate training. As far as possible, at least two consultants should be involved in service provision per centre. This enables joint discussion of more complex cases and allows continuation of service during leave or illness.

As procedures are performed under deep conscious sedation or general anaesthesia, an anaesthetist and an operating department assistant (ODA) are core team members. It is preferable to have a limited number of anaesthetists involved, so that they are familiar with the procedure, including patient positioning within CT or MRI, the potential complications, and the facilities available within the radiology department. The Royal College of Radiologists’ guidelines on sedation and anaesthesia provide information on requirements for their safe provision.4
Recommendation
It is likely that the precise nature of staffing required by each RFA service will vary dependent on both the mix and number of cases. However, it is desirable that individuals are recruited into the service on a substantive rather than ad hoc basis so that they may become familiar with the patient pathways and facilities available and thus provide a timely and high-quality service. The numbers of staff and their time related to the service is likely to increase as the numbers of referrals and cases increase. The exact numbers of staff and their involved time is not prescriptive, but one case per fortnight when starting the service requires:

1. Consultant staff – equivalent to two programmed activities (PAs) per week
2. Secretarial/clerical – four hours per week
3. Nursing staff – 4–6 hours per fortnight
4. Anaesthetist and ODA – 4–6 hours per fortnight.

As the referral numbers and the length of time that the service has been provided increase, significantly more time is required than on a pro rata basis. A service providing weekly RFA for two patients requires at least one half-time consultant entirely devoted to service provision as a minimum and similar additional support. (This must also acknowledge the cumulative, post-procedural imaging burden, as image-guided ablation [IGA] is inherently a non-extirpative technique.)

Sessional/logistic support

Patients need to be seen as outpatients before the procedure by the radiologist and a team member to explain the risks and benefits and to discuss any patient concerns. This may provide an opportunity for further imaging and assessment within the department. Patients requiring general anaesthesia may require an anaesthetic assessment. Access to pre-assessment clinics will greatly aid in the co-ordination of preoperative investigations and facilitate patient pathways, as day-case or overnight stay procedures.

The patients may be transferred after the procedure to a day-case bed – either within the radiology department or elsewhere within the hospital. Adequate day-case or overnight bed facilities are necessary, as are nursing staff familiar with potential interventional complications. Admission under a named clinician is necessary to provide overnight medical cover, and formal arrangements for this provision are needed prior to admission. The patient should be seen by a team member and carefully examined for any procedural complications before discharge.

Arrangements for outpatient follow-up are necessary where patients will need to be seen by an RFA team member. There must be clear communication between the referring team and the RFA team regarding the procedure that has been performed and the follow-up that is required. Follow-up imaging may be performed either at the RFA centre or at the local referring centre and made available to the performing radiologist for assessment of treatment success, disease relapse or local recurrence amenable to further ablation. Local follow-up is popular with patients who do not wish to travel but is seldom as good, timely or effective as follow-up by the ablation team at the ablation centre. The local cancer network needs to ensure that clear guidelines exist for the management and follow-up of these patients.

Recommendation
To provide a comprehensive service, it will be necessary to negotiate access to a full range of pre- and post-procedure facilities. Units with a specialist interest in single organ ablation may not require some facilities. The lead radiologist for RFA should ensure that there are network guidelines for RFA referral and follow-up.
Time support

The provision of a successful RFA service is time-consuming. Ideally, radiologists who perform RFA should attend all the relevant multidisciplinary team meetings (MDTs) – liver/colorectal, lung, urology and bone – and be able to discuss the relative merits of image-guided ablation alongside other standard therapies. As this is unlikely to be achievable in all but a few centres, familiarity with the indications and success rates of RFA in these MDTs by an attending or chairing radiologist is appropriate. Clear guidelines should be disseminated across the cancer network regarding the referral of cases for RFA to the tertiary centre (see earlier). Following on from potential case selection, it is essential that all these patients are discussed at a MDT, even if it does not include all those involved in treating that particular tumour type. This is of critical importance in liver and lung RFA, as the role of chemotherapy, surgical resection and RFA frequently requires detailed discussion in relation to risks and benefits, the timing of the intervention and the potential if necessary for combined surgical and interventional procedures.

The provision of these inherently image-guided procedures has significant implications for cross-sectional imaging facilities. Departments undertaking this work will have to set aside time for dedicated CT and, eventually, MR sessions. Increasingly complex cases will require a six-hour CT session to carry out approximately two cases.

Training

There are no formalised requirements for training, but it is recommended that a period of secondment at a unit providing the service occurs. This may be on a case-by-case basis if the trainee is a consultant at another institution, or may be for a block attachment at specialist registrar (SpR) level. As with all other radiological procedures, there is no guaranteed level of competence provided by observing and then performing a certain number of examinations. The number of examinations necessary to achieve competence will depend upon the trainee’s core experience and competence either as a consultant or an SpR, but a minimum number of observed and then performed examinations is recommended. This will also vary depending on the service to be offered – hepatic, renal, lung, bone or a combination of them. As with many procedures there is a significant learning curve. For liver ablation, the learning curve is estimated at 100 procedures.

A number of postgraduate training courses are provided by subspecialty societies such as the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) and the European Society of Gastrointestinal and Abdominal Radiology (ESGAR). Post-competence training is also necessary and this is best achieved by performing a minimum number of ablations per year and auditing the results. The unit’s outcomes should be made available to patients and referring clinicians. Attendance at continuing professional development (CPD) lectures and courses will also ensure that advances in the techniques available will be incorporated into local practice.

Recommendation

Timetabling in job plans to allow for outpatient consultation for discussing risks and benefits and consenting are necessary. Time for reviewing the patient after the procedure, at discharge and potentially at follow-up appointments is necessary. Time for follow-up imaging interpretation is necessary. Time for correspondence and liaison with referring clinicians is often underestimated.

Recommendation

Initial training, familiarity with equipment and post-competence training are likely to be part of any revalidation process of radiologists offering a RFA service. All those involved in RFA should keep a database of referrals, procedures and outcomes.
Cancer Reform Strategy and extended waiting time standards

As of December 2008, the extended waiting time standards in the Cancer Reform Strategy\(^5\) came into force. For all subsequent treatments for patients with cancer, there is a 31-day deadline from the decision to treat and commencement of treatment. For RFA, most treatment decisions will be made at the MDT and it is at this point that the 31-day clock will start. To accommodate new patients, it would be difficult to meet the standard with a sessional frequency of less than one per week. Such a service will have important implications for cross-sectional imaging and should now start to be factored into CT and MR provision in centres deemed appropriate to provide IGA.
Case selection

The National Institute for Health and Care Excellence (NICE)

There is guidance available on the use of RFA for lung, renal, hepatocellular carcinoma (HCC) and hepatic colorectal metastases on the NICE website for clinicians and the general public. The guidance is supportive of the provision of RFA for these patients, but aside from HCC, recommends that RFA is performed in the context of appropriate clinical governance procedures, research and audit.

MDT

All cases should be discussed at an appropriate MDT; this is clearly good practice and is mandatory from the NICE guidance. As discussed earlier, relevant expertise at MDTs is necessary. It is probable that patients suitable for ablative therapy are not referred because this is not considered during the discussion on therapeutic options or because the radiologist(s) that perform RFA are not present and able to suggest the treatment. As such, an increase in awareness of the scope and role of RFA is necessary among the radiological and clinical community. Guidelines regarding referring patients for RFA should be disseminated across cancer networks through the relevant site-specific groups.
Service provision

Referrals

Direct referrals from physicians, surgeons and oncologists following outpatient consultations, referrals following an MDT discussion, general practitioner referral, and direct patient referrals may all occur. All these referrals should be channelled via the appropriate MDT. Direct tertiary referrals to radiologists from other centres also occur and should be reviewed once again at the tertiary MDT. The primary care trusts (PCTs) and commissioning groups need to be aware of these services, appropriate provision and costings.

Numbers of centres

The numbers of patients and procedures necessary to achieve competence have been discussed earlier. The numbers of patients referred into each current unit currently providing RFA is unknown, as is the potential number of patients that might benefit from the procedure. It is probable that RFA should be limited to centres that are designated for the specialist treatment of those tumours. This allows discussion of potential combination therapies, such as partial hepatic metastectomy and RFA, neoadjuvant chemotherapy and RFA, combined (chemo) embolisation and RFA, and so on.

It is likely that the numbers of patients that would benefit from ablation of hepatic or lung metastases will exceed all other referrals. At present, it is estimated that up to 50% of patients with colorectal metastatic disease have liver-only metastases.\(^{10}\) Approximately 20% of these patients are thought to be suitable for hepatic resection,\(^{11}\) but the numbers of patients unsuitable for resection but potential candidates for RFA is unknown. The incidence of colorectal cancer in the UK is approximately 37,000 per year.\(^{12}\) Nearly 14,000 of them would synchronously have, or metachronously develop metastatic disease.\(^{13}\) Only about 10% of those with metastases undergo liver resection.\(^{11}\) A conservative estimate would suggest that another 10% of these cases may be suitable for ablative therapy often as an adjunct to chemotherapy. RFA is also being used in conjunction with resection to extend the number of patients treated with curative intent. Additionally 50–60% of surgically treated patients will have disease relapse,\(^{11}\) with the majority of these being local hepatic relapse; these patients may also be suitable for RFA.

Another consideration is the potential to retreat patients, further increasing the number requiring treatment. Perhaps the biggest potential increase in patients suitable for hepatic ablative therapy is due to the advent of the newer chemotherapeutic agents. These may make up to 30–40% of patients with organ-confined hepatic metastases previously thought untreatable for cure, suitable for either surgery or ablative therapy. The CLOCC Trial (Chemotherapy + Local Ablation Versus Chemotherapy) – a randomised phase II study of local treatment of liver metastases by radiofrequency combined with chemotherapy versus chemotherapy alone in patients with unresectable colorectal liver metastases – reported significantly improved progression-free survival in the RFA arm as compared with the chemotherapy-only arm.\(^{13}\) If the CLOCC results are translated into standard clinical practice given the recent evidence on the numbers of patients that might benefit from RFA, the potential number of ablative therapies required for hepatic disease alone may be in the order of 7,000 to 10,000 patients annually.

As the incidence of cirrhosis rises in the UK,\(^{14}\) the numbers developing hepatocellular carcinoma and those referred for RFA will increase. Ablation has been shown in prospective trials to offer similar oncological outcomes to resection while maximally preserving non–tumour-bearing liver volume. Ablation will become the treatment of choice in early HCC.\(^{15}\) Combinations of chemoembolisation and HCC are preferred in moderate-sized HCC. Large tumours still need to be dealt with by resection.

The number of patients suitable for renal ablation is also significant, with some centres increasingly ablating small (<4 cm) renal tumours as the primary procedure or in patients unfit for surgical resection. Up to a 100% successful ablation rate has been reported in patients with small renal tumours,\(^{16}\) with up to a 90% successful ablation rate in larger tumours, although recent reports in large series suggest the overall success may be less than this.\(^{16}\) The impact of RFA on overall survival in patients with small renal tumours is less readily assessed.
than for hepatic or pulmonary RFA because of the potentially indolent nature of some small renal cancers, but where complete ablation has been achieved a five-year survival of 100% has been reported. ¹⁷

The number of thoracic ablations is expected to increase significantly due to the increasingly aggressive treatment of paucimetastatic disease. Several groups have reported on large series of ablation in colorectal lung metastases.¹⁸–²¹ In particular, ablation of bilateral metastases is far better tolerated than bilateral thoracotomies or VATS procedures. The number of lung metastases that can be treated with ablation is increasing; originally between three to five, some centres are now treating up to ten small metastases. In general, one lung is treated at a time with an interval of two to four weeks between the two ablation procedures. A further increase in numbers is likely as the role of IGA in the palliation of bone metastases expands. To treat this number of patients requires a significant expansion in both the numbers of centres providing ablative therapy and the numbers being performed in each centre.

**Recommendation**
Each cancer network should be encouraged to identify patient pathways for RFA within each tumour type, and preferably develop RFA services within the network, with the initial service provision from a centre already providing hepatic or thoracic surgery.

**Baseline and follow-up imaging**
Before treatment, each patient should have appropriate recent baseline imaging. Assuming the treatment is to be provided as a curative procedure, a multi-slice CT of the chest, abdomen and pelvis should be performed using an agreed scanning protocol.

There is no defined accepted follow-up scanning protocol after RFA. A baseline scan performed shortly after the procedure is advisable and then scans at pre-agreed time intervals should be performed either at the referring institute or at the centre, dependent upon local agreement and likely tumour biology. MR may play an increasing role in this context.

**Patient information**
Written and online information should be provided for each of the types of procedures to be performed. This should be available in outpatients, with referring clinicians and local radiologists familiar with the information included. Patients should have easy access to a key worker who they can contact with any queries or requests for further information. Patients who are discharged after the procedure should have clear guidance about possible problems and what they should do in such a case.

**Recommendation**
Each centre should provide written and online information on each procedure.
Audit and research

Audits

Each unit must regularly audit its own practice. The audit should include the number of patients considered for RFA and declined, as well as those accepted. The following parameters should be assessed:

1. The patient pathway
2. Complications – major and minor
3. The incidence of incomplete treatment and local relapse
4. Survival – disease-free and overall
5. Patient satisfaction.

The results of these audits should be made available to referring clinicians, patients, the trust clinical governance committees, and the cancer network.

Research

There are a number of unresolved questions regarding the use of IGA. It would be desirable that large centres, performing more than one case per week, were involved in active research, with coordination between centres to further research goals. Serious consideration should be given to establishing large multicentre, randomised clinical trials to assess the role of RFA in clinical scenarios where the evidence in the literature at present is scanty and clinical equipoise exists. In future, participation of patients within such trials could be considered as an endpoint for audit.

Approved by Clinical Radiology Faculty Board: 20 June 2013
References


Citation details


Ref No. BFCR(13)7
© The Royal College of Radiologists, November 2013.

For permission to reproduce any of the content contained herein, please email: permissions@rcr.ac.uk

This material has been produced by The Royal College of Radiologists (RCR) for use internally within the specialties of clinical oncology and clinical radiology in the United Kingdom. It is provided for use by appropriately qualified professionals, and the making of any decision regarding the applicability and suitability of the material in any particular circumstance is subject to the user’s professional judgement.

While every reasonable care has been taken to ensure the accuracy of the material, RCR cannot accept any responsibility for any action taken, or not taken, on the basis of it. As publisher, RCR shall not be liable to any person for any loss or damage, which may arise from the use of any of the material. The RCR does not exclude or limit liability for death or personal injury to the extent only that the same arises as a result of the negligence of RCR, its employees, Officers, members and Fellows, or any other person contributing to the formulation of the material.