CLINICAL PROCEDURES

Radiofrequency ablation (RFA) in the treatment of liver tumours

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BACKGROUND AND HISTORY

The incidence of primary liver cancer in Canada has been steadily increasing, having more than doubled since 1980.¹ This increase is partially attributed to the increasing rates of hepatitis C infection, alcohol abuse, and immigration from developing countries where the incidence of hepatocellular carcinoma (HCC) is much greater.¹ ² The liver is also the most common site of metastases, especially from colorectal cancers.³ The best treatment option for HCC and liver-only metastases is surgical resection; however, only 10-15% of patients are suitable candidates for this procedure.⁴ As such a small proportion of patients are eligible for surgical resection or able to receive a liver for transplantation, a number of different modalities have been explored as treatment options, including, but not limited to, radiofrequency ablation (RFA), radiotherapy, percutaneous ethanol injection, and transarterial chemoembolization. RFA is safe, and associated with fewer side-effects and shorter hospital stays compared to surgical resection.⁵

The use of heat in medicine dates back to antiquity when various ancient societies from the Greeks to the Chinese knew of the use of cautery to stop bleeding. In 1891, Jacques-Arsene d’Arsonval found that alternating current at 20kHz or higher can heat tissue in the human body without muscle excitation.⁶ Nearly four decades later, Harvey Cushing and William T Bovie developed the Bovie knife, a small knife where an alternating current was passed so that it can burn through or cauterize the tissue on contact.⁷ In the early 1990’s radiofrequency electrocautery was further explored, and modified into what is now RFA as a way of treating small liver tumours.⁸

EVALUATION AND CONTRAINDICATIONS

Prior to operation, the nature of the liver tumours are carefully evaluated by abdominal CT or MR imaging. Tumours larger than 5cm or numbering greater than five are contraindications for treatment by RFA due to the difficulty in ablating a tumour of such a size.⁴ Their location relative to pertinent structures such as other visceral organs, bile ducts and vessels are noted as it complicates the procedure. It is difficult to completely ablate tumours near vessels due to the cooling effect of the blood flow. Ablation also poses a risk for causing necrotic damage to nearby organs such as the bowel or diaphragm, as well as causing biliary obstruction and damage. Although the majority of RFA in the liver are performed on primary HCC tumours or colorectal metastases, it is also performed on metastases from other areas such as the pancreas and breast. Despite the advantages presented by RFA, surgical resection is still considered the gold standard, and should be considered if the patient is found to be eligible on evaluation. However, this is rapidly changing as more advanced RFA techniques emerge. Extra-hepatic involvement is also a relative contraindication for RFA. Hematology tests for coagulopathies are performed as the procedure may require multiple insertions of large gauge needles as well as poses a risk of complications resulting in surgery.⁸

RADIOFREQUENCY ABLATION

There are three primary approaches to performing an RFA: percutaneous, laparoscopic, and open. Percutaneous RFA is above all the preferred approach as it is the least invasive, requires only conscious sedation, inexpensive, has minimal side effects, and the patient can be discharged within 24 hours. Earlier percutaneous procedures were limited to those with a few small tumours in the periphery and away from the diaphragm. However, with advanced techniques such as hydrodissection these challenging lesions can also be treated. Advanced ultrasound and 3D ultrasound, coupled with CT scanning has helped to visualise the entire liver to help in ablation.

There are only a few centres where interventional radiology is not available that perform laparoscopic RFA, and this is usually used in conjunction with liver resection, or other debulking surgeries. This approach is generally used on patients with centrally located tumours, tumours located near large blood vessels, and those with minimal abdominal procedures performed in the past. As it is a more invasive approach, it is less cost-effective, associated with more complications, and requires a longer hospital stay. It is also much more technically challenging to perform, as the angle of approach of the radiofrequency needle is restricted.¹⁰

The open approach is generally reserved for those patients with multiple large tumours ranging from 4-5cm or involves a large vessel. An open approach allows for the temporary occlusion of the hepatic artery and portal vein, known as a Pringle maneuver, which minimizes blood flow. As the cooling effect from the blood flow is minimized, the larger tumours are more likely to be completely ablated. If the patient also presents with a separate tumour that cannot undergo RFA but is suitable to be resected, it can be surgically removed during the same operation. The disadvantages of this approach are similar to those of other open surgeries as it is more expensive, requires general anesthesia, a longer hospital stay and is associated with increased morbidity and mortality.⁴

Prior to the operation, the site of entry is locally anesthetized and the patient is given an IV sedative. General anesthesia is indicated for percutaneous RFA when poor tolerance is expected with local anesthetic alone as in cases of drug abuse or cancer patients, or if the operation is expected to last more than 3 hours.⁸

The RFA needle is guided towards the tumour by ultrasonography. The aim of the procedure is to ablate the entirety of the tumour as well as a 1-2cm tumour-free margin.¹¹ However, ultrasonography is unable to accurately show the extent of the ablation, and tumour margins tend to be obscured by the ablative action, so care must be taken to ensure complete ablation.¹² Tumours are usually treated from the deepest to the
most superficial as the ablated area may obscure ultrasonographic visualization of deeper tissue. Single ablations are usually suitable for small tumours smaller than 3cm, but for larger tumours, multiple overlapping ablations should be considered. The RFA needle remains active during removal from the tumour to prevent seeding of malignant tissue along healthy liver tissue. Post-operatively patient is given an antiemetic and analgesics to control the nausea and pain often associated with RFA.⁶

POST-OP AND COMPLICATIONS

An abdominal CT is performed one month after the operation to assess the extent of the tumour ablation. A waiting period is necessary as ablation causes a temporary hyperemic ring to appear on CT that may obscure any remaining tumour areas. After this a repeat CT is performed routinely to look for possible intra or extrahepatic tumour recurrence. If an intrahepatic tumour recurrence is found, the patient can undergo percutaneous RFA again. Percutaneous RFA can be repeated as many times as necessary in contrast to the other RFA approaches which are often one-time procedures. If the recurrence is large or complicated, then other treatment modalities may be considered such as chemoembolization.⁷

A portion of patients may experience flu-like symptoms 3-5 days post-operation that is also described in patients of similar procedures such as chemoembolization and cryoablation. The fever may be accompanied by fatigue and night sweats lasting anywhere from 1-3 weeks. Supportive care is recommended, but if the fever lasts longer than 5 days, the patient is assessed for possible sepsis. RFA is generally considered safe, but some serious complications have been reported such as pleural effusions, intraperitoneal bleeding, and burns to the diaphragm and colon.⁸

FUTURE DIRECTIONS

A major hurdle in RFA is the difficulty in fully ablating large tumours. Currently, a single ablation can reach a tissue volume 2-3cm in diameter, but multiple ablations in the same area or reducing hepatic vascular inflow can increase the effective ablated volume. Newer and more effective needles and radiofrequency generators have been developed since the advent of RFA to increase ablation volume and further improvements continue to be researched. One such innovation being investigated is the use of pulsed current RFA as opposed to constant current RFA where the former was found to produce a larger volume of tissue necrosis. Other energy sources such as Microwave technology are also being used for ablation.

The benefits of the minimally-invasive nature of percutaneous RFA are obvious in the treatment of small tumours in early stage HCC. However, in a situation where a patient would be suitable for both RFA and surgical resection, the latter would be the standard of care, but very few patients are candidates for surgical resection due to pre-existing complex liver disease. If a large randomized control trial can show that best curative treatment between RFA, surgical resection, and liver transplantation in early HCC is RFA, then it may become the new standard of care due to its cost-effectiveness and minimal complications.

REFERENCES