Assessing the Liver After Interventional & Surgical Cancer Therapy

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Introduction

The liver is the largest solid organ in the body, and uniquely, has the ability to regenerate itself and regrow after partial removal or destruction. It is also one of the only two organs with a dual blood supply (the lung is the other), receiving at least 70% of its blood via the portal vein and the remainder via the hepatic arteries. It is also relatively straightforward to transplant, and is the second most commonly transplanted organ after the kidneys.

The liver is one of the most commonly affected organs by cancer, whether arising in the liver itself or by spread from other sites. Its involvement by secondary cancer (called metastases) is almost always incurable, and is the most common cause of death in patients with metastatic disease.

Despite its regenerative capabilities, the liver is relatively radiosensitive, and most hepatic cancers cannot be successfully treated by radiotherapy without causing terminal liver failure. Chemotherapy is variably successful and its outcomes are highly dependent on the combination of tumour biology and patient tolerance. As a result, a wide range of different treatments has evolved to try to either cure or at least locally treat liver cancers in an attempt to prolong patient survival.

Detection, planning, treatment and monitoring the outcomes of treatment of liver malignancy are increasingly dependent on sophisticated medical imaging. The appearance of the liver and its tumours is usually altered by such treatments, and interpretation of the findings and their clinical significance is increasingly dependent on understanding how the treatments work and what imaging features should be expected from successful or unsuccessful treatments.

This presentation will discuss the imaging approaches and findings in patients who have undergone partial liver resection, and especially, interventional radiology treatments for primary or secondary liver cancer.
Liver Malignancy

Malignancy of the liver falls into two main categories — primary (arising from the tissues of the liver itself) and secondary or metastatic, where neoplasm arising in other organs spreads to the liver, either by direct invasion from an adjacent organ or through the blood stream (hematogenous spread).

Primary cancers include hepatocellular cancer (HCC), by far the commonest primary liver malignancy, cholangiocarcinoma (cancer of the bile ducts), and hepatic angiosarcoma. Only HCC will be discussed in this presentation.

Secondary cancers are very common. Metastases from the colon, stomach, oesophagus and pancreas most frequently arise from the gastrointestinal tract because of spread via the portal venous system, and many other cancers also spread to the liver via the systemic circulation, especially breast and lung cancers. Cancers that spread by direct invasion from adjacent organs (e.g., the gall bladder) are rarely treatable except by complete surgical excision.

We will focus on metastatic colon cancer, as this type of secondary tumour is the most common, and is most often treated by chemotherapy, surgery and interventional radiology. Increasingly, other secondary malignancies are being treated using the methods that are fairly well-established for metastatic colon cancer.

Curative Surgery

With either type of liver malignancy, complete surgical removal remains the only hope for a true cure. Ideally, the entire liver will be removed and replaced with a transplant. However, transplantation is very expensive, the supply of organs is very limited, the patient or donor may die from complications of the transplantation surgery, and long-term survival is not guaranteed, even if the disease appears to be limited and confined to the liver. In general, patients with metastatic liver malignancy will rarely be offered a transplant as it is generally (and often correctly) assumed that they will already have metastatic disease outside the liver as well. Thus, the only patients with liver malignancy who are routinely offered transplantation are patients with primary liver cancer who are in otherwise very good health, who have very limited local disease, and who have access to a liver transplantation program. This represents a tiny fraction of the patients with liver cancer.

Surgical resection of an entire lobe or several segments of the liver containing the malignancy is also feasible, and is generally regarded as the best chance of a cure for most patients with liver cancer. However, this is only possible if all the disease is confined to one part of the liver, and if the patient will have sufficient liver function remaining after resection to live without developing liver failure. Subsegmental and local tumour resection is generally not favoured because of the very high likelihood of local recurrence. Typically no more than 10-20% of all patients with liver cancer will be suitable for surgical resection.

Imaging after transplantation is the subject of an entirely separate lecture. Imaging after partial resection is aimed primarily at:
• Monitoring regrowth of the residual liver
• Detection of unresected residual malignancy in the remnant liver
• Detection of new malignancy in the remnant liver remote from the resection site

Palliative Treatments

The vast majority of liver cancer patients therefore require chemotherapy, image-guided therapy using interventional radiology techniques, or a combination of both. Chemotherapy is usually achieved through a range of drugs, but increasingly, biologic agents developed to attack specific proteins or molecular targets in liver cancers are also being used.

A small proportion of patients who receive such treatment respond so well that they can undergo curative surgical resection (so called “downstaging”). Such treatments have proliferated enormously in the last 20 years, and fall into two broad categories — arterially delivered and percutaneous. They include:

Intra-arterial
• Chemotherapy (chemoinfusion)
• Blockage of the liver arteries (embolotherapy)
• Chemotherapy followed by embolisation (transarterial chemoembolisation or TACE)
• Delivery of Yttrium-90-labelled radioactive microspheres (radioembolisation)
• Delivery of radioisotopes attached to Lipiodol (Radio-Lipiodol using Iodone-131 or Rhenium-188)

Percutaneous
• Percutaneous ethanol infusion (PEI)
• Radiofrequency ablation (RFA)
• Cryoablation
• Microwave ablation (MWA)
• Electroporation

For most patients, such treatments merely temporise by destroying, shrinking or stabilising visible disease. They may prolong the patient’s life, but are never curative and cannot prevent the development of new lesions. In this situation, the goal is to prolong survival while preserving quality of life and minimising complications.

Each of these treatments can produce a variety of imaging changes within the liver and elsewhere in the body, depending on complications or side-effects of the therapy, including:
• Reduction or loss of tumour perfusion
• Peri-tumoural increased perfusion
• Accumulation of radio-opaque Lipiodol infused during treatment (TACE and Radio-Lipiodol)
• Immediate increase in size
• Gradual reduction in size
• Progressive increase in size
• Alteration of liver size and shape
• Altered diffusion
• Reduction in metabolic activity
• Haemorrhage
• Abscess formation
• Thermal injury to adjacent organs
• Liver failure (ascites, shrinkage of liver)

The presentation will highlight some of these appearances, expected findings after such treatments, and some of the complications that can arise from them.