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Graft complications following orthotopic liver transplantation: Role of non-invasive cross-sectional imaging techniques

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ABSTRACT

Orthotopic liver transplantation is the treatment of choice in adult patients with endstage liver disease. Survival of both graft and patient has progressively improved over time due to improvements in surgical and medical treatment. However, post-transplant complications still have a significant impact on morbidity and mortality associated with transplant surgery. The most common adverse events of the graft include vascular (arterial and venous stenosis and thrombosis), biliary (leakage, strictures, stones) and parenchymal complications (hepatitis virus C infection, HCC recurrence, liver abscesses). The diagnosis of these adverse events is often challenging because of the low specificity of clinical and biologic findings. Different diagnostic algorithms have been proposed for the detection of graft complications and, in this setting, radiological evaluation plays a key role in differential diagnosis of graft complications and the exclusion of other adverse events. Ultrasound examination is established the first-line method of identifying adverse events in liver transplant recipients but a normal or a technically unsatisfactory study cannot exclude the presence of biliary, vascular and/or parenchymal complications. In these circumstances, before planning any treatment, multi-detector CT and/or MR imaging and MR cholangiography should be performed for the evaluation of vascular structures, biliary system, liver parenchyma and fluid collections. The aim of this review is to illustrate the role and state-of-the-art of non-invasive cross-sectional imaging techniques in the diagnosis and management of complications which primarily affect the graft in patients after liver transplantation.

1. Introduction

Liver transplantation is currently the preferred treatment for patients with acute or advanced chronic liver failure for whom no other treatment option is available [1,2]. Over the last decades, refinement of surgical techniques and advances in perioperative management has significantly improved the outcomes of liver transplantation. However, postoperative complications after orthotopic liver transplantation (OLT) still have a significant impact on the morbidity and mortality of recipients. The common adverse events include vascular (arterial and venous stenosis and thrombosis), biliary (leakage, strictures, stones) and parenchymal complications (hepatitis virus C infection, HCC recurrence, liver abscesses) [3].

Postoperatively, the main goal of diagnostic imaging techniques is to identify early and late complications, thus influencing the management of recipients and significantly contributing to increase graft and patient survival [4]. Knowledge and prompt recognition of post-OLT complications with the most suitable imaging method are crucial for both graft and patient survival.

A series of diagnostic and interventional imaging techniques are actually available for the evaluation of liver transplant recipients. Radiologists and clinicians should aware of capabilities and limits of each of them in order to optimize the diagnosis of adverse events, especially in the presence of life- and graft-threatening biliary and vascular complications.

The purpose of this review is to illustrate the role and new developments of state-of-the-art non-invasive cross-sectional imaging techniques in assessing and managing complications primarily affecting the graft in patients previously undergoing orthotopic liver transplantation.

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2. Non-invasive imaging techniques in post-OLT complications

In the postoperative period after liver transplantation complications primarily affecting the graft often shows a largely overlapping spectrum of clinical and laboratory findings [5]. Acute rejection is a serious adverse event following OLT and its final diagnosis is definitively established only by graft biopsy and histological analysis. On this basis, imaging techniques have the specific role of excluding the other complications, which can have clinical signs and symptoms very similar to those of acute rejection [6]. In particular, in the early post-OLT phase the differential diagnosis between organ rejection and biliary and/or vascular adverse events impairing the graft function is extremely difficult [7]. In order to obtain a prompt and effective treatment and to ensure the survival of the graft, the main objective of non-invasive imaging techniques is to identify or exclude vascular, biliary and parenchymal complications. In this setting Doppler ultrasound (US), multidetector computed tomography (MDCT), Magnetic Resonance Imaging (MRI) and MR cholangiography, and direct cholangiography are the main imaging diagnostic modalities that are currently utilized for this aim [8].

In Fig. 1 we show the algorithmic approach that is routinely used in our center for liver transplantation to assess post-OLT complications with the above imaging modalities. Whenever we suspect a complication in a liver transplant recipient for the presence of clinical symptoms and/or abnormal liver function tests results, the diagnostic work-up usually begins with the serology tests and a Doppler ultrasound, that can allow the contemporary evaluation of hepatic vasculature, biliary system and hepatic parenchyma. This technique represents the ideal initial imaging modality to detect post-operative complications of the transplanted liver since it is accessible, accurate, cost-effective, avoids the use of ionizing radiation, and can be easily performed at the patient's bedside [9,10]. The results of US are highly reproducible when performed by expert operators and in a dedicated clinical scenario. If a complication is identified and no intervention is required, it is usually followed-up with serial US exams [11–14].

Although Doppler ultrasound is a non-invasive method of identifying adverse events in liver recipients, a normal US examination or a technically unsatisfactory US study cannot exclude the presence of biliary, vascular and/or parenchymal complications. In these circumstances and in the case of repeated US demonstration of an abnormality that can require therapeutic management, further evaluation is advocated and multidetector computed tomography and/or MR imaging and MR cholangiography are usually performed.

3. Multidetector computed tomography

Multidetector computed tomography imaging is accepted as a second line non-invasive diagnostic method in various complications after OLT. MDCT is a valuable examination to detect and evaluate complications because it provides non-invasive and rapid imaging of the entire abdomen including angiographic studies, liver parenchyma, biliary tract, and the other abdominal organs. MDCT is usually reserved for patients with clinical-laboratory and/or vascular abnormalities at Doppler US.

Recent introduction of 64-section MDCT and the subsequent development of 256-section MDCT and dual energy CT have markedly changed the way of performing and evaluating CT imaging [15]. The current temporal resolution of modern CT scanners permits to obtain angiographic CT studies at the peak of arterial enhancement without motion or respiratory artifacts. Furthermore, the spatial resolution now available permits to obtain high quality three-dimensional reconstructions, including Maximum Intensity Projection (MIP) and Volume Rendering (VR) [16]. Some dual-energy CT (DECT) applications became available in the abdomen thanks to the recent advances in CT technology, especially the possibility of current scanners to simultaneously acquire images at two different energies [17,18]. DECT is based on different attenuation of photons with different energies by tissues. DECT can be obtained with two x-ray tubes operating at two different energies or with a single x-ray tube rapidly switching between two different energies or with detectors capable to discriminate different energies. With DECT it is now possible to calculate virtual unenhanced imaging set with consequent lower radiation exposure, improve visibility of iodine enhancing lesions at lower energy or increase temporal resolution in angiographic studies. A recent study demonstrated that DECT allowed CT angiographic studies using low concentration contrast media, vascular signal intensity being increased compared to single energy CT [19].

Post-processing of the imaging data sets using three-dimensional reformatting techniques such as Maximum Intensity Projection (MIP) and Volume Rendering (VR) is needed to better recognize hepatic artery anatomy and most of vascular complications. MIP imaging extracts the highest attenuation voxels in a data

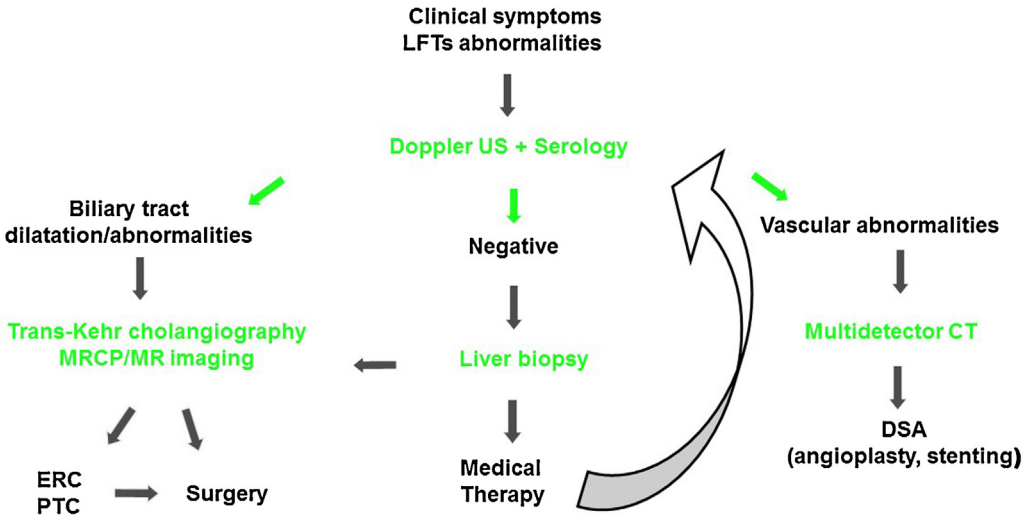

Fig. 1. Complications after liver transplantation: algorithmic approach. LFTs: liver function tests; US: ultrasound; MRCP: Magnetic Resonance Cholangiopancreatography; CT: computed tomography; ERC: endoscopic retrograde cholangiography; PTC: percutaneous transhepatic cholangiography; DSA: digital subtraction angiography.