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Investing in Interventional Imaging

Which Technology is Worthwhile?

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New Techniques in Interventional Imaging

Interventional radiology is one of the youngest, fastest-growing specialties in medicine. The technology of diagnostic imaging is progressing at an equally rapid rate as the development of new techniques of intervention based on new instruments and material but, above all, on the creativity of the human mind. The domain of interventional radiology includes almost all body systems, as any area that can be imaged radiologically can also be treated under imaging guidance. The vascular system is the most prominent field of intervention which can be divided into therapeutic vaso-occlusion or embolisation and revascularisation.

Embolisation involves tumour feeding arteries, bleeding arteries, aneurysms, arteriovenous malformations or fistulas. More recently venous occlusion was introduced in several clinical situations such as varicocele, erectile dysfunction due to venous leakage, and lower limb varicose veins. Inferior vena cava (IVC) filters are a unique technique for protection against pulmonary embolism without occlusion of the IVC. Revascularisation includes mainly balloon angioplasty and stenting of stenosed or occluded arteries, thrombus aspiration and local thrombolytic therapy. More recent revascularisation techniques are laser angioplasty, cryoplasty, and brachytherapy.

Applications of Interventional Imaging

Interventional tumour management is a broad field which involves various techniques based on different physical and medical principles. Regional transarterial chemotherapy of malignant tumours is another category that can be combined with embolisation or performed solely as chemoperfusion. Tumour biopsy and thermal ablation can be guided by X-ray fluoroscopy, ultrasound, conventional CT, CT fluoroscopy and open/closed MRI. Radiofrequency waves, laser, microwave, and galvanotherapy (direct electric current) are all used as mechanisms of ablation through extreme heating, whereas cryoablation depends on extreme cooling. Percutaneous alcohol injection and brachytherapy are other methods of chemical or radiotherapy ablation.

Breakthroughs in spinal interventions include vertebroplasty, disc prolapse aspiration, disc chemonucleolysis and image-guided nerve blockage for pain management. Under normal circumstances, these procedures can be performed on an outpatient basis without the need for a long hospital stay with all its financial and manpower requirements. These techniques mentioned represent most but not the complete range of interventions available in practice or research. New techniques are being added to the list at an amazing pace.

Advances in Technology

Interventional imaging is dependent on imaging systems. We are privileged now to experience a breathtaking rate of development in imaging equipments. Both CT and MRI are highly valuable for image-guided interventions and vascular imaging with regard to intervention planning. The

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development of multidetector row CT (MDCT) and CT fluoroscopy gave CT the chance to stay ahead and maintain a key role in vascular and interventional imaging. Interventions can be performed under CT fluoroscopy guidance in near real-time imaging. CT angiography is nowadays comparable to MR angiography and even to conventional angiography with regard to sensitivity and specificity and is a valuable, quick and minimally invasive screening technique in peripheral, visceral, coronary and cerebral arterial diseases.

However, this is only possible due to the multidetector row advantage, which allows faster imaging of the contrast medium bolus with minimal loss of information and hence superior spatial and temporal resolution and also more efficient 3D reconstruction. The more the numbers of detector rows, the more these advantages are pronounced. With the advent of 64-slice CT, interventions can sometimes be performed without the need for CT fluoroscopy as the whole area under examination is covered by one scan in a fraction of a second.

Benefits of MRI

MRI has also shown remarkable development with the production of machines up to 4 Tesla while 3 Tesla MRI is now widely supplied by Gems, Philips and Siemens for clinical applications. The benefits of higher field strength are mainly an improved signal-to-noise ratio, hence diminished acquisition times and/or better spatial resolution at equivalent acquisition times and improved patient comfort (shorter examination time due to parallel acquisition, diminished noise level, and shorter magnets). An increase in the magnetic susceptibility effects is an associate shortcoming but is sometimes an advantage for certain types of examination.

Open low-field MRI units (0.2-1.5 Tesla) are used in many centres partially in diagnostic studies for claustrophobic patients or other patient-related reasons. However, in future they should play a bigger role in guided interventions, which would be more valuable in the broader context.

Although all percutaneous procedures, whether biopsy, drainage or ablation, can be successfully performed under CT guidance, the superior soft tissue contrast afforded by MRI makes it attractive to interventionalists for less risky access to lesions and better monitoring of ablation. A small monitor console in the MRI room is more practical for near real-time surveillance of the procedure.

The necessity of using MR-compatible needles and applicators increases costs by approximately 10 - 15% in comparison to a similar procedure under CT guidance. MR-guided interventions can sometimes take a little longer than CT-guided interventions. This is why open MRI could not replace CT for routine use in all interventions and should be warranted only for selected cases where other imaging techniques lack tissue contrast or vascular conspicuity to provide safe access.

Angiographic Devices

There are some angiographic devices which are not always abundant in interventional units although the need for them is progressively growing. They deserve a large share in the budget of interventional imaging. Stent-grafts used successfully nowadays in thoracic and abdominal aortic and iliac aneurysms and dissections are an example.

The use of limb extensions and fenestration has extended its applications to cases with iliac, renal and mesenteric involvement. Endovascular repair has proved to be a cost-effective alternative compared with open surgery for the elective repair of abdominal aortic aneurysms. Another type of stent-graft is the covered stents which have a valuable role to play in the treatment of large bleeding arteries that cannot be considered for embolisation. They are also used during transjugular intrahepatic porto-systemic shunts (TIPSS) and percutaneous biliary drainage (PTD) to reduce the probability of endostent mucosal growth and narrowing.

Rapid exchange angioplasty catheters and balloon-expandable stents are much more practical than over-the-wire counterparts especially in sophisticated cerebral, renal or below-knee angioplasty. They are much easier to use and can be more accurately applied which increases the technical success.

Conclusion

In conclusion, there are a myriad of ways in which interventional imaging is developing not only in terms of the diseases in which it can treat but also the technology that is facilitating it, into an exciting and forward-looking field for the provision of better standards in healthcare.

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