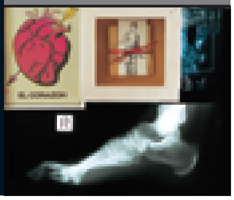
THEME

Imaging



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What's new in vascular interventional radiology?

Aortic stent grafting

BACKGROUND
Medical therapies are moving progressively toward 'minimally invasive' techniques resulting in less physiological disruption, smaller 'entry points', reduced intra- and post-operative complications, and earlier discharge. This is exemplified by the emerging technique of abdominal aortic aneurysm treatment with percutaneous endoluminal stent grafting.

OBJECTIVE
This article aims to provide an update on aortic stent grafts.

DISCUSSION
Aortic stent grafting carries less risk to the patient, is associated with less morbidity and mortality than traditional surgical procedures, and results in earlier discharge. Care in preoperative assessment to ensure the best match between patient and graft is essential, as is attentive postoperative follow up.

General practitioners will be aware of a not so silent revolution occurring in the world of medicine centred around the all purpose term: 'the stent'.

It is now possible to place a stent in virtually any body tubular system, primarily for the purpose of maintaining luminal patency. In the vascular system, stents are now routinely deployed within the iliac arteries, the renal arteries, the coeliac axis and superior mesenteric artery for luminal restoration. Femoral and popliteal stenting is more problematic as these vessels are subject to considerable deformity, usually resulting in stent fracture and thrombotic occlusion.[1,2] Balloon angioplasty remains the treatment of choice for short segment stenoses and occlusions below the level of the inguinal ligaments. In the coronary arteries, stenting is now the primary treatment modality for stenotic disease. Stenting to reconstitute the vessel lumen in emergent myocardial infarction results in significant short and long term patient benefit.[3,4] Carotid stenting is now performed worldwide.

Percutaneous treatment of aneurysms

The success of percutaneous stenting – particularly in relation to the arterial system – led creative minds to think that if narrowing of the arteries can be treated with a percutaneous procedure, why not look at percutaneous treatment of dilated arteries, ie. aneurysms? Increased life expectancy, the widespread incidence of atherosclerosis and the coincidental detection of asymptomatic aneurysms on abdominal imaging has led to increased recognition of this potential life threatening but eminently curable condition.

Virtually all aneurysms are thought to be secondary to atheromatous weakening of the vessel wall. The process begins in the lower abdominal aorta and extends distally to the aortic bifurcation and progresses proximally toward the origin of the renal arteries. The segment of normal aorta between the renal artery origin and the proximal extent of the aneurysm is termed 'the neck'. Occasionally the aneurysm will extend proximally to involve the renal arteries and even the superior mesenteric artery and coeliac axis, rendering effective treatment more difficult. Alternatively, the aneurysm may be limited to a short segment of mid abdominal aorta, or may project from the side of an aorta of normal calibre; the latter sometimes being described as an 'ulcerating atheromatous plaque'. Invariably, the iliac systems in these patients show features of advanced atheroma with calcification, tortuosity and often aneurysm formation of the common and internal iliac arteries. There is also usually atheroma in the common femoral arteries.

Traditional treatment of abdominal aortic aneurysms with evidence of leakage, tenderness, complications, or size in excess of 5.0–5.5 cm has been open operation.[5] The approach is via a large abdominal incision and may be either transperitoneal or extraperitoneal. Following clamping of the aorta either below or above the level of the renal arteries the aneurysm sac is opened and an inlay Dacron graft placed into the sac. Such a procedure is highly effective and provides long term cure for aortic and/or iliac aneurysms. However, surgery is a major procedure usually performed under general anaesthesia in frail elderly patients with multi organ compromise. Clamping of the diseased aorta is often problematic and may result in impaired renal perfusion and postoperative deterioration of renal function. Postoperative recovery is also impaired by the presence of a large abdominal incision.

Twenty years ago it was appreciated that if we could restore lumen diameter with a percutaneous stent, then theoretically we should be able to reconstitute a normal lumen within the centre of an aneurysm. The various materials from which such a stent could be manufactured were already widely available in surgical grafts and percutaneous stents. The main technical issues to be dealt with were how to contract a manufactured stent into a small sheath to enable percutaneous insertion via a peripheral vessel and how to achieve effective sealing at the proximal and distal graft ends, thereby isolating the aneurysm sac from arterial pressure.

Aortic stent grafts

Many thousands of aortic stent grafts have been inserted since the early 1990s and considerable technological evolution has occurred during this period. Currently, grafts typically come as three separate components: the main body, the ipsi and contralateral limbs (*Figure 1*). These components are self expanding and are supplied within a small calibre, withdrawable sheath. The main body is a Dacron tube with asymmetric lower trouser legs. Multiple self expanding radial metallic stents lie along the graft. Some grafts will have a noncovered stent at the upper end of the main body which is deployed at and above the level of the renal arteries and a metal limb of this stent may lie across the origin of a renal artery without compromising flow. In addition, multiple metallic hooks may be incorporated into the proximal end of the graft to further anchor the graft to the aortic wall. Distally, the ipsi and contralateral limbs are simple Dacron tubes with self expanding metal stents. These limbs are deployed in a coaxial fashion into the iliac legs of the main body graft and a friction fit seals the junction and also seals the distal ends of the limbs against the internal surface of the iliac arteries.

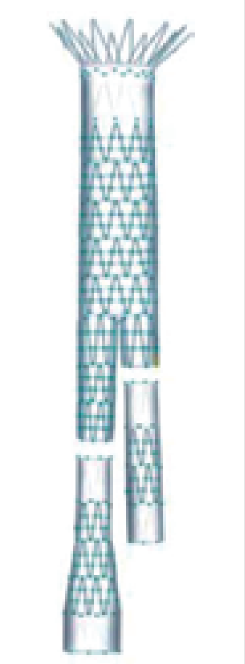

Figure 1. Three piece aortic graft

The procedure

Usually the procedure is performed in the interventional suite of a major hospital's radiology department, where sterility will not be compromised and abdominal imaging is far more satisfactory than in the main theatre suite. Anaesthesia may be either general or spinal. Following bilateral surgical exposure of the common femoral arteries, angiography is performed for accurate anatomical mapping. The main body of the graft is then partially deployed, attempting to place it as close as possible but slightly below the renal artery origins. The ipsi and contralateral limbs are then positioned with their distal ends 'landing' in the common iliac arteries (*Figure 2*). In

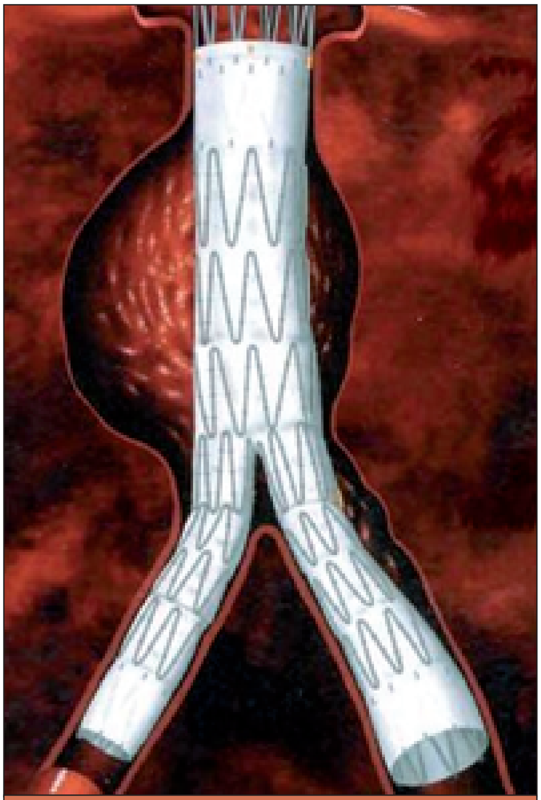

Figure 2. Three piece graft in situ

the presence of a common or internal iliac aneurysm it may be necessary to 'land' the distal end of the graft in an external iliac vessel, however, internal iliac occlusion should be avoided if possible as there is a significant incidence of buttock claudication. Check angiography is performed at various stages of stent deployment, and following deployment to confirm the position of various graft components, and to ensure there is no filling of the isolated aneurysm sac. The noninvasive nature of the procedure often allows patient discharge at 48–72 hours. This is the major advantage of percutaneous stent insertion compared with traditional treatment.

Preoperative evaluation

While most patients with aneurysms are suitable for endoluminal stent insertion, preoperative evaluation is critical as this determines suitability of the aorta and iliac systems for percutaneous stenting and enables the various parameters to be measured to ensure that a graft with the correct diameter and length of the main body and iliac limbs is obtained. Custom made graft components may be required.

Modern preoperative workup is nearly always performed with computerised tomography (CT) angiography on a 16 or 64 slice CT scanner. Technique and image reconstruction is critical, and this procedure is preferably limited to sites with relevant expertise and good liaison with the vascular surgery team. Accurate preoperative assessment with a high quality CT angiogram combined with correct graft selection should render the actual graft insertion a quick and uneventful procedure (*Figure 3–6*). Difficulties are usually only encountered with incorrectly selected graft components or highly tortuous vessels.

Complications

At our institution the vascular surgeons and radiologists work as a team to insert the grafts and we have now performed in excess of 70 procedures with minimal complications. No patient has required conversion to an open procedure, postoperative renal failure and abdominal wound dehiscence is no longer an issue; there have been no significant septic complications, and no patient has required a postoperative transfusion.

Of course no breakthrough comes without some cost; and with endoluminal grafts this is in the form of the so-called 'endoleak'. The term endoleak refers to persisting flow within the aneurysm sac following stent deployment

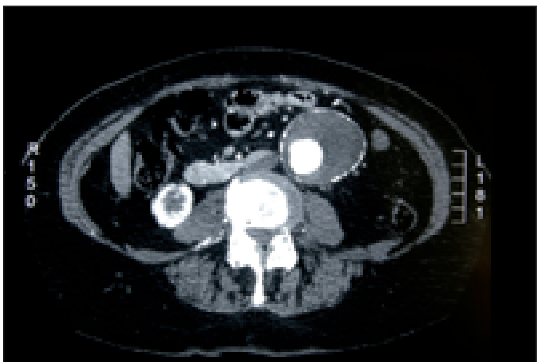

Figure 3. High resolution axial scan through 5 cm abdominal aortic aneurysm

Figure 4. Vessel tracking software demonstrating aortic lumen and left iliac system

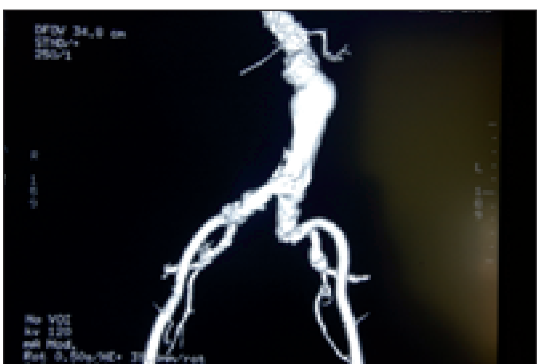

Figure 5. Surface shaded display of aortic and iliac system lumens demonstrating vascular tortuosity

Figure 6. Specialised software measuring package for calibration of stent

Figure 7. Arterial phase CT scan demonstrating large secondary endoleak adjacent to iliac limbs within aneurysm sac

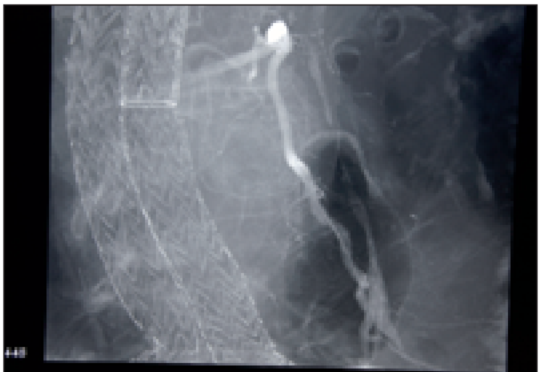

Figure 8. Super selective angiogram demonstrating retrograde flow into aneurysm sac (same patient as Figure 7)

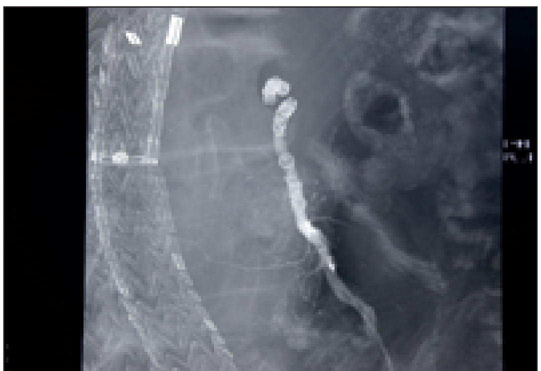

Figure 9. Successful trans catheter coil embolisation/occlusion of vessel producing secondary endoleak

and may be either 'primary' (arising from a leak at the junction of the graft and native vessel) or 'secondary' (where flow into the aneurysm sac is seen secondary to reversed collateral flow from a lumbar artery or the inferior mesenteric artery) (*Figure 7*).

All postoperative patients have CT scans performed, usually within 30–60 days and at variable times in the following 18 months. Initially the demonstration of an endoleak during this period was felt to be highly problematic, however, with more experience we now know that endoleaks in general represent a benign phenomenon, and provided the aneurysm sac is stable or shrinking no further action is required.[6,7] Larger leaks can be treated with percutaneous stent insertion into the graft lumen to produce further radial force at the site of a primary endoleak. Problematic secondary endoleaks may require highly selective catheterisation of the supplying vessels and coil obliteration (*Figure 8, 9*).

Conclusion

The transfer of techniques and technology developed for the percutaneous dilatation of stenosed arteries has created an alternative treatment option for people with abdominal aortic aneurysms, a condition with significant mortality and morbidity of its own and of its traditional surgical remedy. Care in preoperative assessment to ensure the best match between patient and graft is essential, as is attentive postoperative follow up.

Conflict of interest: none declared.

Acknowledgment

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