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## Endoleaks Following Conventional Open Abdominal Aortic Aneurysm Repair

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**Objective:** to describe the complication of "endoleak" following conventional open abdominal aortic aneurysm (AAA) repair.

**Design:** prospective case study.

**Setting:** two specialist vascular surgical centres.

**Patients and Methods:** six patients who had successful conventional open AAA repair.

**Results:** six patients presented with back or abdominal pain or hypotension between one and eighteen months later. An endoleak at the distal anastomosis was noted in five of the cases and one endoleak at the proximal anastomosis. All six cases were successfully repaired; two of these patients required Dacron graft replacement, whilst in four cases only direct resuturing was needed. There was no evidence of infection.

**Conclusions:** an endoleak is not a phenomenon confined to stent grafts. It should be considered in all patients who present with back or abdominal pain within eighteen months of open AAA repair. The combination of computed tomography (CT) scan and digital subtraction angiography is most useful for preoperative diagnosis.

**Key Words:** Endoleak; Open, aortic aneurysm; Anastomosis.

### Introduction

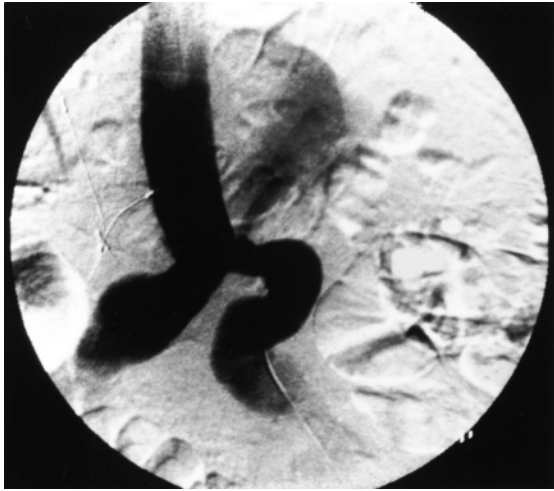
Complications of open infrarenal abdominal aortic aneurysm (AAA) repair are well described. They approach 25% in some studies<sup>1,2</sup> and are predominantly of cardiac or pulmonary origin. With the introduction of endovascular techniques, a growing number of patients with infrarenal AAA have been offered treatment by endovascular implantation of a stent-graft prosthesis. A major limitation of this method, however, is the potential to develop an "endoleak".<sup>3</sup> The concept of endoleak was introduced by White and co-workers<sup>3</sup> to describe the occurrence of a leak outside an endoluminally placed stent graft, which was contained within the aneurysm sac. More recently these have been classified into four major types.<sup>4</sup> This may arise at once or develop up to 18 months postoperatively.<sup>5</sup> This concept has not in our knowledge been described before following conventional surgery. We describe six patients who have developed contrast leaks within the old aneurysm sac following apparently successful elective and emergency open AAA repair from two

university specialist vascular units and two district general hospitals.

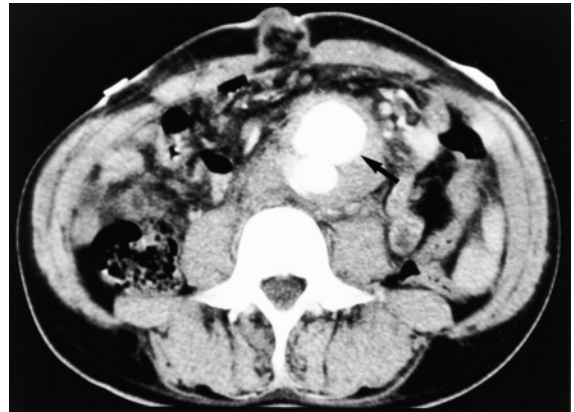
### Patient 1

A 71-year-old man underwent elective repair of an 8.2-cm infrarenal AAA with a straight Dacron tube graft. He made an uneventful recovery and was discharged home, well, on the tenth postoperative day. Three months later he developed sudden right hypochondrial pain. A contrast-enhanced computed tomogram (CT) scan performed at that time showed a moderately dilated aneurysm sac. The pain resolved and he was followed up in the out-patient clinic. A year later he re-presented as an emergency with abdominal pain and collapse. An urgent CT scan and digital subtraction angiogram (DSA) confirmed leakage of contrast at the lower end of the graft anastomosis (Figs 1 and 2) due to a loose suture. Because of the possibility of an infective cause, the original Dacron tube graft was removed and a new Dacron bifurcated graft was successfully sutured in place. He made an uneventful recovery and no evidence of infection was found on culture.

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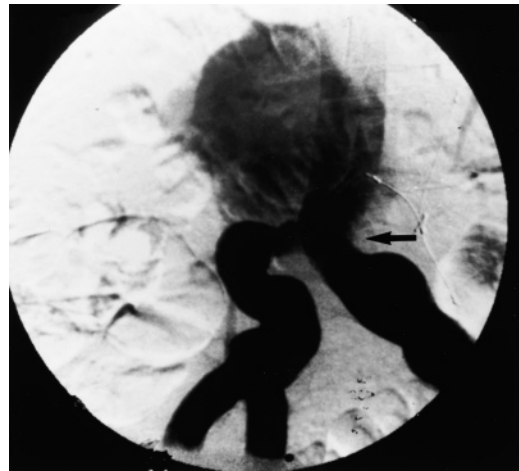
**Fig. 1.** Digital subtraction angiogram of the aorta and iliac vessels with extravasation of contrast outside the Dacron graft.



**Fig. 3.** Contrast CT scan demonstrating leakage of contrast into the aneurysm sac (black arrow).



**Fig. 2.** Digital subtraction angiogram (lateral view) showing leakage of contrast from the anastomotic suture line (black arrow).



**Fig. 4.** Digital subtraction angiogram demonstrating leakage of contrast from the distal anastomotic suture line (black arrow).

## Patient 2

A 71-year-old man had an elective repair of a 9.7-cm infrarenal AAA with a straight Dacron tube graft. Preoperatively he had suffered a deep-vein thrombosis, treated with an inferior vena cava filter. He was discharged home 2 weeks following his operation and was well for 18 months, when he then developed left-sided back pain. An urgent CT scan (Fig. 3) and DSA revealed the presence of a perigraft endoleak (Fig. 4). At operation complete breakdown of the left side of the distal anastomosis was confirmed due to breakage of the Prolene suture. He underwent a successful emergency repair with a new Dacron bifurcated graft. There was no evidence of infection.

**Patient 3**

An 80-year-old man underwent an emergency bifurcation graft repair for a leaking 8-cm aneurysm of the aorta and left common iliac artery. He recovered well from the operation despite having had history of poor cardiovascular function (hypertension, myocardial infarction and a permanent pacemaker): he was discharged 3 weeks from the time of surgery. One month later he developed back pain and a CT scan and DSA revealed leakage of contrast at the proximal anastomosis. At operation, the anastomosis suture was loose and there was no evidence of infection; the defect was successfully resutured and did not necessitate removal of the graft.

**Patient 4**

A 58-year-old man with a leaking 6.1-cm inflammatory AAA underwent urgent repair with a straight Dacron tube graft. He was discharged home, well, on the fifteenth postoperative day. However, he presented 1 month later with pyrexia and back pain. A CT scan and DSA revealed an endoleak from the anterior part of the distal anastomosis. This was successfully managed by resuturing of the anastomosis and did not require a new graft. There was no evidence of infection.

**Patient 5**

A 59-year-old man had an elective straight Dacron tube graft for a 6.2-cm AAA and was discharged home, well, 10 days following surgery. He presented 2 months later with hypotension and tachycardia. He underwent an emergency laparotomy for suspected bleeding. He was found to have an endoleak at the distal anastomosis due to a loose suture. Haemorrhage being confined within the aneurysm sac, this was successfully repaired by direct resuturing. There was no evidence of infection.

**Patient 6**

A 70-year-old man had a bifurcated woven Dacron graft for a ruptured 7-cm AAA. He was discharged home after an uneventful postoperative recovery. He presented 2 months later with back pain. An emergency CT scan was performed and demonstrated an endoleak in the region of the left common iliac artery.

He underwent an emergency laparotomy and was found to have an endoleak at the left distal anastomosis due to a loose suture. This was successfully treated by tightening the original suture. There was no evidence of infection.

For all six patients the primary repair was carried out using a woven Dacron polyester fabric graft sutured with continuous 3'0' Prolene (Ethicon™) or 3'0' Surgilene (Davis & Geck™) at both proximal and distal ends by a consultant surgeon or senior vascular trainee under consultant supervision. In no cases was there evidence of local or systemic infection from cultures of tissue, graft, blood or CT scans or evidence of blood outside the sac of the aneurysm. Following repair of the anastomotic suture-line endoleaks, all patients were discharged home without further complication and none have developed further anastomotic problems to date (median follow-up period of 3 years, range 6 months to 5 years). One patient has died due to myocardial infarction 9 months after repair of his endoleak.

**Discussion**

The term "endoleak" was originally proposed to describe incomplete aneurysm exclusion by an endoluminal graft.<sup>3,6</sup> The resultant paragraft flow within the aneurysm sac is thought to arise from an inadequate or incomplete seal between the aorta and endoluminal graft due to stent displacement of aortic expansion, but other potential sources of an endoleak include patent aortic side-branches<sup>7</sup> and a defect in the body of the graft itself. The incidence of primary endoleaks has been reported to range from 5–44%,<sup>8–10</sup> of which up to 50% may seal spontaneously.<sup>11</sup> However, the true prevalence is unknown and demonstration of the defect depends on the method of examination.<sup>5</sup>

Various combinations of contrast enhanced CT scanning, angiography, plain abdominal X-ray and colour-flow duplex scanning have been employed to detect endoleaks.<sup>6,11,12</sup>

The ideal method has not been established, but it is clear that detection of continued aneurysm sac expansion is presently the most reliable indication of an endoleak.<sup>5,12</sup> In our small series of patients, we have found a previously unrecognised complication of open AAA repair, of inappropriate blood flow within the aneurysm sac arising from the distal anastomotic suture line in five cases and proximal in one. There was no evidence in any of the cases of Dacron graft defects or patent lumbar or inferior mesenteric vessels. However, there may be pressure "cheese-wiring" through

**Table 1. Summary of diagnosis, presentation and management of endoleaks following conventional open abdominal aortic aneurysm repair.**

Case no.	Age (years)	AAA size (cm)	Open repair AAA	Aortic graft configuration	Endoleak site (anastomosis)	Time of presentation post AAA repair (months)	Diagnosis	Surgical treatment
1	71	8.2	Elective	Tubular	Distal	12	CT scan and DSA	Graft replacement
2	71	9.7	Elective	Tubular	Distal	18	CT scan and DSA	Graft replacement
3	80	8	Emergency	Bifurcated	Proximal	1	CT scan and DSA	Resuture
4	58	6.1	Emergency	Tubular	Distal	1	CT scan and DSA	Resuture
5	59	6.2	Elective	Tubular	Distal	2	Laparotomy	Resuture
6	70	7	Emergency	Bifurcated	Distal	2	CT scan	Resuture

poor-quality tissue or calcified plaque not allowing close approximation of tissues. All these patients had made an uneventful postoperative recovery following the primary AAA repair and it is reasonable to presume that the leaks have developed late.

Until now endoleaks which may arise as late as one year after initially successful endoluminal grafting have been recognised as a mechanical complication confined to endovascular graft placement. Our experience suggests that it should also be included as a rare complication of open methods and should certainly be looked for in any comparative trials. The incidence of endoleak following open AAA repair is less than 1% (personal series of 453 consecutive AAA repairs with three endoleaks occurring in cases performed by trainees under consultant supervision (PRT)), but could be more common than expected from clinical presentation, as many may seal spontaneously as in endoluminal grafting. Certainly, symptomatic cases appear to be relatively rare. The precise cause of an endoleak following open AAA repair is unclear, but is likely to be due to technical factors such as insufficient tension in a continuous suture line, suture fatigue and breakage, deficient anchorage or cheese-wiring through calcified plaques. We propose that the term "endoleak" should also be used for the late presentation of non-infective leaks into and confined within the sac following open AAA repair. An endoleak should certainly be considered in all patients who present with symptoms of abdominal or back pain within eighteen months of open AAA repair. If the leak is large, diagnosis may be obvious on a contrast CT scan, but leaks of smaller volume may require arteriography with lateral views for diagnosis and preoperative localisation. We have also suggested a

**Table 2. Classification of endoleak following conventional open AAA repair.**

Classification	Aetiology	Therapeutic management
Type Ia	Loose suture	Direct resuture
Type Ib	Suture breakage	Direct resuture
Type II	Complete disruption secondary to wall disintegration	Graft replacement

classification system for endoleaks following conventional open AAA repair (Table 2). A Type I endoleak would refer to suture problems in relation to lack of tension or breakage and would usually only require direct resuture. A Type II endoleak would refer to arterial wall disintegration, which would necessitate graft replacement. With accurate preoperative diagnosis the chance of successful open repair appears good. Early diagnosis may also give an opportunity to consider endoluminal methods of repair in the future.

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