POSTOPERATIVE ARTERIAL THROMBOSIS IN MAJOR LIMB ARTERIES: A SURGICAL HAZARD

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Venous thrombosis in the lower extremities is a well-recognized and not uncommon postoperative complication. It is associated with a significant mortality and morbidity from pulmonary emboli and post-thrombotic limb sequelae and most surgeons are on the alert for it. By contrast, although far less common, *postoperative arterial thrombosis* in the lower extremities is equally, if not more, hazardous. Unfortunately, its frequency is not generally appreciated. Furthermore, the onset is often silent and the diagnosis may be delayed with serious consequences. Gangrene may occur and result in a major amputation. Apart from the disability, a major amputation carries a significant mortality rate in the middle-aged and elderly, which in thigh amputations may be as high as 20% (Gilchrist 1961). It therefore behoves the surgeon to be aware of this serious complication and to prevent or diagnose and treat it as soon as possible.

Key[1] reported on 4 patients who developed postoperative arterial thrombosis. The diagnoses were made after they had been discharged from hospital, when they complained of intermittent claudication. This paper is a report of 15 cases of postoperative arterial thrombosis that occurred in the lower extremities of patients who had a variety of surgical operations, and which manifested either in the early postoperative period, or subsequently when the patient was discharged and ambulant. The following are the case histories of the patients concerned, the relevant features of which are summarized in Table I.

CASE REPORTS

Case 1

A 67-year-old male had a prostatectomy 2 years after an attack of myocardial infarction. Three days following the operation he complained of numbness and paralysis of the right foot. There was no history of previous arterial insufficiency and there was no record of the state of the pulses pre-operatively. Examination showed coldness and pallor of the right leg and foot with mild cyanosis of the toes. The femoral pulse was palpable but the popliteal and ankle pulses were absent. On the left, the posterior tibial pulse at the ankle was not palpable. He was given anticoagulants, and 2 days later because of the onset of pain and the threat to the viability of the limb, a right femoral arteriogram was done. This showed an occlusion of the popliteal artery with no refilling of the tibial vessels. The superficial femoral artery was irregular and narrow. The popliteal artery was explored at the bifurcation. Recent thrombus superimposed on atheroma was found, and as there was no backflow the arteriotomy was closed. Pain persisted after the operation with slow deterioration of the limb and an above-knee amputation was carried out 10 days later. A prosthesis was subsequently fitted. Six months later, the patient died from another attack of coronary thrombosis.

Case 2

A 63-year-old male had a cholecystectomy. Nine days later he complained that the left foot was numb and painful. There was a history of mild claudication in the left calf before the operation. On examination, the left foot was cold with marked postural colour changes. The left femoral pulse was present but no distal pulses were palpable. In the right lower limb all the pulses were present. Soft systolic bruit were audible over both common femoral arteries. A left femoral arteriogram showed a femoro-popliteal occlusion extending distally to involve the proximal tibial vessels. Direct arterial surgery was not considered possible and when his pain became intolerable, an above-knee amputation was carried out. Examination of the occluded artery showed thrombosis superimposed on atheroma.

Case 3

A 71-year-old hypertensive female patient was admitted with established gangrene of the left leg and foot. No pulses were palpable in the affected limb. On the right, the femoral pulses were present but the popliteal and ankle pulses were absent. An above-knee amputation was done on the left. On routine examination the following morning, the right leg and foot were cold, mottled and anaesthetic. The patient was weak and did not complain of any symptoms. A right above-knee amputation was carried out the following day. She died 8 hours later from a cerebrovascular incident. The amputated limbs showed occlusion of both femoro-popliteal arteries by atheroma and superimposed thrombus.

Case 4

An 80-year-old male sustained a fracture of the neck of the right femur, for which a Smith-Petersen pin was inserted under general anaesthesia. There was a long history of intermittent claudication in both lower extremities, and dyspnoea on effort. On the next day, extensive mottling and coldness of both lower extremities, extending on to the abdomen, was observed. The legs from the knees down were paralysed and anaesthetic. The patient did not complain of pain. An aorto-iliac occlusion was diagnosed, but because of his poor general condition, operation was not done. He lapsed into coma, failed to pass any urine and died 2 days later, presumably from renal failure. The history of dyspnoea and claudication on effort is strong presumptive evidence of pre-existing atherosclerosis. There was no pre-operative record of the state of the pulses in the lower limbs.

Case 5

A 59-year-old male complained of progressive bilateral claudication of the calf and pain at rest in the right foot of

TABLE I. SUMMARY OF SALIENT CLINICAL FEATURES IN PATIENTS SUFFERING FROM POSTOPERATIVE ARTERIAL THROMBOSIS

Case no.	*Age*	*Sex*	*Operation*	*Presentation*	*Site of occlusion*	*Pre-op. pulses*	*Treatment*
1	67	M	Prostatectomy	Numbness and paralysis	Popliteal	Not recorded	Arteriotomy, amputation
2	63	M	Cholecystectomy	Numbness and pain	Femoro-popliteal	Not recorded	Amputation
3	71	F	Thigh amputation	Cold, mottled extremity	Femoro-popliteal	Recorded	*Amputation
4	80	M	Smith-Petersen pin	Mottling and coldness	Aorto-iliac	Not recorded	*Conservative
5	59	M	Bilateral sympathectomy	Mottling and coldness	Aorto-iliac	Recorded	*Conservative
6	62	F	Hiatus hernia	Numbness	Popliteal	Not recorded	Amputation
7	57	M	Inguinal hernia	Claudication	Iliac	Not recorded	Endarterectomy
8	63	M	Prostatectomy	Claudication	Aorto-iliac	Not recorded	Conservative
9	58	M	Haemorrhoidectomy	Numbness	Femoro-popliteal	Not recorded	Conservative
10	59	M	Tendon transfer	Cyanosis	Tibial	Recorded	Toe amputation
11	54	F	Varicose veins	Ulcer	Popliteal	Recorded	Conservative
12	58	F	Thrombo-endarterectomy	Absent pulses	Femoro-popliteal	Recorded	Conservative
13	52	F	Intestinal obstruction	Pain	Femoro-popliteal	Not recorded	*Thrombectomy, amputation
14	82	M	Thigh amputation	Pain	Femoro-popliteal	Recorded	*Amputation
15	55	M	Nephrectomy	Claudication	Femoro-popliteal	Recorded	Pending

* = Deaths.

several months' duration. Apart from a weak femoral pulse on the left, no pulses were found in the lower extremities. Severe postural colour changes were present. An aortogram showed extensive aorto-iliac and femoro-popliteal occlusion. A bilateral lumbar sympathectomy was done, and at operation atherosclerotic plaques were felt in the wall of the aorta. Several hours after the operation both feet were found to be mottled and cold, and the left femoral pulse had disappeared. Later, he complained of paralysis of the legs but not of pain. Because of persistent hypotension, myocardial infarction was suspected and confirmed on ECG. The patient died from cardiac failure on the third postoperative day. The cause of the ischaemic changes in the lower limbs was probably an extension of thrombosis in atherosclerotic vessels, precipitated by hypotension.

Case 6

A 62-year-old female had a transabdominal repair of a hiatus hernia. The postoperative course was complicated by distension and vomiting, which was treated by gastric suction and the administration of intravenous fluids for 5 days. On the 10th postoperative day she complained of numbness in the left foot. Examination showed the left foot to be colder than the right, with absent popliteal and ankle pulses. The right dorsalis-pedis pulse was also absent. There was no history of arterial insufficiency before the operation. ECG was normal. She was treated conservatively, but after discharge from hospital she complained of claudication in the left calf and occasional mild nocturnal rest pain. Arteriography showed an occlusion of the left popliteal artery with diffuse narrowing of the superficial femoral artery and segmental areas of occlusion in the tibial vessels. Reconstructive surgery was not considered possible and several weeks later, because of persistent pain on resting, an above-knee amputation was carried out. The amputated limb showed atherosclerosis of the popliteal artery.

Case 7

A 57-year-old male had a repair of a right inguinal hernia. Soon after discharge from hospital he complained of pain in the right calf after walking a distance of about 300 yards. While in hospital he did not notice anything unusual in the affected leg. There was no record of the pulses in the lower limbs before the operation. After 2½ months he was readmitted to hospital with severe pain and coldness of the right foot, of sudden onset. Examination showed a cold foot with marked postural colour changes and no pulses in that limb. All the usual major pulses were present in the left lower extremity, but on auscultation a soft systolic bruit was audible over the left iliac artery. Aortography showed irregularity of the left common iliac artery and a segmental occlusion of the right common and external iliac arteries. The common femoral and profunda femoris arteries were patent, but there was an occlusion of the superficial femoral artery at the adductor hiatus. A thrombo-endarterectomy of the common and external iliac arteries was done with complete relief of symptoms. The peri-adventitial tissues of the iliac artery were oedematous, suggesting that this was the site of the more recent occlusion. The 'core' of tissue removed from the iliac artery showed atheroma.

Case 8

A 65-year-old male had a prostatectomy for a benign hypertrophy of the middle lobe. The operation was uneventful, but about 2 weeks after discharge, when he resumed his normal activities, he complained of claudication in both calves, which forced him to rest after walking about 200 yards. While in hospital he had noticed nothing unusual in his lower limbs. Before the operation, he had felt lameness in the legs on walking, but no pain. There was no pre-operative record of the state of the pulses. On examination, both femoral pulses were reduced in amplitude, and the popliteal and ankle pulses were absent. There was a systolic bruit over the aorta and iliac arteries. Because he was retired and his symptoms not incapacitating, surgery was not offered to him. The history of lameness in the legs and the presence of a bruit suggests that arterial disease was present pre-operatively. The postoperative claudication was probably the result of pre-existing thrombosis.

Case 9

A 58-year-old male had a haemorrhoidectomy in the lithotomy position. After the operation, he felt numbness in the right leg. About a week later, after discharge from the hospital when he was fully ambulant, he experienced claudication in the right calf. There was no history of arterial insufficiency before the operation and no record of the state of the pulses. Examination showed absent popliteal and ankle pulses on the right. All the pulses were present on the left. Because his symptoms improved spontaneously and were not incapacitating, surgery was not advised.

Case 10

A 59-year-old male underwent a bilateral flexor-to-extensor tendon-transfer operation for claw toes. The posterior tibial pulses at the ankles were known to be absent before operation. The operation, which took about 2 hours, was done under a bloodless field, using an Esmarch's bandage. After the operation, cyanosis of the left third and right fourth toe, with subsequent gangrene, developed. The gangrenous toes were amputated through the lines of demarcation without suture of the skin and with complete healing.

Case 11

A 54-year-old female had a bilateral vein-stripping operation of both saphenous systems of veins. There was no history of previous arterial insufficiency and the pulses were stated to be present before the operation. On the third postoperative day, she complained of discomfort behind the right heel and was found to have a small area of pressure necrosis. After discharge from hospital on the 7th day, she complained of mild numbness of the foot and weakness of the calf on walking. On examination, there was a healing ulcer on the posterior aspect of the heel. The popliteal pulse was weak and the tibial pulses were absent. The ulcer healed after 6 weeks and her symptoms improved on conservative treatment.

Case 12

A 58-year-old female gave a long history of bilateral claudication. No pulses were felt in the lower extremities. ECG was normal. An aorto-iliac thrombo-endarterectomy was done and at the end of the operation all the lower-limb pulses were present and of good amplitude. Half an hour later, while in the recovery room, there was a marked fall in blood pressure associated with pulmonary oedema. She was treated for left-ventricular failure. An ECG at the time showed no obvious abnormality. Shortly afterwards the pulses in the left lower extremity became impalpable. When the blood pressure had been satisfactorily restored by vasopressors, the left femoral pulse re-appeared, but not the distal pulses in that limb. A subsequent ECG showed changes of posterior myocardial infarction. At no time did she complain of pain in the limb. Five days later, she complained of pain in the chest and coughed up a small quantity of blood-stained sputum. Because of tenderness in the left calf, pulmonary embolism caused by deep vein thrombosis was diagnosed, and the left superficial femoral vein ligated under local anaesthesia. After discharge from hospital and when she resumed her normal activities, she complained of mild claudication in the left calf, which was less intense than before the operation. Examination of the 'core' removed at the thrombo-endarterectomy showed atheroma as the underlying cause of the aorto-iliac occlusion.

Case 13

A 52-year-old female was admitted complaining of abdominal pain and vomiting of 5 days' duration, and pain and numbness of the right leg and foot of 24 hours' duration. Five weeks previously a Billroth I gastrectomy had been carried out for a gastric ulcer and 3½ weeks later, a laparotomy was done for intestinal obstruction. On examination, she was

lethargic and dehydrated. Signs consistent with peritonitis were found, the abdomen was distended, tender and silent. The right leg and foot were cold, and the fore-foot anaesthetic. The right femoral pulse was present but the distal pulses absent. On the left, the ankle pulses were absent. ECG was normal. There was no record of the limb pulses during her previous illnesses. Because the abdominal condition was more serious, laparotomy was done first. The gastro-duodenal stoma was found to be obstructed and a gastro-jejunostomy carried out. After this, a thrombus was removed from the superficial femoral, popliteal and posterior tibial arteries. There was no backflow from either the anterior or posterior tibial arteries. The limb deteriorated and 6 days later an above-knee amputation was done. Examination of the femoro-popliteal artery in the amputated limb showed no obvious atheroma. The patient subsequently died of bronchopneumonia.

Case 14

An 82-year-old hypertensive male was admitted for pain of the left foot on rest, which had been present for 6 weeks. The femoral pulse was present, but the distal pulses were absent. All the pulses were present in the right lower extremity. A left femoral arteriogram showed an occlusion of the superficial femoral artery commencing in the mid-portion of Hunter's canal and extending distally to involve the tibial arteries. Reconstructive arterial surgery was not considered possible. ECG showed advanced myocardial ischaemia. Because of persistent pain on rest an above-knee amputation was carried out. After the operation there was a fall in blood pressure with changes in the ECG compatible with further coronary occlusion. On the 7th postoperative day he complained of mild pain in the right foot. Examination showed mottling, coldness and anaesthesia of the foot. The proximal part of the right popliteal artery was palpable, but no pulses were present distally. The popliteal bifurcation was exposed under local anaesthesia and showed recent thrombus superimposed on atheroma. There was no backflow from the anterior and posterior tibial arteries and the arteriotomy was closed. This foot deteriorated slowly and 5 days later an above-knee amputation was done. Four days later he became confused and died, presumably from a cerebrovascular accident.

Case 15

A 55-year-old male had a left nephrectomy for hydronephrosis. The previous history told of pain in both calves on walking a distance of about 500 yards, which was relieved by rest. After the operation, the pain became worse and forced him to rest after walking a distance of about 150 yards. On examination, both femoral pulses were easily palpable but the popliteal pulses were diminished and the ankle pulses absent. Bruit were audible over both femoral arteries. Postural colour changes were evident on both feet, but more marked on the right. Because his symptoms were incapacitating, bilateral femoral arteriography was advised. At the time of writing, the patient had not returned for this investigation. The history of previous claudication and the presence of femoral bruit was indicative of pre-existing arterial disease. The worsening of his claudication after the operation strongly suggested an extension of pre-existing thrombosis.

DISCUSSION

In arterial occlusion of a major limb artery there is often difficulty in differentiating between thrombosis and embolism. The clinical features alone are not always diagnostic because in both the onset may be acute and dramatic, or insidious and mild. Embolism, in fact, may be silent (Learmonth[2]). Even the presence of a cardiac lesion does not prove the diagnosis of embolism, especially if the patient is middle-aged or elderly, and the cause of the heart condition is atherosclerosis; atherosclerosis is a generalized disease and a patient suffering from fibrillation caused by coronary atheroma may well have atheroma in the lower extremities. An acute peripheral occlusion under these circumstances may then denote either embolism or thrombosis.

The commonest cause of arterial occlusion is thrombosis with atheroma as the usual precipitating factor. There was good evidence of atherosclerosis in the lower limbs of all the patients in this study, except case 9. In 8 patients atheroma was encountered at arterial exploration or at amputation, and in 5 patients the absent pulses in the contra-lateral limb, or the appearance of the arteries on arteriography, was presumptive evidence of atheroma. The age incidence of the patients and the absence of ischaemic episodes in the upper extremities is also in keeping with this. In view of this, it is considered probable that the cause of the arterial occlusions in these patients was thrombosis and not embolism.

Precipitating Factors

Although arterial thrombosis is common in atherosclerosis, and often occurs without any apparent precipitating incident, it would be difficult to deny a causal relationship between the operations and the subsequent thrombotic episodes. It is well recognized that hypotension owing to blood loss, trauma or dehydration, cardiac failure, polycythaemia, altered states of blood coagulability or local arterial trauma may precipitate thrombosis in atherosclerosis. One or more of these factors could have been responsible in these patients. The precise mechanism involved in the individual patient is often difficult to establish in a retrospective study. However, in some of the patients, apart from the well-accepted state of increased blood coagulability after surgery, the thrombotic complications could almost certainly be ascribed to certain incidents which occurred in the postoperative period, e.g. in case 6 (hiatus-hernia repair) there was vomiting after the operation which was treated by prolonged naso-gastric suction and intravenous therapy. The fluid-balance charts showed a diminished urinary output, suggesting dehydration as a possible cause. In case 13 (intestinal obstruction) dehydration was also a possible factor. In case 12 (aorto-iliac thrombo-endarterectomy) acute left ventricular failure occurred about ½-hour after the operation. There was a precipitous fall in blood pressure with subsequent occlusion of the left superficial femoral artery. Electrocardiography showed a posterior myocardial infarct. The severe hypotension was probably responsible for precipitating the arterial occlusion. In case 14, (thigh amputation) postoperative hypotension was the probable cause. In case 9 (haemorrhoidectomy) it is possible that flexion of the knee and hip joints in the lithotomy position, or pressure on the thigh by the post, was responsible for the arterial occlusion. In case 10 (flexor-to-extensor tendon transplantations) the prolonged application of tourniquets to both lower limbs, in which there was known pre-existing arterial disease, was almost certainly a precipitating factor.

Absence of Pain

Acute arterial occlusion of a major limb artery usually presents with pain, numbness or coldness of the extremity, or the sudden onset of claudication. In these patients pain was not a notable feature, except in 2 cases (Table I). In

4 patients the limbs were found to be ischaemic on routine examination, and in 5 because they complained of numbness or coldness of the extremity. In 4 patients, symptoms of arterial insufficiency were not experienced while in hospital. The diagnosis became apparent in this group after discharge from hospital, when they became fully ambulant and complained of intermittent claudication.

Although sudden occlusion of a major artery may occur silently, this is rare, and the absence of pain as a presenting feature in most patients in this series must be regarded as unusual. Key[1] stated that postoperative arterial thrombosis is often of a silent nature, could occur with surprising frequency and was possibly not well-known or appreciated. How then can the absence of pain be explained? Several factors are probably responsible. Atherosclerosis, the underlying pathology in all these cases, is usually a slowly progressive disease. As the arterial lumen becomes slowly narrowed, the collateral circulation develops *pari-passu*. Should thrombosis supervene in the presence of a pre-existing efficient collateral circulation, the symptoms may then be mild and transient, and may even pass unnoticed by the patient. Another factor to be taken into account is that an operation may modify the clinical features of certain illnesses when they occur in the post-operative period. Intestinal obstruction, for example, seldom presents with colicky pain; the features are usually those of a paralytic ileus. Postoperative coronary thrombosis too, may be silent and completely overlooked if the atypical presentation is not recognized. Frequently, the first clue to the diagnosis may be an unexplained fall in blood pressure or the development of an arrythmia.

The absence of pain can be accounted for in other ways. The patient is recumbent and relatively immobile, and the circulatory needs of the resting limbs are reduced. This could explain why the condition manifested itself in some patients only when they were ambulant, when they complained of claudication. A further explanation is that in the postoperative period, sedatives or analgesics are frequently given and thus perception of pain is often dulled. Or, perhaps the pain of the ischaemic limb is overshadowed by that of the operation.

Although postoperative venous thrombosis is common, it is surprising that arterial thrombosis after surgery is unusual, having regard to the frequency of atherosclerosis in the lower extremities. Perhaps the slower velocity of blood flow in veins and the greater susceptibility of veins to trauma and spasm, are responsible for the higher incidence of venous thrombosis. It is possible, however, that the real incidence of arterial thrombosis after surgery is greater than is apparent, because of the silent nature on presentation in many patients. Only by routine examination and recording of the peripheral pulses before and after surgery, will the true incidence of the condition become known.

A disconcerting finding in this study was that investigation of the pre-operative records showed that examination of the lower limb pulses was omitted in most of the patients. Excluding the 3 patients in whom surgery was performed for arterial insufficiency, in only 2 of the 12 patients was there a record of the pulses before the operation. That the routine recording of limb pulses in surgical patients is not common practice, was shown on investigating the clinical records of patients (not suffering from peripheral vascular disease) in general surgical units. Out of 78 patients the peripheral pulses were recorded in only 13.

The treatment of the ischaemic limbs in these patients followed well-established surgical principles. If the viability of the limb was threatened and the general condition of the patient was satisfactory, arteriography or exploration of the occluded artery was done to determine whether reconstructive arterial surgery was feasible. However, in most cases it was not done (Table I). The arteriogram showed that extensive distal thrombosis or gangrene appeared inevitable. In those patients who presented with claudication, surgery was offered only if the symptoms were incapacitating. Most were elderly with mild symptoms and did not require reconstructive vascular surgery.

Morbidity and Mortality

Sudden arterial thrombosis in a major limb artery, and especially in the postoperative period, is a serious complication. In this series of cases, 6 out of 15 ischaemic limbs (40%) had to have a major amputation, all above the knee. The total mortality was 33·3% (5 patients) of which 3 (50%) followed above-knee amputation. The high mortality is understandable considering that a major amputation, in itself a procedure carrying a significant mortality rate, was carried out in patients who had just previously had a major surgical procedure. Furthermore, atherosclerosis, the underlying precipitating factor in these patients, is usually a generalized disease and these patients are often not good surgical risks.

Prevention

Although postoperative arterial thrombosis may not always be preventable, the incidence could conceivably be diminished by taking certain precautions. A pre-operative evaluation of the peripheral circulation, especially the pulses of the lower extremities, should be a routine part of the examination, particularly in middle-aged and elderly patients. Examination of the pulses demands no special skill and can be rapidly done. An absent pulse is usually good presumptive evidence of atherosclerosis obliterans and the possibility of latent arterial disease elsewhere, such as in the coronary and cerebral vessels, should always be considered. According to McDonald[3] peripheral vascular disease is associated with subjective or objective signs of coronary artery disease in 40% of patients presenting with intermittent claudication. Previous knowledge of the presence of atherosclerosis should alert one to the possibility of postoperative vascular complications. Steps to prevent them, such as adequate oxygenation of the patient during surgery, avoidance of hypotension from whatever cause, and perhaps anticoagulant therapy, commencing either before or soon after the operation, should be considered. Low molecular weight dextran ('rheomacrodex') may be useful.[4] Other predisposing factors such as dehydration, anaemia, electrolyte imbalance, cardiac arrhythmias, excessive trauma to tissues and excessive blood loss, should be avoided or promptly treated, either before, during or after operation.

In the same way as the temperature and pulse rate are recorded daily and the lower limbs examined for evidence of venous thrombosis as a routine procedure postoperatively, the state of the peripheral pulses should be noted. Although the disappearance of a major pulse after operation usually denotes thrombosis, this is not always so, and embolism from a silent coronary thrombosis may be the cause. It should be remembered that the first clue to a silent coronary thrombosis may be the onset of a peripheral arterial occlusion.[5] The BP, too, should be frequently recorded after major surgery. Not only does a fall in blood pressure predispose to arterial thrombosis, but an unexplained fall in blood pressure may also indicate a silent coronary thrombosis. Thus, even in the absence of a cardiac history, middle-aged and elderly patients undergoing major operative procedures should always have an ECG investigation.

Great care should be taken to avoid unnecessary trauma to the limbs during surgery. Acute flexion of joints and pressure on the limb should be avoided. Pressure points should be carefully protected and tourniquets eschewed where there is pre-existing arterial disease. Active movements in bed, breathing exercises and early ambulation should be encouraged. Not only does this improve the venous return, but the arterial circulation is also enhanced. Sedatives and analgesics should be used judiciously so as not to suppress physical activity unduly.

SUMMARY

1. 15 cases of arterial thrombosis of major lower limb arteries following surgery, are reported. The predisposing factor was atherosclerosis.

2. Pain was not a notable presenting feature, the reasons for which are discussed.

3. The condition manifested itself either in the early postoperative period or as claudication when the patient was discharged and ambulant.

4. The morbidity and mortality rates were high.

5. Measures to prevent this serious complication are discussed.

6. A plea is made for the routine pre- and postoperative examination of pulses in the lower extremities of middle-aged and elderly people undergoing major surgery.

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ADDENDUM

Since this report was submitted 2 additional cases of postoperative arterial thrombosis have been encountered. Severe painless ischaemia of the right upper extremity, resulting from occlusion of the subclavian artery, occurred in one patient. The patient died of a cerebrovascular accident. In the second patient severe ischaemia of a leg occurred after its opposite member had been amputated for gangrene.

REFERENCES

1. Key, J. A. (1960): Surgery, **47**, 743.
2. Learmonth, J. R. (1948): Edinb. Med. J., **55**, 449.
3. McDonald, L. (1953): Brit. Heart J., **15**, 101.
4. Bergentz, S-E., Gelin, L-E., Rudenstam, C. M. and Zenderfelt, B. (1963): Acta chir. scand., **122**, 343.
5. Harrison, C. E., Spittell, H. A. and Mankin, H. T. (1962): Proc. Mayo Clin., **37**, 293.