VASCULAR INSUFFICIENCY COMPLICATING TRAUMA
TO THE LOWER LIMB

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Damage to blood vessels is a well known but fortunately uncommon complication of limb injuries (Kirkup 1963, Eastcott 1965, Nolan and McQuillan 1965). Early diagnosis is the most important single factor for successful vascular reconstruction.

This paper records our experience with five cases of traumatic vascular injuries of the lower limb seen in these hospitals in the past year.

Case 1—A man aged thirty-five was transferred from a hospital 300 miles away with a fracture of the shaft of the left femur. When first seen forty-eight hours after the accident he complained of anaesthesia and loss of movement of the left foot since the limb was manipulated and immobilised in a Thomas's splint with fixed skin traction about two hours after the injury.

On examination there was severe swelling of the left thigh, which was obviously shorter than the right. There was loss of movement of the left ankle and toes, with pallor, coldness and anaesthesia extending up to the junction of the upper and middle thirds of the leg. The popliteal posterior tibial and dorsalis pedis pulses were absent on the left side; all other pulses were palpable. No bruit was heard over the line of the femoral artery. Arteriographs revealed a leak from the lower superficial femoral artery, which was in severe spasm (Fig. 1).

Operation—While the femoral artery was being exposed cardiac arrest occurred and open cardiac massage was necessary. During resuscitation a clip was applied to the superficial femoral artery proximal to the leak, to prevent further blood loss. A tear affecting half the circumference of the artery was found and, as the intima surrounding the tear appeared undamaged, direct suture was performed. On removal of the clamps good pulsation returned beyond the repair. A medullary nail was inserted into the femur.

Soon after the operation a line of demarcation was obvious on the leg, the previously pale lower part having taken on a dark shade. By next morning blistering had occurred on the antero-lateral aspect of the leg. The limb was warm as far as the ankle, and on the following day the proximal half of the foot was warm.
On the fourth day after operation there was gangrene of all five toes. Three weeks later the proximal two-thirds of the foot was warm, but gangrene had spread to include the forefoot and the blistered skin had sloughed, which needed skin grafting. Before amputation of the foot could be carried out, the patient took his own discharge and left the country. Arteriographs on the day before his departure showed narrowing of the artery at the site of repair and a block in the anterior tibial artery near its origin (Fig. 2).

Comment—Muscle undergoes irreversible changes after six hours of complete ischaemia (Nolan and McQuillan 1965), and continuing gangrene of the extremity due to previous acute ischaemic damage is a common experience after successful restoration of the main artery. However, unless the limb is obviously beyond any hope of survival, arterial reconstruction should always be attempted irrespective of the time elapsed since injury.

Case 2—A man aged forty was first seen six hours after sustaining an open fracture of the shaft of the right femur. From ten centimetres above the knee the limb was pale, cold and anaesthetic, with no active movements of the toes or ankle. No pulsation was found in the limb below the femoral artery, but all other pulses were readily palpable.

Arteriographs revealed a complete block in both superficial and deep femoral arteries, and a separate proximal segment of the superficial femoral artery did not fill with opaque fluid (Fig. 3).

Operation—A laceration involving five to seven centimetres of both superficial and deep femoral arteries and veins was found, with extensive destruction of all thigh muscles except the lateral head of the biceps femoris muscle. The nerves were intact. There was no active bleeding and surprisingly little haematoma. The fracture was reduced and a medullary nail inserted. The arteries were cleared of clots and a reversed saphenous vein graft, taken from the left leg, was used to join the superficial femoral and popliteal arteries. This produced brisk bleeding from the popliteal vein. This latter was then united to the femoral vein by means of another saphenous vein graft from the same vein.

Hypotension persisted for twenty-four hours after operation, and on the second day the lower half of the leg was still cold. Arteriographs showed the graft to be functioning satisfactorily, but the arteries were patent only as far as the upper leg region (Fig. 4). The operation wound was reopened and satisfactory flow was re-established. The graft used to join the veins had clotted.

The limb did not recover, and below-knee amputation was carried out a week after the grafting operation. Brisk bleeding was observed at the stump.

Comment—The vessel ends are often damaged more extensively than would appear on inspection and about one centimetre of apparently normal artery should be resected on either side of the injured segment (Nolan and McQuillan 1965). On releasing the clamps in this case
a leak occurred above the anastomosis although all apparently damaged vessel wall had been resected. The anastomosis was refashioned after excision of another centimetre of the proximal artery.

Hypotension may have precipitated the venous thrombosis in this case and must be avoided. As in Case 1, successful vascular reconstruction was followed by continuing peripheral gangrene.

Case 3—A man aged thirty was admitted with a dislocation of his left knee which was reduced under general anaesthesia. Nothing untoward was reported until thirty-six hours later when the toes of his left foot were colder than those of the right and there was loss of sensation. He was unable to move his toes or ankle and pulses were absent below the femoral on the left side, all other pulses being normal. Swelling was not marked and no bruit was heard.

Arteriographs revealed a block in the popliteal artery with no dye visible below this level (Fig. 5).

The lower femoral and popliteal arteries were exposed and a contusion of the popliteal artery 2.5 centimetres long just above the level of the knee joint was found. This was resected, the distal artery was cleared of clots and a reversed saphenous vein graft was used to restore continuity of the artery. Good pulsations were present below the site of repair. A padded full-length plaster cylinder was then applied to the leg. However, the leg muscles did not survive the prolonged period of ischaemia and an ischaemic contracture developed giving rise to equinus of the foot. This was corrected by lengthening of the tendo calcaneus and he has now returned to work, symptom-free.

Arteriographs before discharge showed the graft to be functioning (Fig. 6).

Case 4—A boy aged nine was admitted with a fracture of the shaft of his right femur, which was treated with gallows suspension, and about seventy-two hours later blistering developed on the injured leg below the knee. He was not treated by us and the blistering of the skin was assumed to be due to the strapping. He was then treated in a Thomas’s splint, and only in retrospect, when fixed plantar-flexion at the ankle and fibrosis of the calf muscles were observed, was it realised that vascular insufficiency had occurred.

Comment—Gallows suspension must be avoided in patients over five as the ever-present danger of ischaemia of the elevated legs is quite significant in older children. Ischaemia, if it occurs in these patients, affects the injured limb only and so elevation per se cannot be the sole cause. Stretching of the artery and irritation of the vessel by the fractured bone ends, when the child moves about, may initiate spasm which is then aggravated by the effects of gravity.

Case 5—A man aged fifty-five was admitted with severe pain just below his left knee which had come on suddenly whilst walking. He had had a similar episode one year before and this
subsided in twenty-four hours with symptomatic treatment. He had fractured the upper ends of his left tibia and fibula five years earlier and complained of a gradual increase in the size of his leg at this level, with occasional pain, for four years. Notes relating to his fracture were not available. The leg was explored for a presumed tumour and the wound packed with gauze because of uncontrollable haemorrhage.

The patient was then referred to us. On examination, the leg was swollen but not tender. All pulses except the left dorsalis pedis were palpable. No bruit was audible and there was no oedema. Arteriographs (Fig. 7) revealed an abruptly ending anterior tibial artery, with collateral vessels curving round a cavity that had been an aneurysm and was now packed with gauze. The neighbouring upper ends of the tibia and fibula were eroded by this aneurysm at the site of an old united fracture.

The bifurcation of the popliteal artery was explored and the anterior tibial artery was tied proximal to the aneurysm. The patient made an uneventful recovery.

Comment—Arteriographs at the time of injury five years earlier would have revealed the damaged anterior tibial artery and avoided the long delay in treatment.

FIG. 7
Case 5—Arteriograph showing erosion of bone at the site of an old united fracture of the upper ends of the tibia and fibula. The cavity of an aneurysm of the anterior tibial artery has been packed with gauze, and the neighbouring arterial tributaries can be seen curving round this.

DISCUSSION

Vascular insufficiency due to injury to lower limb bones may be classified as 1) acute, 2) delayed and 3) remote. Because of the seriousness of such lesions the surgeon should be on his guard against them and should repeatedly assess the integrity of the blood supply of the injured limb from the time of injury to the time of final discharge of the patient.

Acute vascular insufficiency—The possibility of damage to major blood vessels must be considered in every case of bone injury in a limb, and the presence of severe or increasing swelling, with or without expansile pulsation, makes the diagnosis likely. A punctured major vessel may be associated, initially, with palpable peripheral pulses which later become impalpable as pressure builds up in the large haematoma produced by the leak.

Pallor, cyanosis, coldness, anaesthesia, loss of active movements of the toes and absent pulses can be difficult to assess in a severely shocked patient, and they should be looked for repeatedly during resuscitation.

Suspicion of femoral or tibial artery involvement is an urgent indication for exploration. Conservative measures must not be undertaken without radiological evidence of an undamaged main limb artery. Arteriography is a simple procedure calling for no special apparatus and results are available within a few minutes.

An assessment of the state of the entire circulation is mandatory especially in older patients. Concomitant hypovolaemia and other states of surgical hypotension may be present and a bruit at the groin may be the clue to coexisting disease in the lower aorta or iliac artery.

The incision should be planned to avoid damage to the long saphenous vein. This may be required for a patch or graft and may provide an important channel for venous return after restoration of the arterial supply to the leg, as in Case 2.

Having determined the nature of the injury, we have dealt with the fracture first and have preferred internal fixation. In this way, undue manipulation at the site of vessel repair is
proximal symptoms after Remote endarterectomy

I. Callus-Thrombosis

should diameter, results. The proximal symptoms after Remote endarterectomy may be dealt with in the same way: we believe that the benefits of internal fixation outweigh the risks of infection in these cases.

In the presence of another undamaged vein or in the absence of extensive muscle trauma, injured veins may be ligated (Kirkup 1963). Osteotomy and bone shortening should be considered if venous return can be assured only by vein grafting, because better results follow direct anastomosis when dealing with veins of this calibre. Shortening also makes extensive débridement easier and it is readily concealed with a built-up shoe.

Should the use of fine balloon catheters and retrograde irrigation of heparinised saline from the ankle fail to clear the distal arterial tree of clots, the artery must be further explored and another damaged segment will be found lower down. We have seen this in another patient not included in this series.

In some late cases with inevitable loss of tissue, reconstruction may lead to an increase in the length of limb stump that can be salvaged and may make all the difference between a good or bad prosthesis. This is particularly applicable in countries where artificial limbs are not available.

The success rate of vascular repair is directly related to the severity of the damage sustained: the more complicated the procedure of repair, the less is the chance of successful restoration of circulation (Hughes 1958). The earlier this can be done, the better the chances of success.

The fate of grafts in arterial injuries was reviewed by Jahnke (1958). Even though the restored artery may become occluded later, the prognosis for viability of the limb is excellent. In his series no limb was lost although 28.7 per cent of the arteries became occluded.

Delayed vascular insufficiency—Under this heading are grouped arterial occlusion from thrombosis, arterial spasm, ischaemia from tight plaster or bandage, occlusion from adjacent confined haematoma and pressure from callus.

Arterial occlusion may arise from thrombosis at the site of intimal damage insufficient to cause immediate occlusion (Porter 1968). This occurred in Case 3.

Arterial spasm—The effects of this may not manifest themselves for some days after the injury (Seddon 1964). We have not found the local application of papaverine, as advocated by Kimmonth (1952), effective in relieving arterial spasm, which is often due to bruising of the arterial wall. Resection of such a segment will usually relieve the situation. When all other measures fail to relieve spasm, Mustard and Bull’s method (1962) of injecting the lumen of the artery with saline between bulldog clamps, segment by segment, is said to give good results. We have not seen pure arterial spasm and have no experience of this method.

Tight plaster or bandages—Allowance must be made for actual or expected increase in limb diameter, either by splitting the plaster or applying an incomplete cylinder. Calico bandages should be avoided.

Confined haematoma—Arterial occlusion by a haematoma enlarging beneath unyielding deep fascia is relieved by fasciectomy (Benjamin 1957).

Callus—Thrombosis due to pressure from callus has been treated successfully by endarterectomy (Bonney 1963).

Remote vascular insufficiency—Vascular insufficiency after bony injury, developing in a limb after final discharge, is included in this group. The patient in Case 5 did not present with symptoms of vascular insufficiency, but would have done so had the aneurysm involved a more proximal artery.

SUMMARY

1. Five cases of fracture and dislocation in the lower limb complicated by vascular injury are described and discussed.
2. Suspicion of arterial injury is an urgent indication for exploration. Conservative measures must not be undertaken without radiological evidence of an undamaged main limb artery.

3. The eventual outcome of arterial reconstruction cannot be forecast, but it is always worth while attempting unless the limb is obviously beyond hope of survival.

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REFERENCES


