VENOGRAPHY OF THE VEINS OF LOWER LIMB BY INTRA-OSSEOUS TECHNIQUE

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The injection of radio-opaque substances into veins was first introduced by Dos Santos in 1938 to investigate acute thrombo-phlebitis, but the suggestion to inject contrast media into bones for venograms was due to the pioneer work of Dusing et al. (1951), who demonstrated the physiology of circulation in bone. Intra-osseous venography, in spite of being shown by Begg in 1954 and Dodd and Cockett in 1956 to be safe and practicable, has not yet found general acceptance amongst surgeons and radiologists on account of imaginary difficulties and dangers.

Using the intra-osseous technique, we report our experience of 50 consecutive venograms and we hope to show that the procedure is a satisfactory one.

Technique of Intra-osseous Venography

Half an hour before the venogram the patient is given distaquine, 600,000 units, with atropin, 1/100 gr. These are prophylactic and we have always used them. The patient usually lies supine on the X-ray table, but may be on the side when the short saphenous vein is in question. The limb to be X-rayed lies on the cassette tunnel. The site of injection is selected according to the position of the suspected pathology. Injection of the contrast medium into the greater trochanter of the femur is chosen in order to demonstrate the internal iliac, common iliac veins and the inferior vena cava, whilst the tibial tubercle is suitable for the deep veins of the thigh. For the posterior tibial venae comites and sometimes the popliteal vein, the lower end of tibia is good (Fig. 1). The os calcis has not been used by us because Begg (1954) believes that the radiographs are not so satisfactory.

The patient is made comfortable and the site of injection is cleaned with 'Cetavlon' and spirit. The limb is draped so that only the injection area is exposed. The sterile instruments are conveniently assembled (Fig. 2).

Begg (1954) used local anaesthesia in his later cases. We tried local anaesthesia in four cases, but the rapid injection of diodone was very painful. To prove that the pain was not due to the contrast medium, normal saline was tried, and this also was resented by the patient. Light general anaesthesia with buthâlitone sodium ('Transithal') and gas oxygen is now used in our cases.

The site for injection is selected and a puncture
is made down to the bone with a Bard-Parker blade No. 15, and the periostium is scratched. The trocar, which is a Kirshner's wire mounted on a handle, is introduced through the cortex into the bone marrow, using a bradawl action. The trocar is removed and through the same hole the cannula, which is slightly bigger than the trocar, is inserted (Fig. 3). Normal saline is injected to prove that the cannula is in the marrow space.

The contrast medium used is diodone ('Pyelosil,' Glaxo Laboratories) 35 or 50 per cent., using 20 c.c. If a second view is required, 20 c.c. more may be given. Solutions stronger than 50 per cent. are not injected in order to avoid iodism, injury to the marrow endothelium and deep thrombosis.

Diodone is injected steadily through the cannula and the first plate is exposed after 10 c.c. have been inserted. The second plate is taken after 20 c.c. and the third 10 seconds later. The cannula is withdrawn and the wound sealed by a sterile dressing. An elastic webbing bandage is applied for 48 hours. Patients quickly recover and return home after two hours, but it has occasionally been necessary to keep a patient overnight.

We never do venography in the presence of unhealthy skin, e.g. an ulcer, eczema or moisture. These conditions are healed first by pressure bandaging.

The advantages of this intra-osseous technique over the intravenous one of Gryspeerdt (1953) are:

(a) Tourniquets or compression bandages to deflect the contrast medium from the superficial to the deep veins are unnecessary.

(b) Good radiographic pictures are obtained.

(c) The technique can be used at any level of the limb, depending on the part it is wished to investigate.

**Difficulties of Intra-osseous Venography**

Our chief difficulty has been that of hard, dense bone which causes the trocar to bend. We overcome this by selecting another site for the puncture. This has occurred three times.

The second difficulty has been the leakage of the contrast medium by the side of the cannula. This is avoided by introducing the trocar with a firm, steady pressure and avoiding lateral burring of the hole.

In one case the cannula broke in the bone, due to a sudden violent movement, but no ill effects have followed.

Injury to a superficial vein whilst introducing the trocar may occur. Elevation of the limb and digital pressure with gauze stops this and the procedure continues. This is avoided by selecting the point of puncture while the patient is standing.

**Complications of Intra-osseous Venography**

Intra-osseous venography, if carried out as described, is practically free of complications.

**Bruising and Ecchymosis.** The commonest complication has been bruising and ecchymosis. This has been severe in one patient, where it was so diffuse and painful that the patient was unable to walk for a couple of days. A pressure bandage, as already mentioned, prevents this.

**Pain.** About 10 per cent. of cases complained of pain that prevented them from sleeping the night following the examination. Patients are advised to take two tablets of aspirin and to report to the casualty department or their doctor.

**Infection.** If asepsis is observed, wound sepsis and acute osteomyelitis must indeed be rare. We have had no infection and we attribute this to aseptic precautions and not performing veno-
graphy in the presence of ulceration or moist skin; the use of penicillin is empirical.

Thrombosis. Immediate movements of the legs on recovery from anaesthesia and patients returning home avoids thrombosis; we have had no such trouble.

Iodism. Dodd and Cockett (1956) mention that the most important complication is sensitivity or anaphylaxis to contrast medium. As a routine we have used 35 to 50 per cent. diodone, never stronger. We have had one patient who collapsed immediately on injection of diodone. The procedure was stopped and he recovered, but he was kept in the hospital overnight. Adrenaline 1/1,000 is always kept at hand; we give 5 minims intramuscularly, if necessary.

We were unsuccessful in obtaining venograms in four cases (8 per cent.). One already mentioned was allergic to iodine. In two cases the opaque medium leaked at the bone puncture and in the fourth case the cannula broke in the bone; we now use a solid trocar for the puncture.

Of the 46 successful venograms, 23 showed incompetent ankle communicating veins, nine incompetent tributaries of the short saphenous veins, seven incompetent communicating veins of the Hunter's canal, three incompetent communicating veins at the upper end of tibia, three showed no abnormality and one showed a large varix of the deep veins at the level of the knee joint. These diagnoses illustrate the growing field of venous disorders of the lower limb and gone are the days when they were limited to varicosity of the long and occasionally short saphenous veins. Intra-osseous venography has helped us to a precise diagnosis in this developing field.

Indications for Intra-osseous Venography

Venography for Chronic Ulceration of the Leg

The condition and efficiency of the superficial veins of the lower limb can be assessed by clinical examination, but the state of the deep veins, and leaking communicating veins, is more difficult or, sometimes, impossible to determine clinically. Intra-osseous venography has given accurate pictures of the condition and function of the perforating and deep veins. It demonstrates the site of the incompetent communicating veins between the deep and superficial systems.

According to Anning, only 11 per cent. of chronic ulceration of the leg is due to varicose veins. Therefore 89 per cent. of chronic ulcers of the leg may be due to former deep thrombosis. Linton and Hardy (1948) showed by surgical explorations, and Lockhart-Mummery and Smitham (1951) by venography, that in phlebitic legs the clot in deep veins becomes canalized, but the valves of the deep and communicating veins are destroyed. Therefore retrograde flow via the communicating veins leads to superficial venous hypertension, causing ulceration (Fig. 4, A, B, C). Cockett and Jones from their studies showed that the venous drainage of the ulcer area of the leg is by three or four perforating veins direct to the deep system.
Thus, in cases of post deep venous thrombosis intra-osseous venography localizes the level of the damage by the thrombosis, the presence and the level of leakage through the perforating veins leading to superficial venous hypertension. We have found unsuspected faulty perforating veins at the ankle, knee and mid-thigh.

**Venography in Recurrent Superficial Varicosities**

Dodd and Cockett (1956) mention five causes for persistence or recurrence of varicose veins. Of these incorrect and incomplete diagnoses are important.

When an attempt to diagnose clinically the source of filling of recurrent varices fails, or the results of the tests are conflicting, a venogram is invaluable. For example, incompetence of the external saphenous veins is more common than we formerly believed, and therefore persistence of superficial varices. At present, in our opinion, the ratio of incompetence of external saphenous veins to internal saphenous veins is around 1:6; previously it was 1:10.

Quite frequently incompetent communicating vein or veins are present above the ankle, in the calf, or in the thigh. Our venograms have shown us that an incompetent vein passing into Hunter's canal is associated with some incompetence of the deep veins and we now suspect that it, too, is a post-thrombotic feature (Fig. 5). An appreciable number of our persisting varicose veins after operation are due to this faulty perforating vein.

A long oblique incompetent perforating vein passing from the middle of the calf to the popliteal vein may mimic incompetence of the short saphenous vein; Dow (1951) also showed this. Another possibility is varicosity of the vein draining the inner head of gastrocnemius. Venography in such cases may avoid the error of tying the short saphenous vein only. We apply the term 'pseudo-short saphenous vein' to incompetent tributaries of the popliteal vein.

**Venography for other Symptoms of Post-thrombotic Syndrome**

(a) **Oedema.** Patients with uncomplicated incompetence of the superficial varicose veins seldom develop oedema of the legs and ankle, but where the deep veins are faulty it is a frequent symptom. Venographic studies in these patients have shown
us that the ankle communicating veins of the leg are frequently incompetent and occasionally that passing into Hunter's canal.

(b) Bursting Pain in the Calf and Leg. Bauer drew attention to the 'bursting pains' in deep venous thrombosis. Cockett (1956) is of the opinion that the cause of this lies in the destruction of the valves in the deep calf veins. He further suggests that one indication for Bauer's popliteal vein ligation is for the 'bursting pains.' We have found in our venograms that in some of these cases there is incompetence of veins in the legs and of muscular tributaries of the popliteal vein. We believe that this is the real pathology, for it has been relieved by the ligation of these incompetent perforating veins.

Venography for Acute Deep Phlebo-thrombosis

We have not used venography in diagnosis and we think that it is contraindicated, because it is unnecessary, may precipitate an embolism, and that by irritation of the endothelium it may cause an extension of the thrombosis.

Venography for Skin Diseases

In pigmentation, eczema and induration due to post-thrombotic syndrome, when the skin condition is quiescent venographic studies are useful in showing incompetent perforating veins.

Interpretation of Venograms

It is easy to interpret a venogram of a normal leg, but after the deep veins have been thrombosed and re-canalized and communicating veins rendered incompetent it may be difficult. It is necessary to have an open mind with regard to the findings and to have clinical assessment of the possibilities also. We recently diagnosed an incompetent tributary of the popliteal vein and a faulty communicating vein passing into Hunter's canal. The venogram confirmed the latter and operation proved both were present.

Knowledge of the variations of veins and their tributaries is essential in interpreting the venograms. The studies of Kosinski (1926) and Cockett (1956) are helpful in diagnosing the findings. Deep veins may be absent or replaced by collaterals; this is rare.

Venographic studies sometimes show no valves; this may be due to their congenital absence or, more commonly, to their destruction by deep venous thrombosis. In this case the somewhat large irregular channel unbroken by valves lends support to this. The channel may show a moth-eaten appearance due to an old thrombus within its walls. We have not found it necessary to use Valsalva's manoeuvre to demonstrate the valves during venography. We can discern them with the patient supine under general anaesthesia. Begg (1954) also showed this.

Extension of Knowledge of Venous Disorders

Our venograms have widened our conception of the possible venous disorders. First in connection with the perforating veins passing into Hunter's canal. They have shown us that the resulting varices may be above or below the perforator and also that this vessel itself may run an irregular course. We now diagnose the varicosity of this vessel oftener and are exposing the femoral vein in Hunter's canal to tie it. Similarly, the ankle perforating veins may cause varices in the upper leg or about the ankle. Further, we now recognize as a clinical entity incompetent tributaries of the popliteal vein.

Conclusions

We are reporting our experience with intra-osseous venography and have found that it is a safe and valuable procedure. Its technique, indications, complications and usefulness are discussed. It has extended our knowledge of diagnosis.
and operations on venous disorders of the lower limbs. We do not wish to convey that this should be adopted as a routine. It is exacting and time-consuming, but it is an invaluable auxiliary in difficult presentations.

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