Access to Blood Sites for Haemodialysis:
The A-V Fistula

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The most important contribution to haemodialysis since Scribner's introduction of the external shunt in 1960, occurred in 1965 when Cimino and his co-workers (Brescia et al, 1966) created an artificial arteriovenous (A-V) fistula to permit repeated venepuncture access to the blood stream. In the past 7 years it has become clear that this approach is probably the definitive method of access for long term haemodialysis.

The successful use of the A-V fistula in overnight home dialysis in adults was reported in 1968 (Shaldan & McKay, 1968). Further follow-up over four years has confirmed initial impressions that this access site offers a long term approach to the vascular compartment without need for further surgery, together with a significant reduction in medical complications resulting in a more than 50% reduction in the number of hospital back up dialyses required to support home dialysis.

Adult patient and child acceptability (Shaldon et al, 1971) is now almost 100%, the principal attraction being the greater degree of physical freedom experienced between dialyses.

In order to achieve satisfactory results with fistula dialysis one must start by defining the aim of a satisfactory fistula. Our definition of a satisfactory fistula is one that will yield indefinite access to the blood stream with adequate blood flows on up to five times a week dialysis in either or both upper limbs. Ease of puncturing by the patient or a relative, nurse or doctor is a prerequisite to achieve this goal. The safe use of a blood pump in fistula dialysis requires simple but reliable monitoring to avoid the major risk associated with the use of a blood pump which is death from air embolus.

SURGERY

A satisfactory A-V fistula can be achieved in the upper limbs of all patients, provided average surgical skill is available and adequate thought is given to
the individual patient. Medical assessment and briefing of the surgical team is essential to motivate the surgeon to produce a functional entity.

Preoperative assessment

The entire arteriovenous anatomy must be identified. The history of previous surgery must be known. In virgin limbs simple venous constriction allowing visualisation of veins and palpation of the artery will suffice. However, when previous surgery has been performed and where the anatomy is not obvious, arteriography and venography are indicated. In the virgin limb where a normal cephalic vein is present in the forearm, the fistula should be created in a side to side fashion approximately 8 cm above the styloid. Where the cephalic vein becomes a single channel higher in the arm a midforearm antero-posterior side to side fistula should be created.

The antecubital approach should be used in:
(a) Patients with no demonstrable forearm veins
(b) Patients with arteriosclerotic or calcified radial arteries
(c) Patients with previous extensive forearm surgery.

In patients where no superficial veins are available in the antecubital fossa one of the venae committantes of the brachial artery may be anastomosed to the artery and subsequently mobilised to lie in a superficial plane. The artery of choice may be either radial, ulnar, or brachial depending on availability of a suitable vein for anastomosis. Venous transplants have not been found necessary as they do not fulfil criteria of satisfaction.

Technique

Anaesthesia with brachial block is preferred since it gives vasodilatation without hypotension and in no way complicates the metabolic state of the patient.

Apart from normal surgical techniques involved in the creation of a fistula, various points should be noted. Whenever possible the incision should be transverse to avoid the formation of a scar tissue under future puncture sites. An adequate length of both artery and vein should be dissected free from all fascial sheaths to allow approximation without stretch or kinking. All venous tributaries must be tied off to provide a high pressure system, otherwise arterial pressure will tend to be dissipated resulting in an inadequate low pressure system. The fascia anterior to the selected vein should be split longitudinally to allow the fistularised vein to lie superficially. Once apposition has been achieved the vessels should be clamped with vascular clamps such as De Bakey peripheral arterial clamps and not with 'bulldog' clamps or silk ties. These latter may damage the wall of the artery or vein. A side to side anastomosis should be performed if possible as in the event of thrombosis of the proximal venous limb, the distal limb
will still function. In addition the distal limb provides an excellent outflow site, with eventual dilatation of other forearm veins. The anastomotic size should on closure be 0.75-1.00 cm. The anastomosis should be performed with Tycron 5/0 presiliconised polyester sutures. Prior to closure all accessible venous valves should be excised; there should be no kinking or tethering of the vessels due to adventitious bands, and vascular spasm if present should be relieved.

**Postoperative care**

The fistula arm should be dressed with a tight non occlusive bandage. The arm should be elevated for 24 hours, particularly following the antecubital approach to avoid perianastomotic oedema and lymph collection. Antibiotics should be given routinely to avoid infection particularly around the anastomosis. No anticoagulation should be used for at least 48 hours. Hospitalisation is preferable during this period and the fistula should not be used until arterialisation of the venous limbs has developed. In practice it should never be punctured before a minimum period of two weeks has elapsed postoperatively.

**TECHNIQUE OF NEEDLE INSERTION**

The development of a short 14 gauge stainless steel needle with a cutting edge but not a sharp tip has permitted venepuncture without local anaesthesia. Our current needle is now 20 mm in length. The needle is introduced with a butterfly holder to enable the skin to be punctured without the puncturer's fingers contacting the skin before the needle. Stabilisation of the needle remotely from the needle hub by a separate stabilising unit joined to the needle hub with silastic tubing permits flexible movement of the needle within the vein without disturbance of the tip within the lumen of the vein. This technique permits relatively free limb movement during dialysis without interference with blood flow. By reducing the length of the needle and the small bore tubing within the connection system between the needle and the main blood tubing set a significant reduction in resistance to outflow and the return of blood to the patient have been achieved. Currently blood flow rates of up to 400 ml per minute have been obtained with this latest needle and the return of this blood to the patient is achieved at a relatively low venous pressure which does not produce high ultrafiltration rates. A 60 kg male is able to dialyse for up to 8 hours on a 1 m² pyramidal parallel flow dialyser without added saline.

In training patients to venepuncture confidence would appear to be the main problem and the technique should be as painfree as possible. To achieve this, rapidity of insertion is essential and no hesitancy should be acceptable between launching the needle and its final position in the vein.
It is a continuous flight pattern from the moment of starting the movement to the moment that the needle hub is firmly resting against the skin. The risks of sepsis and pulmonary embolus may be considerably reduced by this quick insertion technique as pulmonary emboli may result from plugs of material lodging in the lumen of the needle during a slow transit from the skin to the vein with a blunt rather than a cutting needle; and sepsis may result from repeated puncture attempts using the same needle tip.

The removal of the needle is achieved by compression of the fistula so that at the time the needle is removed from the vein no blood spurts up the subcutaneous needle track. Pressure tape is then applied over the fistula itself or between the fistula and the puncture site. This technique reduces the pressure in the vein so that when the arm is elevated no blood comes out when the needle is removed. Protamine may be given if required and it is usual to give 5-10 ml of 1% protamine at the end of the individual dialysis. Pressure dressings are rarely if ever required after dialysis and bleeding after dialysis at puncture sites is minimal when a firm compression technique is used during the removal of the needle.

MONITORING

The three basic monitors which are best incorporated into a dialysate supply and monitoring unit to permit safe overnight fistula dialysis with a blood pump comprise a fast reacting venous pressure monitor, a level detector on the bubble trap and a sensitive microswitch vacuum monitor. The lamp voltage to the level head should be DC and stabilised and all trigger circuits should be failsafe. The blood pump should have a remote speed control for ease of operation by the patient during the night. Delay overriding of the low venous alarm allows correction of low venous alarms without the need to open the alarm contacts. Adjustment of the bubble catcher height relative to the venous manometer permits a constant venous pressure under resting conditions which permits presetting of the venous alarms and eventually their fixation. This increases the safety factor and at the same time allows a wider gap between the venous pressure and the alarm limits as no patient obligation to re-set the alarm is required. The use of these techniques has virtually eliminated false venous alarms during sleep and there is no requirement for the patient to move to the machine while resting in bed. The benefit of stabilisation of our newer needle has also contributed to the absence of alarms during night dialysis. The other essential feature of equipment related to fistula monitoring should include an efficient internal degassing system which prevents bubble aggregation on the membrane during dialysis and its subsequent transfer into the blood compartment as foam.

The major risk of pumped haemodialysis is death from air embolus. The approach to this problem has been to avoid the introduction of air by
using blood tubing sets without inlets of any form between the patient and the blood pump, and by efficient internal degassing of the dialysis fluid to prevent the transfer of gas across the dialysing membrane. The use of plastic containers without air inlets is another essential feature of safety. If saline is required during dialysis, the blood pump is switched off and the infusion is given directly into the venous bubble trap through the venous manometer air line connector. Heparin is also delivered continuously through a side arm directly into the venous bubble trap from a sealed plastic reservoir without an air inlet.

The value of a clamping device between the bubble trap and the patient on the return blood tubing circuit has potential advantages of preventing air under pressure reaching the patient’s blood circulation even when an alarm has switched off the blood pump. However, this external clamping device whilst protecting against a potential air embolus has the disadvantage of cutting the blood tubing when it is used too frequently. In our experience with over 120 patients treated in the past 4½ years with fistulae both in the home and in hospital, such a monitoring device would appear to be unnecessary as we have not experienced any air emboli of significance to date.

One weakness in the pump system (which is not fully covered by any monitoring to date) is the risk of a slow leak of blood from the blood pump tubing insert itself. Using silicone rubber tubing the incidence of such slow leaks have been extremely low although it has been higher in our experience when vinyl tubing inserts have been used. On two occasions the loss of blood following a partial rupture of the blood pump insert resulted in blood losses of up to 1 litre before a drop of pressure in the circuit caused an alarm either on the vacuum monitor or on the venous pressure monitor; neither case died. A complete disruption of the blood pump insert due to a major disintegration would of course produce a much more rapid alarm from a drop in the venous pressure on the return blood tubing circuit.

CONCLUSIONS

Four years experience of A-V fistula dialysis in 121 patients (ages 8 - 69) indicate that this is the answer to the access site for long term haemodialysis in both hospital and the home. The technique can be performed safely overnight with adequate monitoring of the blood pump and the incidence of air embolus to date has been zero.

REFERENCES

Shaldon, S. and McKay. (1968) British Medical Journal, 4, 671
OPEN DISCUSSION

SHALDON: First, before considering how to use a fistula, it would be appropriate to comment or discuss Dr Crockett's detailed and intentionally dogmatic approach on how a successful fistula should be constructed. The essence, as I see it, is that the surgeon has got to have an interest in the outcome; and that the goal is a single surgical procedure which will take this patient through his access problems to the bloodstream for the remainder of his life. Dr Crockett thinks this can be done, and as someone who has benefited considerably from his surgery, I would agree with him. The main points are motivation, and attention to detail. Tired surgeons doing this as the end of the day, as a sort of encore after having performed, say, an aortic graft, cannot be the best motivated or equipped people to undertake what may be small surgery to them, but is extremely important surgery for the renal physician and to the patient.

R F P BRUNNER (Basle): I would like to get some advice. There are a few patients who clot up all their veins whenever you needle their fistula. I think these are only a very small minority, maybe 1% or 2% of patients. What do you do with them?

CROCKETT: I believe that if you create a fistula with high enough pressure, having tied off your veins, and you strip the deep fascia in front of the vein, that you will not come across this problem. I think what you are probably talking about is what happens when the vein is left in its fascial sheath. I have frequently seen this mistake in fistulae which I have not created; one gets an intra-sheath haematoma and this produces subsequent clotting on needling.

BRUNNER: Am I correct in thinking that you suggest splitting the fascia over a long region?

CROCKETT: Yes, you are correct.

A BLUMBERG (Aarau): I wonder whether you have ever encountered patients with extremely fine superficial veins. I have seen two of them and our surgeon, whom I would consider very well motivated, has not been able, even on repeated trials, to create a fistula which was adequate for dialysis.

CROCKETT: I wonder at what position in the arm he was attempting to create this fistula.
BLUMBERG: In the classical position, and even higher up the arm in the antecubital fossa, with deep veins as well as superficial ones.

CROCKETT: Within my experience (which is about 150 fistulae, some of which have been complicated and many simple) I have only come across one person who did in fact seem to have no forearm or antecubital veins. This was a major challenge, but when I cut down into the antecubital fossa, I then came across a multitude of veins accompanying the brachial artery. I dissected one of these out and made a superficial fistula by bringing the vena comitantes brachialis superficial, and in this way, overcame the problem. I think if you look hard enough, everyone has got veins in the arm.

BLUMBERG: But have you got sufficient length of superficial veins to dialyse them properly afterwards?

CROCKETT: I would say that about 6 to 8 cm were superficial. There were post-operative complications to this procedure and the patient had a swollen hand for two months and some venous stasis. I haven’t seen the fistula for a little while, but I am told it is being used very adequately now.

M Ch LEGRAIN (Paris): You emphasised the necessity of avoiding spasm; how do you do this, because in our experience it seems to be one of the main factors of early thrombosis?

CROCKETT: I think that is a very important point indeed. There are various tricks, I think: one is that a brachial block is advantageous, because you do get vasodilatation without hypotension. In addition I think you should consider the patient as a whole. One knows that one gets reflex spasm in one arm if you put the opposite hand in cold water. I think in practical terms, you want to keep the whole patient very warm. As regards actual operative tricks, I think that super hot saline, really hotter than you think the patient should tolerate, is sometimes useful. Also, I have found the trick of using paediatric vascular clamps to clip across the vein successively, both up and down adjacent to the fistula. I have never seen it fail to work, although this is about the only surgical trick I could suggest.

SHALDON: I should like to just amplify that. I don’t think one should let the surgeon close the arm until you can demonstrate a perfectly visible flow through the anastomosis and actually see a pulsatile vein. I think often a surgeon, particularly when tired, is prepared to say, well let’s close and the spasm will pass off and the flow will pick up. These, I think, are often failures ab initio. I think you can play tricks with these vessels, and you
have just got to breathe over the surgeon’s shoulder and tell him to keep going, or you will get a very high failure rate. I think the other factor which may minimise the incidence of spasm is the way that the vessels are handled. In particular, one must avoid ligatures for holding up vessels at the time that you open them to achieve haemostasis, and avoid the use of these terrible bull-dog clips which are very prevalent in the vascular surgeon’s armamentarium.

H J GOLDSMITH (Liverpool): I would confirm Dr Crockett’s point about getting swelling of the veins of the hands if you use an anastomosis in the anatomical snuff-box. If for any reason it is desirable to use this site, one should tie off the peripheral branch to the hand at the same time as making the anastomosis.

CROCKETT: The only objection I would have to that is that you are creating a single channel system, which I don’t consider preferable in that if you do have an accident due to haematoma or infection, there is a total write-off of your fistula. If you make your fistula a little higher, then you do have these two limbs and an escape mechanism if there is an accident when nursing, or non-medical personnel are needleing the fistula.

SHALDON: Yes, I think Dr Goldsmith has a very valid point. There is a very constant branch of the cephalic vein which always curls backwards over the back of the hand and I think this is the usual cause of swelling. You would agree, wouldn’t you? If your anastomosis is located around that particular vein and that vein isn’t tied, then you may have no alternative but to tie off the whole of the distal limb. If you locate that vein, which is very constant in the majority of males, and deliberately tie it, I don’t think you get swelling of the back of the hand because this is the feeder that seems to do it. On one occasion I have seen this disappear by just literally tying that branch.

P KRAMER (Goettingen): I should like to comment on the problem of vascular spasm. We don’t have this problem any more since we started using papaverine routinely. The second comment I should like to make is on those few per cent of patients who have very small vessels and just a network of veins on their forearms. We have tried to overcome this problem recently by attaching a very tiny vein of only 2-3 mm in diameter to the artery, but then you have to change your post-operative treatment. We give them heparin, and also aspirin, to prevent clotting. Later, the second step is to ligate the tributaries to one main vein and then we re-attach this vein, which has now enlarged, to the artery to get a sufficient flow.
SHALDON: When you have produced your natural enlargement do you do that as a side to side anastomosis?

KRAMER: Yes, always side to side.

C MACKENZIE (Bristol): We have been a lot less skilful in creating fistulae in our patients that will last for an indefinite period. We have lost two in the post-operative period and it has been our practice now to do brachial blockage pre-operatively, should any dialysis patient go to theatre for an elective operation. I would also like to ask Dr Crockett about aneurysms. We have had rather a lot of aneurysm formation in fistulae that we have created in the antecubital fossa. I would like his comments.

CROCKETT: I think the aneurysms you refer to, if they appear in the forearm, probably are desirable from a functional point of view, and they usually occur just adjacent to a valve. Brachial aneurysms I have not really come across. I think I have seen only one aneurysm in someone who had a brachial artery fistula, about two months ago. It's early days really, but I am sure there are unfortunate people in whom this may happen, and the fistula may have to be tied off.

SHALDON: This is an appropriate time to switch to the second part of the workshop, which is how to use a fistula. But on the subject of aneurysms, I think perhaps one should clarify whether this was an aneurysm distal or proximal to the anastomosis or an aneurysm involving an anastomosis. I think the area of puncture, (which perhaps we'll come to in a moment), may have caused an aneurysmal dilatation near the anastomosis if you weaken the wall of the vein at the exact site of the anastomosis, but I am rather surprised if you have got a high aneurysm. I would like to know where the exact anatomical location of this is, because if this is involving the anastomosis itself, you are sitting on a land mine: they have been known to blow up and cause considerable blood loss. In contrast, if they are remote from the anastomosis and you have a centimetre or so of clear vein then these are ideal puncture sites, rather like a pin-cushion, you can needle them repeatedly, and I don't think they cause anything but cosmetic disfigurement.

Now perhaps we should turn to the use of the fistula. I am sure that Miss Nichols will be delighted to demonstrate with needles if there are any volunteers? None? The problem that really comes up in analysing this needling is why are people frightened of needles? Is this an acquired characteristic or is it inherited? It is very interesting that when one asks lay people (not necessarily dialysis patients, but those who have been subject to venepuncture), who was a good venepuncturist, and who was not, it wasn't
necessarily the success rate that was important, it was whether the puncture was pain-free. A good nurse, or a good doctor put the needle in because it didn't hurt the patient. When you ask them, well, how did they put it in? they usually said they didn't know it had gone in. One can put in a needle, certainly intra-muscular, extremely fast and the patient doesn't feel it. One of the concepts that has evolved in intravenous puncturing, I think, from this, is that if you analyse skilful venepunctures, they move in one continuous pattern straight into the vein. But when one sees bigger needles being put in, fistula needles particularly, it tends to be a step-wise pattern or approach. There is a certain amount of anxiety with the large needle, particularly if patients themselves or a relative tries to do it, and they have been taught to first go down to the skin, through the skin, thread along under the skin, over the vein and finally into the vein in a series of step-wise procedures. All of these are fairly painful procedures and are going to make it impossible to preserve the true angle of the rigid needle from the moment it cuts the skin to the moment it lies in the vein. We suggest a much shorter needle, when one can go in much faster without anxiety of going too deep and causing damage, and at the same time preserve the angle at which that needle enters the skin in one continuous flight pattern through subcutaneous tissues and into the vein. Then one can fix by a flexible rubber joint and stabilise remotely. This, of course, is highly provocative because all traditional venepuncturing is based on stabilising the needle hub itself, but one can only say that if one had this, we could demonstrate or show it on a video cassette recorder.

BLUMBERG: I have three questions: who is the manufacturer of the needle, what does it cost, and don't you ever encounter obese people where the needle might be a little on the short side?

SHALDON: The answer to the first question is, it is only in prototype form; it is being virtually hand-made at the moment, it won't be available until the end of the year. The second is probably that its cost will not be higher than the standard type of fistula needle, and thirdly, you can vary the length of the needle. This is merely a needle most commonly used for superficial veins, but you can in fact put these needles in at right angles and achieve the same effect, by merely having a slightly longer loop of silicone rubber tubing.

W DRUKKER (Amsterdam): Dr Shaldon, I think your group has done excellent work. We are all using fistulae now and the number of returns to hospital is much less than with cannulae. We all like fistulae and think you are three perfectionists! Only one thing has been missing. Sometimes, (we have it in two or three patients of 30), they have a recirculation of blood and you are
not aware of this problem. It is just that the arterial needle is picking up some venous blood out of the dialyser. We thought specifically that the antecubital sites might do this. I should like to warn you about hyperkalaemia after dialysis. You may then criticise the patient for this when he is actually sticking to his diet, and you are not dialysing him properly. As a simple test you should take blood from the femoral artery on one side and take some arterial blood which is entering the dialyser from the tubing and they should have equal ureas and creatinines, otherwise you have some recirculation.

SHALDON: Thank you Dr Drukker. I think this is a valid point in venous-venous dialysis. I think it's much more prevalent, you will agree, when one is having a high degree of suction on the outflow vein and one of the characteristics of an ideal needle would be to have very low resistance so that one could obtain relatively high flows. With these prototype needles I mentioned, one can, particularly by building up a pressure gradient between the two needles (if space permits), with vinyl tape, using this tourniquet effect one can prevent this recirculation by virtually having a high pressure out-flow site and a low pressure return site. But I think the point is well taken that where you crowd an area like the antecubital fossa with two needles and possibly interconnections of small veins between them, you must be aware of the dangers of recirculation.

R RIGOLI (San Francisco): I want to compliment you on your work. I wish my nurses were here to hear you. Three questions: have you any experience with Angiocaths? How close can you come to a fistula safely? And, finally Dr Crockett when you tie off your tributaries, don't you prevent formation of potential venepuncture sites from collateral channels that may develop, especially in arms that are short where sites may be difficult to find?

NICHOLS: I have never had any experience at all with Angiocaths. I would say leave about 4 cm at least away from your fistula when you are needling it.

SHALDON: I think on theoretical grounds the potential advantages of plastic catheter device are offset by their practical disadvantages. I think when one got interested in fistulae the attractiveness of them was the concept that you could have more flexibility within the vein and I think this does happen. But the cutting edge of the needle is perhaps advantageous when it comes to removal of the needle, in so far as you haven't torn a hole in the subcutaneous tissue of the vein. Our experience with this was very unsatisfactory a few years ago, not with dialysis but with the problem of occasional large amounts of blood loss when an arterial catheter was removed in a fully
heparinised patient. My feeling on this was that no matter how good the edge of your Angiocath is, it is far blunter than the cutting edge of a well-formed fistula needle and that as it is introduced into the vein you don’t cut into the vein, but tear into it. Thus, when you pull it out, you are left with a hole as opposed to a slit which closes, particularly when it is being depressurised. Secondly, they are usually much longer than needles, and this is from a flow characteristic point of view highly undesirable. It will be the narrowest part in your circuit and offer you the highest resistance. The shorter the narrowest part is, the better the flow characteristics of your circuit.

CROCKETT: Regarding the tying off of tributaries, I am not sure that you understood exactly what I recommended. If you do not tie them you will not get a satisfactory fistula in terms of the criteria that I have just mentioned. I did try to stress that the fistula had two limbs – a distal and a proximal. The distal limb is taking blood down into the hand and this will dilate other veins in the forearm which can subsequently be used. However, I would like to suggest that if the fistula is created which fulfils the criteria which I have established should be present if we are to call it a satisfactory fistula, then this fistula should last forever and should not be necessary to use these other veins at all! I would like to think that that would be the case – time will tell. But the distal limb does send that extra blood to the hand and it will dilate up smaller veins.

SHALDON: If there are any nurses here who have any practical problems on fistula dialysis, they usually carry the brunt of the workload, so don’t be frightened in the presence of all these doctors, young ladies!

W R CATTELL (London): Have you any experience in fistulae – which I have no doubt you would not have created yourself – where you have had a series of very small veins going up the forearm, no single one of which is adequate for needling and successful dialysis. Have you had any experience of going back and tying some of the other veins in the forearm in the hope that you will get one or two of them to blow up, or do you think this is too hazardous?

CROCKETT: Well, one does come across a group of people who do not have forearm veins. I think this occurs most commonly in women. Since the first people I saw this in were from the Mediterranean I nicknamed this the case of the Mediterranean vein. I would consider this to be an indication for an elective antecubital fossa fistula.

CATTELL: Yes, but what I really meant is the person who has a first class
shunt at the site of the fistula, but as the veins go up the arm they break up
in a whole multitude of small veins; one is very tempted to go back and tie
some of them, but is worried about what might happen to the fistula.

CROCKETT: Yes, I certainly have seen this situation. I have not, in fact,
tied off veins like this, but I am sure that this is a valid point and I think it
should be done. This will in fact create a high pressure system which should
prevent it clotting.

CATTELL: Just one final thing. If you did do that, do you think there would
be any value in covering it with a brachial plexus block?

CROCKETT: Yes, I am sure there would be.

A M PATON (Glasgow): Do you not feel that as better alternatives to the
antecubital fistula, the saphenous vein loop should be used in these circum-
stances which gives you a greater length of vein and easier access because
it is a straight vessel and you don't have the problems that have been men-
tioned with the higher fistula?

CROCKETT: I am surprised that this hasn't come up before! I am against
the saphenous grafts because they don't fulfil the criteria I mentioned. They
are a single channel system, and this is one point against them; if you do
get an accident to your fistula this means starting from scratch again.

SHALDON: I am sure that we could go on arguing about the various aspects
of fistulae. In sum, I believe that Dr Crockett thinks it is not necessary to
do venous grafts, but I am sure there are many people who disagree with him.

SISTER MARY BAMBER (Sydney): I don't know whether we are very behind
in our puncturing but we have great difficulty. We use Intranulle, we use
local anaesthetic and before we puncture we make a nick with the scalpel
below it so I'm just beginning to think we are very much behind the times!

SHALDON: Well, I think it depends to a certain extent on the size of the
device you are using, but I am sure that you must have a lot more problems
afterwards even if it is a lot easier getting in when one starts. I think this
probably would be the major objection to splitting the skin after heparanising.
One wonders how much bleeding occurs during actual dialysis.

BAMBER: During dialysis, but when we remove the cannula we usually give
them Protamine sulphate to counteract the bleeding.
L C GRUNDY (Newcastle-upon-Tyne): Have any of the panel come across patients who have such intense pain in the fistula that they have had to stop using it? We have one and had to return him to a shunt.

SHALDON: Could we ask for clarification of that question — is it pain during the use of the fistula, or continuous pain in the fistula whether it's in use or not?

GRUNDY: Severe pain if you use the fistula, and a tendency to some pain even when not in use, as well.

NICHOLS: I have only ever seen one with continuous pain throughout dialysis. We have found that this is relieved by changing the needle. Whether the needle that we were originally using was coated with something that she was allergic to, I don't quite know. She had no pain other than during dialysis, never after or before.

GRUNDY: I think this patient is certainly to do with the fistula because you only have to take his blood pressure near it and you get a similar pain.

SHALDON: Yes, I think there are a small percentage of patients who have got extremely sensitive veins, and the distension of those veins continuously by a fistula is, I suspect, the cause of that type of pain, particularly as you say it appears when you blow up the blood pressure cuff. There is another type of pain which is associated with ischaemia, which is due to arterial insufficiency of the limb, but this isn't usually characterised by pain when the vein is punctured. I think one of the commonest causes of pain, which is often pain located in a precise area, may be the irritation of the vein wall by a needle tip actually touching a nerve plexus on the intimal surface of the vein. Having had some of these needles in my own veins I can certainly agree with that phenomenon. You feel the needle tip touching your posterior vein wall and if it hits a certain area of it, it is just like an acute toothache. I suspect that this isn't a question of pain threshold, but an individual nerve supply to various peoples' veins. I have wondered occasionally whether some form of denervation of the venous anatomy would be more acceptable, or possibly even a transplant of a vein graft.

GOLDSMITH: I think that one cause of pain in the hand may be median nerve compression in the presence of raised capillary pressure. It may be worth dealing with this separately. With reference to Dr Catell's problem of multiple small veins, sometimes it may be worth going back after making the primary anastomosis a few weeks later and then re-anastomosing one of
these veins to the artery slightly higher up. Thus, it may be possible to convert a third rate fistula into a second rate fistula; but never I believe into an excellent one.

SHALDON: Thank you Dr Goldsmith. I really am most grateful to all members of the audience who have participated so actively. It seems that there are still many problems to be solved with fistulae, but I hope that some of you will have benefited from being able, at least, to pressurise your surgeons into better efforts!