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Percutaneous recanalization of occlusion of central and proximal veins in chronic hemodialysis
Technical Note

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Percutaneous recanalization of occlusion of central and proximal veins in chronic hemodialysis. Occlusion of the central and proximal veins in chronic hemodialysis patients results in considerable edema of the arm of the vascular access that is unable to drain normally. This is a formidable problem because it is very often necessary to close the vascular access, which is sometimes the last available one. To avoid resorting to this disastrous solution, recanalization of the occluded vein by percutaneous recanalization followed by endoluminal angioplasty was successfully performed in five patients (4 innominate veins and one axillary vein). Immediate failure occurred in a sixth patient, and delayed failure after two months of patency (innominate vein) in another patient for whom there had been no systematic stent placement. Recanalization was still patent in four other patients at 3, 6, 12 and 26 months. These results are an encouragement to attempt percutaneous recanalization by angioplasty of occluded central veins because, when successful, this technique makes it possible to preserve the vascular access and to avoid onerous surgery. We believe that this technique should therefore become better known.

The survival and quality of life of patients with renal failure who are treated by chronic hemodialysis depend on the effectiveness of kidney replacement therapy, which is itself related to the good functioning of the vascular access.

Preservation of the vascular access necessitates identification of all the venous stenoses occurring in arterialized veins, which could result in loss of the access due to thrombosis [1–4]. Although the therapeutic solutions for stenosis of proximal veins are well established, there are few solutions to correct occlusion arising in the central veins [5–9]. This occurs essentially in patients who have had subclavian or internal jugular catheters, which are responsible for the formation of stenoses arising most often in the innominate vein or at the junction with the subclavian vein. This complication is formidable since it causes considerable edema of the arm of the arteriovenous fistula. Blood drainage occurs through the cervical, thyroid, intracranial and internal mammary veins (Fig. 1).

Treatment generally consists of closing the arteriovenous fistula and creating a new vascular access on the contralateral limb or, when possible, transposing the internal jugular vein and creating an anastomosis with the axillary vein [10]. Unfortunately, closure of the vascular access is not always possible in patients with long-standing terminal uremia, given that a venous network no longer exists to be able to create another access. Moreover, peritoneal dialysis is not possible when it has previously been abandoned because of sclerosis of the peritoneum. Transplantation is contraindicated in these patients or difficult to undertake in view of their precarious state of health or, in the youngest patients, there is hyperimmunity due to previous transplantation.

To avoid losing the last functioning vascular access or performing onerous derivation surgery, we suggest attempting recanalization of the occluded vein by percutaneous catheterization with endoluminal angioplasty, complemented if necessary by a self-expanding stent. This technique, which has already been described but little used, makes it possible to substantially prolong the functioning of vascular accesses for dialysis [4, 8, 9, 11]. The method used is original because the recanalization is performed on previous occlusions via the femoral vein, thus preserving the integrity of the vascular access.

We report our experience of six recanalizations.

METHODS

From January 1995 to December 1996 we performed six recanalizations (Table 1) involving four innominate veins, one subclavian vein and one axillary vein in two men and four women aged 57 ± 6 years (range 43 to 71 years).

All patients had had several previous vascular accesses, often created with difficulty. Four had exhausted all the possibilities of creation of a new vascular access in the contralateral limb. For three patients peritoneal dialysis had already been unsuccessful and renal transplantation was contraindicated.

Clinically, four patients had edema of the arm with thoracic collateral circulation, which was associated with inflammatory edema of the breast for one patient. In one case there were difficulties in puncturing the arterialized vein that were related to

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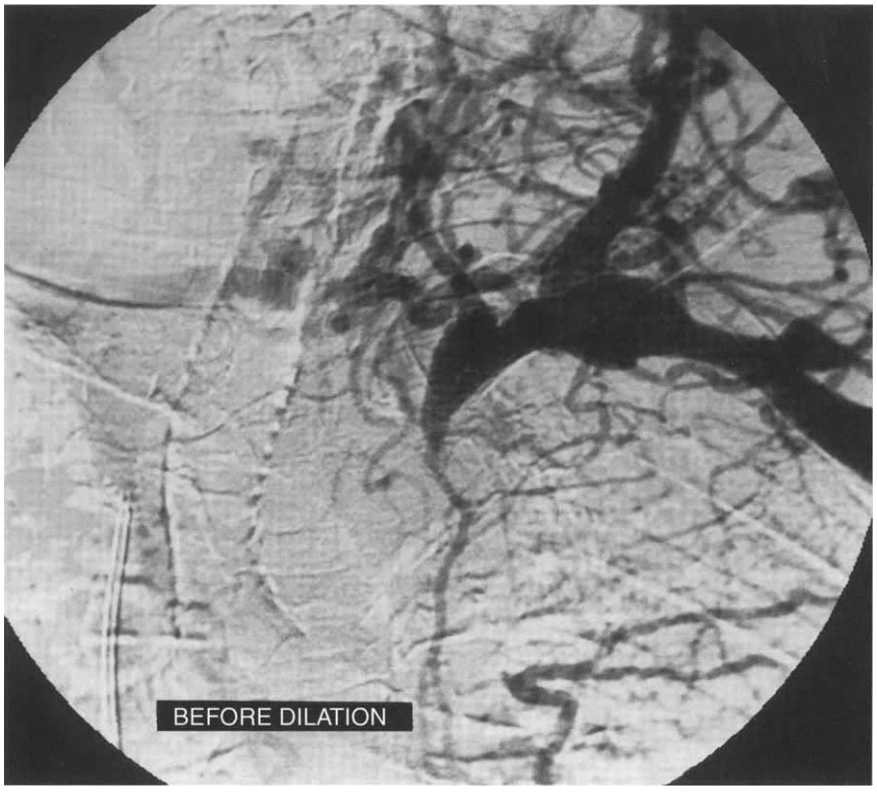

Fig. 1. Occlusion of left innominate vein. Considerable cervico-thoracic collateral circulation (patient 4).

Table 1. Clinical and radiological findings in 6 patients treated by percutaneous recanalization

Patient number	Gender	Age *years*	Vascular access	Clinical symptoms	Interval between onset and dilation *months*	Site of occlusion
1	F	55	Humero-cephalic AVF (R)	Edema of arm (R)	4	Innominate vein (R)
2	F	43	Radial AVF (R)	Edema of arm (R)	18	Subclavian vein (R)
3	M	64	Radial AVF (L)	Difficulty with puncture	3	Innominate vein (L)
4	F	71	Humero-basilic AV by pass (L)	Edema of arm (L)	10	Innominate vein (L)
5	M	61	Radial AVF (R)	Edema of arm (R)	6	Innominate vein (R)
6	F	61	Humero-axillary AV by pass (L)	Thrombosis of bypass	3 days	Axillary vein (L)

Abbreviations are: AVF, native arterio-venous fistula; R, right; L, left.

infiltration of the subcutaneous tissue, and in another case there was thrombosis of the humero-axillary bypass.

Clinical symptoms in our patients had evolved over periods ranging from three days to 18 months. The occlusions were of long standing in all cases, except for the thrombosis of the humero-axillary bypass which had existed for 96 hours.

Phlebography performed from the vascular access showed complete occlusion of the innominate vein in four cases (2 on the right, 2 on the left), of the right subclavian vein in one case and of the left axillary vein in another, after deobstruction of the bypass by blind fibrinolysis 24 hours before.

Contrast imaging showed no intraluminal thrombus warranting fibrinolysis *in situ*. Occlusion was complete and long in each case, since the occluded venous axes could not be evidenced by retrograde contrast imaging on later films. This finding was confirmed during dilation.

In view of the extreme urgency of preserving the functioning vascular access for each of these patients, we attempted to recanalize the occluded veins.

Recanalization technique

To protect the integrity of the arterialized veins close to the arteriovenous fistula, each time we approached them with introducer sheaths of less than 5F diameter. Where we had to use large diameter dilation balloons (> 7 mm), it was necessary to have a larger caliber introduction site. In this case the femoral vein was chosen.

The site and extent of the venous occlusion were always assessed initially by phlebography performed from the arterialized vein. It was thus possible to choose the access approach according to the following criteria:

(*1*) If it was possible to catheterize the occlusion easily via the

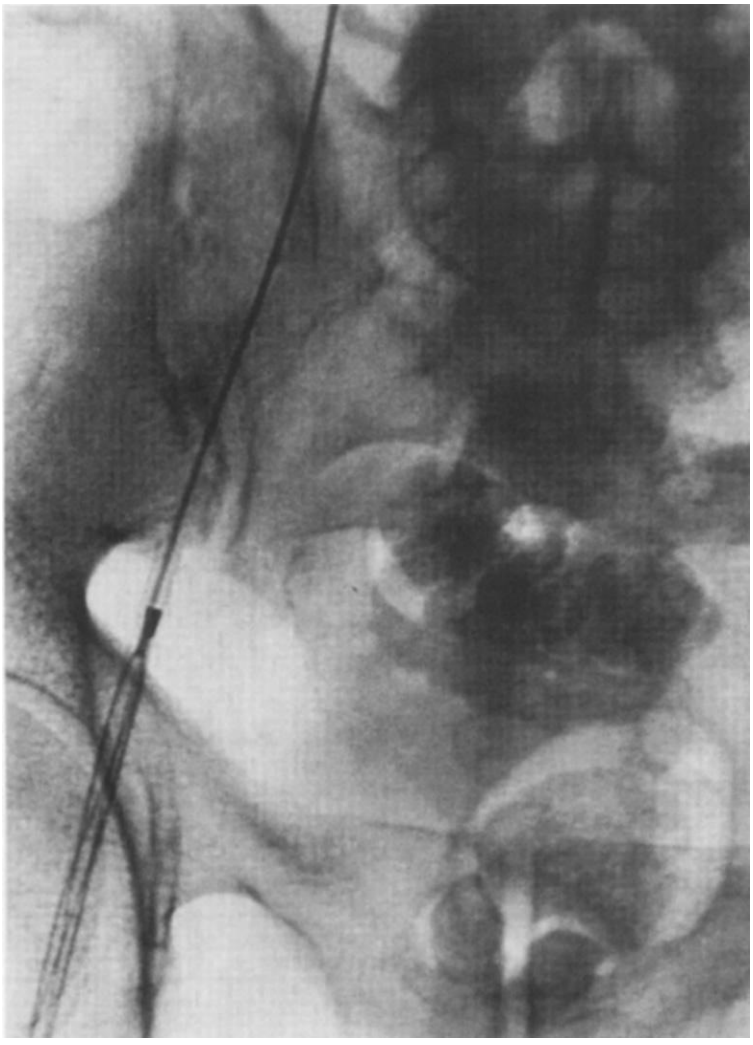

Fig. 2. Snaring of 0.035 extra-stiff guide wire (Terumo) 2.5 meters in length by a Dormia catheter.

femoral route, the femoral vein was used immediately and monitoring was performed via the arterialized vein using an 18 G Cathlon catheter (Critikon; Johnson and Johnson, Paris, France).

(*2*) If catheterization was not possible via the femoral route, it was necessary to use one of the arterialized veins of the arteriovenous fistula, using the following procedure:

(*a*) A 4F arterial introducer sheath (Meadox, Paris, France) was placed in an arterialized vein of the arteriovenous fistula.

(*b*) The occluded area was catheterized by the brachial route with a hydrophilic guidewire (ACS 0.14; Terumo, Paris, France), which was passed down to the inferior vena cava. It should be noted that access to this area is tedious and time consuming, and requires perseverance.

(*c*) As soon as the occluded area was crossed, the 4F catheter was passed into the inferior vena cava using the guide wire.

(*d*) The hydrophilic guide wire was replaced with a 0.035 extra-stiff guide wire (Terumo) 2.5 meters in length. Note that the extra-stiff guide wire could not be used at the outset because it is rigid and there is a risk of either injuring the vein or following the wrong route.

(*e*) The extra-stiff guide wire was snared by the femoral route using a lasso-type or Dormia catheter introduced by an 8F arterial introducer sheath placed in the femoral vein (Fig. 2). Endoluminal dilation was then possible.

(*f*) Monitored by fluoroscopy, the dilation balloon was passed over this guide wire and placed in the area to be dilated.

(*g*) Dilation was performed with Olbert or "ultra-thin" balloons appropriate to the diameter of the healthy vein nearest to the occluded area (diameter 5 to 14 mm). The mean inflation pressure was 10 bars and was maintained for at least one minute and repeated two or three times according to the result obtained.

(*h*) Patency of the recanalization was monitored by injection of contrast fluid from the arteriovenous fistula (Fig. 3).

(*i*) A stent was placed at the outset only if the stenosis appeared to be long (> 5 cm) or if there was residual stenosis of more than 50%. Stent placement was subsequently performed when a clinically obvious stenosis recurred in less than two months after the first angioplasty (Fig. 4).

(*j*) Patency of the recanalized vein was maintained by subcutaneous heparin treatment for ten days.

Fig. 3. Monitoring angiography after dilation. Patency was judged to be inadequate and it was decided to place two stents in patient 4.

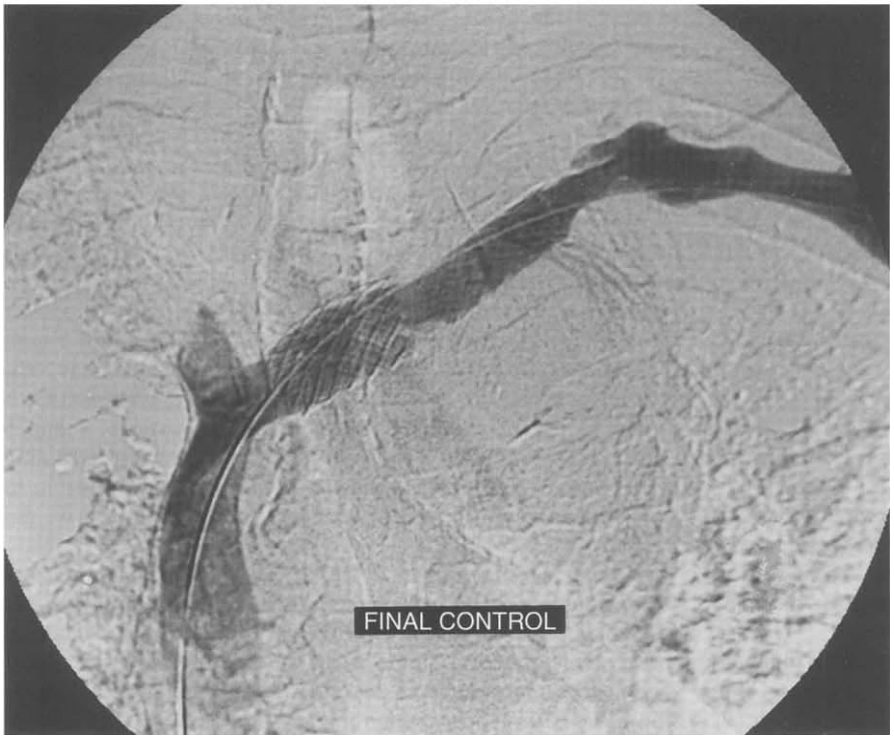

Fig. 4. Monitoring angiography after placing two Palmaz stents (14 mm in diameter, 30 mm in length). Patency was judged to be satisfactory and the collateral circulation disappeared immediately. However, a small stenosis of the left subclavian vein persisted, just after the last stent. This was subsequently dilated. Note that the stent should not protrude into the superior vena cava (patient 4).

Monitoring

Monitoring was above all clinical. Any absence of bleeding at the puncture sites was monitored. Patency of the recanalized vein was ascertained by the disappearance of clinical symptoms.

If there was no stent placement, phlebography was performed 48 to 72 hours after recanalization, just after the hemodialysis session, and then during the following month.

Finally, phlebography was performed after noticing any clinical

Table 2. Results of recanalization of occluded veins

Patient number	Results of recanalization		
	Immediate	At 2 months	Maximum interval
1	Success	Patent	26 months
2	Failure	—	—
3	Success	Definitive Occlusion	—
4	Success[a]	Patent	6 months (deceased)
5	Success	Patent	12 months
6	Success[b]	Patent	3 months

[a] Stent placement at outset
[b] Removal of stenosis using 5 mm diameter cutting balloon

sign that might indicate a difficulty in draining of the blood flow from the arteriovenous fistula.

RESULTS

The results are presented on Table 2. Five recanalizations were immediately successful as confirmed by angiography (removal of the occlusion, disappearance of collateral circulation; Fig. 4) and clinical evolution (disappearance of edema of the arm, correction of venous pressure, disappearance of throbbing at the vascular access). In the case of thrombosis of the axillary vein (patient 6), dilation alone with a 5 mm balloon expanded to 17 bars was insufficient to remove the very tight anastomosed stenosis between the distal extremity of the bypass and the vein. It was necessary to use a 5 mm cutting balloon to permit subsequent dilatation with a 7 mm balloon.

The recanalizations are still patent after 3, 12 and 16 months in patients 6, 5 and 1, respectively.

A stent was placed at the outset in one patient (patient 4) because the stenosis was very long, and patency was maintained for six months until her death from a mesenteric infarctus (Fig. 4).

Rethrombosis occurred in the left innominate vein two months after recanalization in one patient (patient 3) in whom a stent had not been placed.

Immediate failure occurred in one patient (patient 2) with occlusion of the right subclavian vein. It was necessary to perform a surgical autologous internal axillary-jugular bypass.

No complications arose during the six procedures, except for chest pain during dilation for which i.v. sedation was necessary.

DISCUSSION

Occlusion of proximal veins is a formidable complication because it is usually impossible to use the access for hemodialysis.

The physiopathology of this complication primarily entails vascular trauma related to the placing of a central catheter as well as progressive arterialization of the drainage vein where increased flow may induce angio-intimal hyperplasia followed by localized sclerosis.

To avoid this complication it is advisable to perform a phlebography with contrast medium before creating the vascular access in patients with a previous history of central catheters, chest injury or clinical symptoms suggesting central vein stenosis. Unfortunately, this examination is rarely performed because of the risk of the effect of the contrast medium on renal function, and occlusion of the proximal vein is very often diagnosed belatedly after extensive edema of the arm of the vascular access. In general the vascular access is closed to correct the edema.

The use of recanalization by percutaneous angioplasty is not common as it is little known, probably because few reports have been published on the subject. Indeed, few authors have performed recanalization of the proximal veins. The first report was by Hunter (1984) who performed recanalization of occluded arterialized peripheral veins with partial success [8]. In 1991 Newman et al reported their experience of recanalization of four central veins that had been occluded for more than three months in a series of 14 patients who already had recanalization of occluded proximal veins [8]. These four cases were comparable to our own in that they involved occlusion treated late and without using fibrinolytics because no thrombus had been revealed on angiography. Unfortunately, Newman et al did not describe their recanalization technique fully and we do not know whether he selected the femoral route in the same way as we did in the present study. Neither did they explain whether a stent was placed immediately after dilation, although it appears that this was not the case. He reported the patency of recanalization after 2 to 20 months of follow-up with his technique.

In 1994, Criado et al reported eight attempts at recanalization of subclavian veins, only four of which were successful. He reported continuing patency after six and eight months for two patients, respectively, and one patient with re-occlusion at two months and one with restenosis at three months [12].

The main value of the recanalization technique for occluded central and proximal veins in hemodialysis patients is obvious. However, this technique appears to be used infrequently. To us it is important for the future of our dialysis patients that the technique be more widely reported, the more so because it seems to be very effective regardless of the lengths of the stenoses. The good results reported are not in agreement with the established principle that long stenoses are more difficult to dilate, and that in such cases endoluminal angioplasty provides poor long-term results.

Stents were not placed at the outset in all the patients in our small series, and this would probably explain the recurrence of occlusion at two months in patient 3. The findings reported in the literature concerning treatment of stenosis of proximal veins suggest that endoluminal angioplasty alone gives fewer positive results in terms of patency at 12 and 24 months than angioplasty associated with stent placement. Indeed, in the absence of a stent the patency observed at 12 months is 35% and at two years is 10%. Patency increases to 70% and 50%, respectively, when a stent is placed [13]. It is interesting to note that in patients 1 and 5 patency was 12 and 26 months, respectively, after recanalization without stent placement. We believe that is always possible to redilate and place one or several stents at a later date, as we did for patient 4.

Of our two failures, one was a case of occlusion of the subclavian vein that had been recognized for 18 months but not treated, because surgical correction was repeatedly challenged by the surgeons during a period when we did not know that percutaneous recanalization was possible. In this case surgical correction was performed by implanting an autologous saphenous vein between the axillary vein and the previously transposed internal jugular vein, necessitating dilation of stenosed anastomoses of the bypass. This illustrates the classical situation of correction of stenosis of proximal veins.

In conclusion, it appears to us that recanalization of occluded central and proximal veins by the subcutaneous route should

always be attempted before undertaking surgery, because it makes it possible to safeguard a vascular access that often is the final available access, and thus essential to the patient's survival. The short-term benefit is obvious. The clinical success achieved encourages continuing with this technique and repeating it when occlusion recurs. Placing a stent from the outset does not seem unreasonable in the latter case, but it does not seem to be mandatory.

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REFERENCES

1. VORWERK D, GÜNTHER RW, MANN H, BOHNDORF K, KEULERS P, ALZEN G, SOHN M, KISTLER D: Venous stenosis and occlusion in hemodialysis shunts: Follow-up results of stent placement in 65 patients. *Radiology* 195:140–146, 1995
2. TURMEL-RODRIGUES L, PENGLOAN J, BLANCHIER D, ABAZA M, BIRMELÉ B, HAILLOT O, BLANCHARD D: Insuffisance dialysis shunts: Improved long-term patency rates with close hemodynamic monitoring, repeated percutaneous balloon angioplasty, and stent placement. *Radiology* 187:273–278, 1993
3. ROUSSEAU H, MORFAUX V, JOFFRE F, THAT HT, GOUDABLE L, BARTOLI P, YONG MY: Treatment of hemodialysis arteriovenous fistula stenosis by per cutaneous implantation of new intravascular stent. *J Intervent Radiol* 4:161–167, 1989
4. GRAY RJ, HORTON K, DOLMATCH BL, RUNDBACH JH, ANAISE D, AQUINO AO, CURRIER CB: Use of wallstents for hemodialysis access-related venous stenoses and occlusions untreatable with balloon angioplasty. *Radiology* 195:479–484, 1995
5. GLANZ S, GORDON DH, LIPKOWITZ GS, BUTT KMH, HONG J, SCLAFANI SJA: Axillary and subclavian vein stenosis: Percutaneous angioplasty. *Radiology* 168:371–373, 1988
6. MATTHEWS R, CLUGSTON R, EISENHAUER A, DAKE M, SCHATZ R, FEINSTEIN E: Balloon expandable stents to treat central venous stenoses in hemodialysis patients. *Am J Nephrol* 12:451–456, 1992
7. TREROTOLA SO, LUND GB, SAMPHILIPO MA, MAGEE CA, NEWMAN JJS, OLSON JL, ANDERSON JH, OSTERMAN FA: Palmaz stent in the treatment of central venous stenosis: Safety and efficacy of redilatation. *Radiology* 190:379–385, 1994
8. NEWMAN GE, SAED M, HIMMELSTEIN S, COHAN RH, SCHWAB SJ: Total central vein obstruction: Resolution with angioplasty and fibrinolysis. *Kidney Int* 39:761–764, 1991
9. SCHOENFELD R, HERMANS H, NOVICK A, BRENER B, CORDERO P, EINSENBUD D, MODY S, GOLDEN KRANZ R, PARSONNET V: Stenting of proximal venous obstructions to maintain hemodialysis access. *J Vasc Surg* 19:532–539, 1994
10. FULKS KD, HYDE GL: Jugular-axillary vein by pass for salvage of arteriovenous access. *J Vasc Surg* 9:169–170, 1989
11. COOPER SG: Central venous stenoses and occlusions in hemodialysis patients. *Semin Dial* 9:S51–S53, 1996
12. CRIADO E, MARSTON WA, JACQUES PF, MAURO MA, KEAGY BA: Lésions occlusives des veines centrales en aval de fistules artérioveineuses du membre supérieur pour hémodialyse. *Annales de Chirurgie Vasculaire* 8:530–535, 1994
13. MICKLEY V, GÖRICH J, RILINGER N, STOREK M, ABENDROTH D: Stenting of central venous stenosis in hemodialysis patients: Long term results. *Kidney Int* 51:277–280, 1997