

Central Vein Obstruction in Hemodialysis Patients: Results of Radiological and Surgical Intervention

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Background/Aims: symptomatic central venous obstruction (CVO) in dialysis patients with arteriovenous fistulas (AVFs) leads to significant morbidity and patient inconvenience. We evaluated the results of surgical and radiological interventional treatment of symptomatic central venous obstruction.

Methods: clinical data, site and length of vein obstruction, type and outcome of intervention were obtained from patient records. Patency rates of radiological and surgical treatment were calculated using Life Table survival analysis.

Results: in 28 patients with VH, 45 interventions (percutaneous intervention 30; surgical reconstruction 10; AVF closure five) were performed. Mean vessel obstruction length was 4.9 cm, mainly localized in the subclavian vein (55%). Initial clinical success rate of PTA and surgery was 92%, with complications after percutaneous transluminal angioplasty (PTA) on six occasions. Restenosis after PTA was observed in 39%. One-year primary and secondary patency after PTA was 50 and 63%, respectively. One-year primary patency after surgical reconstruction was 75%.

Conclusion: symptomatic CVO in dialysis patients with AVFs can be treated with a high success rate through radiological intervention. Surgical reconstruction is an appropriate alternative method in case of failed PTA.

Key Words: Catheter; Central venous obstruction; Hemodialysis; Vascular access.

Introduction

Central venous obstruction is usually accompanied by few if any complications. However symptoms, manifested by severe arm swelling, pain, and venous ulcers as a result of central venous obstruction in patients with ipsilateral arteriovenous fistulas for hemodialysis, endangers the usefulness of the vascular access^{1,2} and result in significant morbidity of the patient. Venous outflow obstructions are considered to be due to high flow states and occur at sites of turbulence.^{3,4} Moreover, placement of long-term jugular or subclavian vein catheters has been recognized as a significant risk factor.^{5,6}

The most favorable treatment of symptomatic venous obstruction is still topic of discussion. Different treatment entities have been used to correct central venous lesions, including percutaneous radiological (endovascular) procedures and surgical reconstruction. Studies describing surgical reconstruction, like right atrial bypass, axillary–axillary vein cross-over

and jugular vein bypass or transposition, have reported patency rates of approximately 80% at 1 year.^{7–10} Radiological interventions, including recanalisation, percutaneous transluminal angioplasty (PTA) with or without additional stent placement show similar patency rates of 70–90% at 1-year follow-up.^{10–14}

The current study was performed to determine the clinical success and patency rates of surgical and radiological interventions to eliminate symptomatic central venous obstruction in patients depending on hemodialysis vascular access in a single center.

Patients and Methods

From 1991 through 2002, 28 patients (16 male; mean age \pm SE = 66.1 \pm 3.0 year) were treated for symptomatic central venous obstruction, with symptoms of arm swelling, pain, and ulcerations. Clinical data and outcome of surgical and radiological interventions were retrospectively collected from patient records.

Different types of vascular access for hemodialysis were used: 11 patients had forearm prosthetic loop

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(PTFE) AVFs, nine patients with autogenous wrist AVFs (radiocephalic), six patients with upper arm brachio-cephalic (2) and basilic vein transposition (4), and two patients with subclavian artery-to-vein (thorax loop) PTFE grafts. Twenty-four patients (86%) had a history of previous central vein catheters, of which 15 patients had subclavian vein catheters and nine had jugular vein catheters. Central vein pathology was visualized by digital subtraction angiography (DSA) by means of antegrade contrast injection into the vascular access. From 1991 to 1995, the primary treatment option was surgical intervention, while after 1995, radiological intervention was attempted as the preferred primary therapy. The interventional method of choice was considered to be PTA. However, in case of elastic recoil and a long-segment venous obstruction, a primary stent or recanalisation with stent placement was performed.

All patients were subdue to clinical examination and Duplex ultrasonography at regular three-month intervals. In case of symptomatic restenosis, patients were treated by means of re-PTA or reconstructive surgery.

Radiological techniques

Before angioplasty or stent deployment, subtraction angiography (DSA) was performed to study the anatomic and pathologic characteristics of the vessel after antegrade venous puncture of a fistula vein or the graft itself with a 4-French straight catheter (Cordis, Johnson & Johnson, Roden, The Netherlands). Recanalization usually was attempted with an upper arm venous approach using a hydrophilic-coated, steerable, 0.035-inch guide wire (Terumo, Leuven, Belgium). After safe passage of the obstructed segment and subsequent exchange of guide wire to a stiff 0.035 inch guide wire (Boston Scientific, Watertown, MA, U.S.A.), a balloon catheter of adequate diameter, usually 8–10 mm (Cordis, Johnson & Johnson, Roden, The Netherlands), was advanced into the segment and dilated. "Through-and-through" access, where the transbrachially placed guide wire is pulled out through the femoral vein access, was performed when stent placement was deemed necessary. A flexible, self-expanding Wall-stent (Boston Scientific, Watertown, MA, U.S.A.) was introduced through a 9-French sheath placed in the common femoral vein. Correction of the Wall-stent position for exact placement was performed by pulling the partially deployed stent to the affected region. Stents were dilated with a balloon of suitable size after deployment to ensure as close a contact to the venous wall as possible.

Surgical techniques

Jugular vein transposition

This technique has been described previously.⁹ The axillary or cephalic vein is dissected by a horizontal incision just caudal to the clavicle. After splitting of the major pectoral muscle and opening the fascia, the cephalic or axillary vein is dissected free of the adjacent fatty tissue. The external or internal jugular vein is exposed through a vertical neck incision. After clamping, the jugular vein is transected as high as possible and transposed through a subcutaneous tunnel in front of the clavicle towards the infraclavicular axillary or cephalic vein. Subsequently, an end-to-side anastomosis with running prolene 7 × 0 is performed. Patency of the bypass is peroperatively determined by completion angiography. Subcutaneous tissue and skin are closed with interrupted sutures.

Jugular vein bypass

The internal jugular vein is exposed through a horizontal neck incision 2 cm cranial to the clavicle. Then, the cephalic or axillary vein is explored in the upper arm. A subcutaneous tunnel, anterior to the clavicle is then accomplished through which a 6 mm ringed stretch PTFE (Gore-Tex[®], W.L. Gore & Associates, Flagstaff, Arizona, U.S.A.) vascular graft is placed. Subsequently, the graft is anastomosed in an end-to-side manner to the jugular vein and the upper arm vein with a running prolene 7 × 0. Patency of the graft is peroperatively determined by completion angiography. Subcutaneous tissue and skin are closed with interrupted sutures.

Axillary-axillary cross-over bypass

The axillary vein is dissected by an horizontal infraclavicular incision. After splitting of the pectoral muscle the vein is localized and handled by vessel loops. A 6 mm ringed PTFE prosthesis (Gore-Tex[®], W.L. Gore & Associates, Flagstaff, Arizona, U.S.A.) is then inserted into a subcutaneous tunnel in front of the sternum. Graft-to-vein anastomoses are performed with running 7 × 0 polypropylene sutures. After completion angiography the subcutaneous tissue and skin are closed with interrupted sutures.

Statistical analysis

Statistical analysis was performed using the SPSS 10.0 package (SPSS, Chicago, Ill, U.S.A.). Initial clinical success, primary and secondary patency of surgical and radiological intervention were estimated by Life

table analysis and compared with the log-rank test for trend analysis.

Results

A total of 45 interventions (radiological: 30; surgical 15) were performed in 28 patients with vascular accesses and symptomatic CVO. The mean (\pm SE) duration of AVF insertion was 368 ± 317 days (range: 79–921 days).

Angiographically demonstrated venous obstruction was localized in the subclavian vein in 15 patients (46% right side); six patients had an axillary vein obstruction (50% right), and seven patients had an obstruction localized in the brachiocephalic trunc (60% right side). Central venous occlusion was seen in 17 patients and the other 11 patients presented with a significant stenosis ($>50\%$ diameter reduction). Mean (\pm SE) overall length of these obstructions was 4.9 ± 0.5 cm (range: 1–8.5 cm).

PTA was the therapy of first choice in 20 patients. Initial clinical success of angioplasty alone with complete relief of symptoms and AVF salvage was achieved in 18 out of 20 patients. In two patients the obstruction persisted and subsequently in the same session a Wall-stent was placed. Minor complications occurred in six patients resulting in dissection (1), Wall-stent dislocation (1), and limited contrast extravasate (4). The dissection was successfully treated by stent implantation. Stent dislocation was solved by the insertion of an overlapping anchoring stent. In three of four patients with an extravasate during PTA, angioplasty was still successful. Recanalisation of an occluded subclavian vein could not be achieved in one patient, and a conservative treatment was chosen. In this patient the AVF remained functional for hemodialysis therapy. Late restenosis with recurrence of limb edema occurred in nine patients within a mean time period of 4.8 months (range: 1.1–15.1 months). These patients were treated by re-PTA or stent placement in seven cases and through surgery in two patients. In these patients a jugular vein transposition (1) and a bypass graft from the cephalic vein to the ipsilateral internal jugular vein (1) were performed. Patients with failed PTA had mainly central vein obstructions and not stenoses.

A primary surgical procedure was chosen in eight patients and as a second choice therapy (after failed radiological intervention) in another two patients. In total, five jugular vein transpositions, three jugular vein bypass grafts, and two bypasses to the contralateral jugular or axillary vein were performed. No major morbidity or mortality in the operated patients

Table 1. Life table analysis of primary patency rate of percutaneous transluminal angioplasty of central venous obstruction.

Interval (mts)	At risk	Failure	Died	LFU	Cum patency (%)	SE (%)
0–3	20	5	2	1	95	4.8
3–6	12	2	–	–	63	11.4
6–9	10	2	–	–	50	11.9
9–12	8	–	1	–	50	12.1

LFU = lost to follow up; SE = standard error.

Table 2. Life table analysis of secondary patency rate of percutaneous transluminal angioplasty of central venous obstruction.

Interval (mts)	At risk	Failure	Died	LFU	Cum patency (%)	SE (%)
0–3	20	1	2	1	95	4.9
3–6	16	1	–	–	88	6.1
6–9	15	1	–	–	78	9.7
9–12	14	2	1	–	63	11.2

LFU = lost to follow up; SE = standard error.

Table 3. Life table analysis of primary patency rate of surgical reconstruction for central venous obstruction.

Interval (mts)	At risk	Failure	Died	LFU	Cum patency (%)	SE (%)
0–3	8	1	–	–	88	9.8
3–6	7	1	–	–	75	11.7
6–9	6	–	–	–	75	15.3
9–12	6	–	–	–	75	17.2

LFU = lost to follow up; SE = standard error.

were observed. Due to failure of the surgical or radiological procedure in five patients, surgical closure of the AVF was needed. Surgery was thus effective in alleviating arm swelling in eight out of 10 patients, whereas the efficacy of AVF closure in five patients was 100%.

Overall initial success rate of radiological and surgical intervention was 92%. Primary patency after PTA was 63% at 6 months and 50% at 12 months of follow-up (Table 1). Secondary patencies were 88% and 63% at 6 and 12 months, respectively (Table 2). Primary patency after surgical reconstruction was 75% at 12 months (Table 3). No significant difference in patency rates between radiological and surgical intervention could be demonstrated.

Discussion

During the past two decades, large-bore catheters suitable for insertion into the subclavian or internal jugular vein, have been increasingly used not only for

temporary vascular access (<3–4 weeks) but also for longer periods of hemodialysis treatment. After initial enthusiasm, scepticism and pessimism evoked because of the high incidence of infectious and thrombotic complications of central vein catheters. Moreover the risk on central venous obstruction after catheter placement endangers the possibility of future ipsilateral vascular access placement. According to several studies the incidence of subclavian vein obstruction due to catheters ranges from 12 to 29%.^{1,6,14} and internal jugular vein obstruction may occur in about 5% of patients. In the present study, new AVFs were created in 425 patients between 1991 and 2002 of which 28 patients developed symptomatic central venous obstruction for which treatment was necessary. This is an incidence of 7%. In the majority of patients, central venous obstruction is caused by long-term indwelling central vein catheters (82–100%)^{1,3,5–7,10,11,13} and occasionally a permanent pacemaker wire is the culprit.¹⁵ In the present study, 83% of the patients had a history of previous central vein catheters either in the subclavian or internal jugular vein position.

In recent years, a percutaneous approach for the treatment of central venous obstruction became popular as the treatment of first choice. For this reason, we started also after an initially surgical approach, to use radiological intervention, because of its minimally invasiveness. Initially, the intervention consisted either of balloon angioplasty alone or additional stent placement in case of elastic recoil or failure of PTA. Various studies have addressed to the use of angioplasty with or without stenting in case of central venous obstructions in patients with vascular accesses, reporting initial clinical success in approximately 96% of cases and 1-year primary patencies of 17–70%.^{1,3,6,8,11–14} Restenosis rates vary from 14 to 33% and with a policy of multiple re-PTAs, a one-year secondary patency of 47 to 100% can be achieved. The results of these retrospective studies corroborate well with the findings of the present study (1-year primary and secondary patency: 50 and 63%, respectively).

Some authors advocate initial stent placement with PTA only in the case of recurrent stenosis and from this study a 56% primary and 97% secondary patency rate was reported.¹⁴ One may debate whether primary stent placement should be the treatment of choice. We achieved a favourable initial success rate of 89% with angioplasty alone in most patients. However symptomatic restenosis was seen in 39% within 4.8 months, and these restenoses could successfully be treated with re-PTA, stent placement or surgery. With this treatment policy a secondary patency of 63% after 1 year of follow up was achieved and this patency is

comparable to the results of several studies, but worse in comparison with primary stent placement.

Primary surgical treatment in our hands had an acceptable outcome with relief of symptoms in 75% of patients. However, surgery failed in two patients because of a severely diseased internal jugular vein with the inability to perform an adequate anastomosis or insufficient venous drainage through a cephalic-jugular vein bypass in combination with a high flow AVF. Bhatia *et al.*¹⁰ have reported an 1 year patency of 71% after PTA and stent placement and 83% after surgical reconstruction (internal jugular vein transposition and subclavian-to-innominate vein bypasses). Other studies have also shown good patency rates after surgical reconstruction at 1 year follow up (approximately 80%).^{8,9,16,17} Furthermore, Duncan *et al.* suggested subclavian vein-to-right atrial bypass grafting as an alternative treatment option when all other treatment modalities are exhausted.^{7,18} We strongly believe that when radiological intervention is not feasible, surgery should be considered with an attempt to salvage of the AVF. The historical treatment of symptomatic CVO in patients with hemodialysis access was to ligate the AVF and to create a new access site in the contralateral extremity. Recognition and management was minimal and reports were uncommon.^{2,5,20} The increase in the incidence of central venous obstruction is most probable the result of the frequent use of temporary percutaneous catheters in dialysis patients and physician awareness of the problem. In this respect, the American Dialysis Outcome and Quality Initiatives (DOQI) guidelines, first released in 1997 and updated in 2000, state that subclavian vein catheterization should be avoided for temporary access in all patients with chronic renal failure due to the risk of central venous stenosis.¹⁹

The success of the above mentioned treatment modalities has varied but has allowed the physician to prolong dialysis access function for considerable periods of time. Especially with the rapid development of new radiological techniques, the use of endovascular approaches in the treatment of central venous obstruction has improved significantly. Moreover, angioplasty has proven to be an adequate minimal invasive means of improving venous hypertension, although some authors believe that initial stent placement surpasses angioplasty alone.^{6,12–14}

From this study it was shown that radiological intervention, either PTA alone or PTA with additional stent placement, has similar results as surgical reconstruction. The number of patients in this study were small and therefore conclusions should be taken with precaution. PTA may be chosen as the treatment of first choice, considering its relatively noninvasive

character as compared to surgery. However surgical reconstruction remains an appropriate and reliable alternative in case of failure of percutaneous treatment. Furthermore, caution has to be regarded towards the use of indwelling central vein catheters for hemodialysis, for they are the number one culprit in the origin of central venous obstructions.

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