PAPER

J R Coll Physicians Edinb 2005; **35:**116–122

Central vein stenosis in end stage renal failure patients

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ABSTRACT
Background: Central vein stenosis is a late complication of CVC. We assess the risk factors and treatment outcome.
Methods: A retrospective study on chronic haemodialysis patients in Sarawak, Malaysia in 2003.
Results: Out of 315 hemodialysis patients, 127 had CVC. Fifty percent (7/14) of patients with LIJC developed central vein stenosis compared with 0·9% (1/117) with RIJC ($p<0·05$). Seven out of 13 patients with left CVC and left AVF developed signs and symptoms of central vein stenosis in comparison to one out of 24 patients with right CVC and right AVF ($p=0·001$). Among the 14 patients with LIJC, those with central vein stenosis were older ($p=0·028$) and tended to have longer duration of catheterisation ($p=0·142$). Among the eight patients with central vein stenosis, four underwent venoplasty and stenting. All had symptoms improvement.
Conclusion: LIJC is associated with a high risk of central vein stenosis especially in the older patients. Venoplasty and stenting is a feasible treatment.

KEYWORDS Central vein stenosis, end stage renal failure, venoplasty.

LIST OF ABBREVIATIONS Arterio-venous fistula (AVF), central vein catheterisation (CVC), end stage renal failure (ESRF), left internal jugular catheter (LIJC), right internal jugular catheter (RIJC), standard error of mean (SEM)

DECLARATION OF INTERESTS No conflict of interests declared.

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INTRODUCTION

Interim haemodialysis using central venous catheters may have to be performed in ESRF patients while waiting for maturation of the fistulae or during surgical revision. Central vein stenosis can occur as a delayed complication of CVC and may result in significant morbidity including loss of access.

We performed a retrospective analysis to identify the risk factors associated with CVC and the development of symptomatic central vein stenosis. The study included patients undergoing dialysis in Kuching, Serian and Sri Aman. The risk factors studied were gender, diabetic status, age, site and duration of CVC.

We also reported the outcomes of four cases of central vein stenosis treated by percutaneous intervention.

METHODS

Diagnosis

The dialysis patient with arm oedema, difficult cannulation of the vascular access for dialysis, high venous pressure or tortuous and dilated venous collaterals located over the upper chest, neck, shoulder and upper arm should be suspected of central vein stenosis. Diagnosis requires venogram via femoral and upper arm venous cannulation, demonstrating significant stenosis in the central veins, which is defined as 50% or greater narrowing of the vessel.

Patients

Retrospective analysis was performed on end stage renal disease patients undergoing dialysis at Kuching, Serian and Sri Aman Haemodialysis Centres in the year 2003. Figure 1 shows the number of patients included in the study and the analytical method. Cases with CVC via double lumen (non-tunnelled) haemodialysis catheters (majority 11·5–12 Fr Mahurkar or Braun) and central vein stenosis were identified. The outcome of venoplasty and stenting was recorded.

In this study, all patients were attending our dialysis clinic at three-monthly intervals. Symptomatic patients were evaluated earlier. We collected observational and

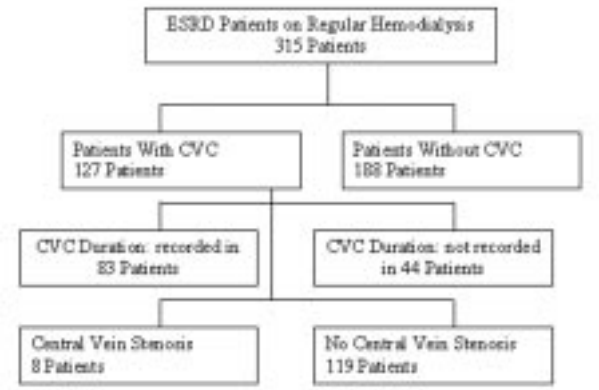

FIGURE 1 Outline of analysis.

management data until June 2004. Thus, the evaluation period for incidence of central vein stenosis after CVC was six months or more.

Venoplasty and stenting method

The venoplasty and stenting method was performed via femoral puncture with a 6, 7 or 10F sheath. Using MPA1 catheter, a Terumo wire was introduced across the occlusion in the central vein. Using an Amplatz Super Stiff wire, a 5 x 20 Opta Pro balloon was used to predilate the lesion. A Wall Stent was deployed, ranging from 14 x 40–18 x 60 mm. Post dilatation was performed with a 12 x 40 mm Opta Pro balloon. Non-ionic contrast such as Omnipaque 300 or Ultravist 370 was utilised.

Statistical analysis

Statistical analysis was performed using SPSS.[1] Results are expressed as mean value ± SEM. Kolmogorov Smirnov test was performed for interval variables. If the Lilliefors significance level was $p>0{\cdot}05$, we assumed a normal distribution and perform independent two-tailed Student t-test for comparison of unpaired data. If the Lilliefors significance level was $p<0{\cdot}05$, normal distribution cannot be assumed and Student t-test was not performed. The recorded duration of CVC was not in statistically normal distribution. Thus, we used logarithm transformation to describe the central distribution and for comparison of catheterisation duration for diabetic status and gender. For small size samples, i.e., in the sub-analysis of catheterisation duration and age at catheter insertion of patients with LIJC insertion, we used Mann Whitney U test of two independent samples.

Chi Square tests were used to assess the association between two nominal variables. When Chi Square could not be applied the Fisher's Exact test was used.

RESULTS

In 2003, 315 patients were dialysed in Kuching, Serian and Sri Aman. Ninety-nine (31%) patients had diabetes. One hundred and seventy-one (54%) were male and 144 female. One hundred and twenty-seven patients (40%) had a history of CVC. There were no significant differences between the patients with CVC and those without CVC in terms of age, gender, diabetic status and duration of haemodialysis.

Of the 127 patients with CVC, 83 (65%) had the duration of catheterisation recorded with a range from one to 224 days. Since the recorded values of the duration were not normally distributed, the geometric mean of the logarithm transform was used. The 5% trimmed geometric mean of total CVC duration and average CVC duration were calculated to be 41 days and 35 days respectively. Diabetic patients had longer durations of catheterisation, as shown in Table 1, as did older patients (Figure 2 (weak correlation)). Duration of catheterisation was unrelated to gender.

Tables 2 and 3 group the patients by site of CVC and number of CVC episodes. All patients with LIJC had undergone a single episode of LIJC. Nevertheless, the 14 patients with history of LIJC had undergone more episodes of CVC prior to LIJC than all the other patients who had undergone catheterisation (median 2 versus 1 episode; Mann Whitney U test, 2 tailed, $p<0{\cdot}001$).

TABLE 1 Comparison of catheterisation duration between diabetes and non-diabetes patients.

Characteristic	Mean by logarithm transformation		*P* value**
	DM*	Non DM	
Total duration of catheterisation	57·6 days	30·3 days	0·002
Average duration of each catheterisation	47·4 days	26·3 days	0·003

*Diabetes Mellitus
** 2-tailed independent Student t-test was used to derive *P* value.

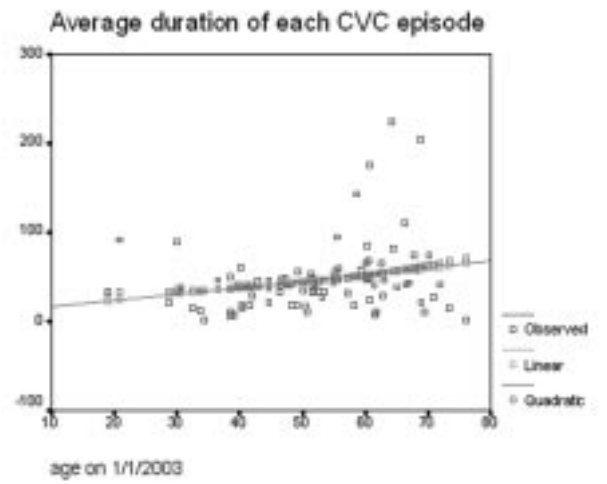

FIGURE 2 Correlation of average duration of each central vein catheterisation episode with age of patient.

Pearson correlation = 0·238
2-tailed p-value = 0·030
Thus, weak relationship between age and duration of each central vein catheterisation episode.

TABLE 2 Grouping of patients based on site of CVC.

Site of CVC insertion	Number of patients CVC	Central vein stenosis	Percentage (%)
RIJC	107	1	0·9
LIJC only	5	2	40·0
Bilateral IJC	9	5 (all on the left)	55·6
Subclavian	6	0	0·0
Total	*127*	*8*	*6·3*

TABLE 3 Episodes of CVC based on site of central vein catheterisation.

Number of episodes	Episodes of CVC Number of patients Bilateral	LIJC	RIJC	Subclavian	*Total*
1	–	4	88	6	*98*
2	6	1	19	–	*26*
3	1	–	–	–	*1*
4	2	–	–	–	2
Total	*9*	*5*	*107*	*6*	*127*

All patients with arm swelling or high venous pressure on dialysis were subjected to venogram. One patient had a cephalic vein stenosis of the long proximal segment.

Eight patients with CVC developed central vein stenosis. The onset of symptoms ranged from four months to four years; most patients present within one year of CVC.

Seven (50%) out of 14 patients who had undergone LIJC developed left CVS. Of 116 patients who had right IJC, only one developed right central vein stenosis. Thus, LIJC is strongly associated with left central vein stenosis (Table 4, p<0·001).

Seven out of 13 patients with left CVC and left AVF developed left central vein stenosis in comparison with one out of 24 patients with right CVC and right AVF developed right central vein stenosis (Fisher's Exact test, 2-tailed p=0·001). This demonstrates that even in cases with ipsilateral CVC and AVF, LIJC was significantly associated with central vein stenosis.

Besides this, none of the six patients who had a history of subclavian catheterisation developed central vein stenosis. However, the last subclavian catheterisation was done more than seven years ago and some patients with subclavian catheterisation or complications may not have been included in the study.

Among all patients with CVC, those who developed central vein stenosis were older, 54 vs 44 years (Student t-test, t(125)=2·442, p=0·016). There were no statistically significant differences between the diabetic and non-diabetic and the male and female patients.

Among the LIJC patients, those who developed central vein stenosis were older during CVC (median 59·2 years versus 44·1 years; Mann Whitney U test, 2 tailed, p=0·028) and tended to have longer durations of catheterisation (median 42·0 versus 8·5 days; Mann Whitney U test, 2-tailed, p=0·142). Diabetes and gender did not have any significant impact on this part of the analysis.

Seven patients presented with significant left upper limb swelling. In two patients, swelling developed within three days of the creation of an AVF in the ipsilateral arm due to brachiocephalic vein stenosis. One had a left brachiocephalic fistula while another had a left radial-cephalic fistula.

When the arm swelling is severe, needle placement for dialysis may be difficult and the arm may get infected. Another patient presented with raised venous pressure during haemodialysis.

Four of the patients with central vein stenosis underwent venoplasty and stenting. All patients reported some degree of improvement in symptoms

TABLE 4 Is central vein stenosis associated with LIJC?

	Number of patients LIJC	No LIJC	*Total*
Central vein stenosis	7	1	*8*
No central vein stenosis	7	112	*119*

Fisher's Exact test, 2-tailed, p<0·001
Odds ratio = 112, 95% confidence interval 12–1041.

after the procedure although the degree of improvement varied. (See Table 5 and Figures 3–6). One patient's arm swelling subsided completely and immediately after the procedure while on the table and she was able to use her AVF for dialysis again. Two patients had decreased swelling of the arm after the procedure and could continue to use vascular access for dialysis.

The last patient who presented with raised venous pressure had some improvement but the venous pressure remained too high and he needed to continue using the other arm to return the blood during dialysis. He developed subacute stent thrombosis about one month after the procedure and this resulted in a sudden increase in swelling of the arm. This was treated successfully with intra lesional infusion of thrombolytic therapy. This patient has polycythaemia rubra vera which may partially explain his tendency for thrombotic events. The patient was subsequently placed on antiplatelet therapy and warfarin.

For the remaining four patients, two were converted to chronic ambulatory peritoneal dialysis, one died of pneumonia unrelated to the central vein stenosis and one refused any intervention.

DISCUSSION

A good vascular access is of critical importance to the success of haemodialysis treatment. Studies have shown that the use of native fistulae is associated with the lowest rate of complication and use of a CVC has the highest rate of complication. Although good predialysis care, early creation of native fistulae and regular monitoring of arteriovenous fistulae may minimise problems with vascular access, interim haemodialysis using central vein double-lumen catheterisation may be needed while waiting for maturation of the fistulae or during surgical revision.

Duration of CVC was significantly longer among diabetic patients. This may be the result of poor vascular accessibility in diabetic patients due to frequent failed fistulae and thrombotic events.[2,3]

Placement of CVC is associated with various complications including pneumothorax, hemothorax, and central vein stenosis.[4–10]

Our study looked at one of the late complications of CVC, i.e. central vein stenosis. Although the reported incidence of central vein stenosis is low (about 7%),[11] it could result in significant morbidity to the patient including loss of access.

Our overall incidence of central vein stenosis was low (6·3%, eight out of 127 patients). However, it occurs in 50% (seven out of 14 patients) of patients with LIJC compared with 0·9% (one out of 116 patients) of patients with RIJC and thus is highly significant. However, the number of patients with LIJC is perhaps too small to support a definitive conclusion. Others have found LIJC to be associated with poorer blood flow rates and higher rates of thrombosis.[12,13]

Although there were no cases of central vein stenosis reported with subclavian catheterisation in our patients, our last documented subclavian

TABLE 5 Clinical features and outcomes of venoplasty and stenting.

Patient	I	II	III	IV
Gender	Female	Female	Male	Male
Age	60	62	76	57
Co-morbidity	Unknown cause of ESRF	Type II DM	Unknown cause of ESRF	Polycythaemia rubra vera
Onset	1 year after LIJC	4 months after LIJC	Time of LIJC uncertain	4 months after RIJC
Time of procedure	13 months after onset	11 months after onset	1 month after onset	15 months after onset
Venogram finding	Left BCV* stenosis > 70%	Total occlusion of left BCV	Total occlusion of left BCV	50% right BCV stenosis
Outcome of Venoplasty	Swelling subsided completely	Swelling subsided partially	Swelling persisted	VP** reduced but not normal. Complication: kinking of stent

*BCV: brachiocephalic vein
**VP: Venous pressure during haemodialysis.

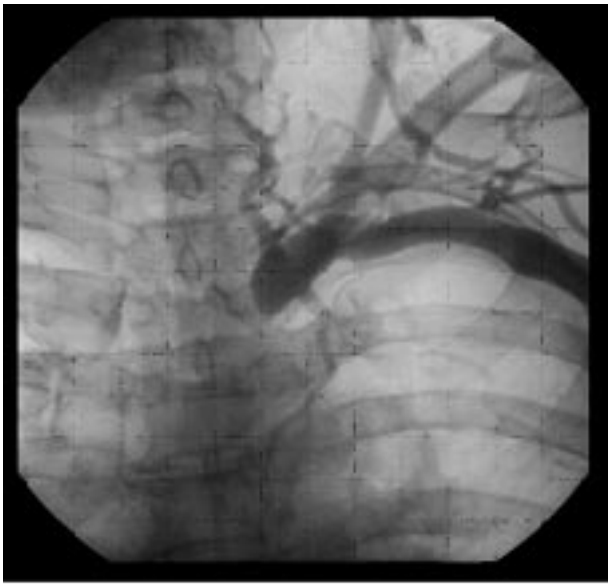

FIGURE 3 Venogram: Total occlusion of left brachiocephalic vein (of second patient in Table 5).

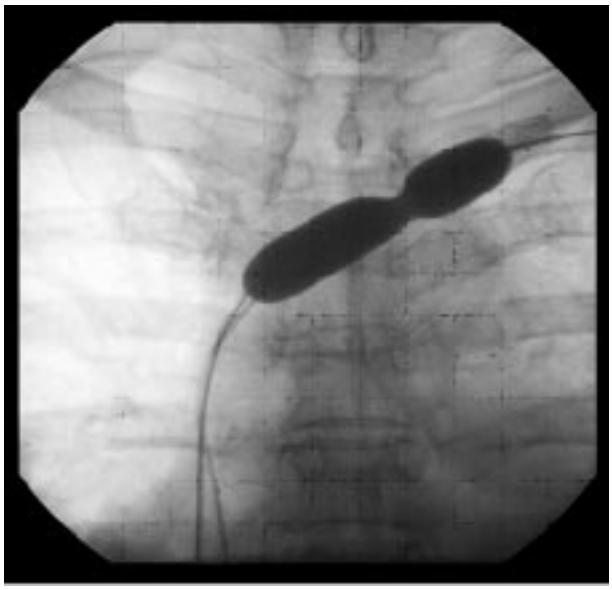

FIGURE 4 Balloonoplasty with stenting (of second patient in Table 5).

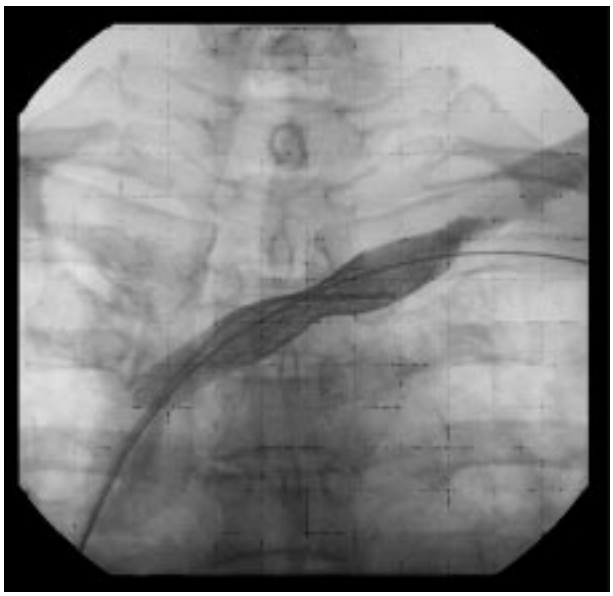

FIGURE 5 Post-procedure view (of second patient in Table 5).

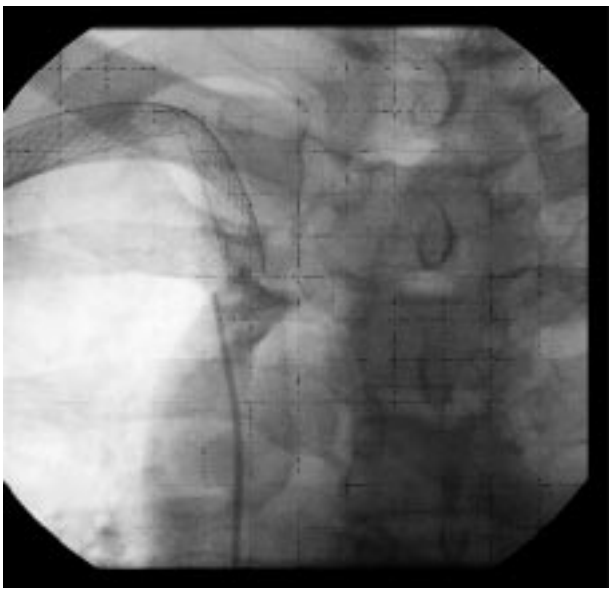

FIGURE 6 Complication: kinking of stent (of fourth patient in Table 5)

catheterisation was seven years ago and this may contribute to bias in reporting. In our patients, the symptoms of central vein stenosis occurred within four years of catheter insertion, and the mean duration of haemodialysis for our patients was only three years. Hence, earlier patients with subclavian catheter insertion and complications may not be captured in this study. Subclavian catheterisation is no longer recommended due to a higher risk of complications such as pneumo or haemothorax besides central vein thrombosis and stenosis.[14–19]

Other studies have also confirmed that RIJC is associated with a lower risk of complications including central vein stenosis compared to other sites.[12, 20, 21] Thus, we fully agree with the current recommendation that the preferred insertion site for venous dialysis catheters is the right internal jugular vein.[22]

Besides the site of catheter placement, other reported factors that increase the risk of central vein stenosis include duration of catheterisation.[11] In our study, older age at the time of catheterisation was associated with an increased risk of central vein stenosis. Longer duration of catheterisation also seems to increase the risk of central vein stenosis but the level was not statistical significance. Gender and diabetes did not affect the development of central vein stenosis.

Central vein stenosis can occur months to years after CVC. Central vein stenosis may result in dilated or congested anterior chest and neck veins or cause mild arm swelling. The arm swelling may increase significantly when an AV access is created on the ipsilateral arm due to increased blood flow.[23, 24]

Treatment of severe arm swelling due to central vein stenosis includes ligation of the AV fistula which usually results in a fast and dramatic improvement. However, some patients may not have alternative sites for AV fistula creation. Percutaneous intervention with transluminal angioplasty is an alternative treatment for central vein stenosis[25, 26] but it has a significant restenosis rate. Since Dotter reported early experimental results of stent placement in vessels in 1969, vascular stents have been used to maintain the patency of the vessel after balloon angioplasty.[27] Percutaneous angioplasty and stenting are recent approaches to managing the problem of central vein stenosis with encouraging results, and help to preserve the vascular access for a substantial period of time.[28, 29] The longest period of follow up after venoplasty and stenting in our patients was two years and we need to continue to monitor these patients to assess the long-term results.

CONCLUSIONS

Left internal jugular catheter is associated with a very high risk of central vein stenosis and the site of CVC is the strongest predictor for this complication. Older patients also seem to have a higher risk of developing central vein stenosis. The venoplasty and stenting method is a feasible treatment option for this complication. The short-term improvement varied widely between patients. Future studies will look at the factors that may predict a good response and the long-term outcome.

ACKNOWLEDGEMENTS

We thank the Cardiac Department of Sarawak General Hospital, Kuching, for their help in venoplasty and stenting.

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