Factors Affecting Outcomes of Percutaneous Transluminal Angioplasty for Central Vein Occlusive Disease in the University of the Philippines-Philippine General Hospital: A 10-Year Experience

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ABSTRACT

Objective. To describe the treatment outcomes of patients who underwent Percutaneous Transluminal Angioplasty (PTA) for Central Vein Occlusive Disease (CVOD) in end-stage kidney disease and determine the association between patient profile and treatment outcomes.

Methods. A single-institution, retrospective review of patients aged 18 and above with end-stage kidney disease who underwent PTA for CVOD in the University of the Philippines - Philippine General Hospital (UP-PGH) from January 1, 2013, to December 31, 2022, was performed. These patients' demographic and clinical profiles were evaluated using means, frequencies, and percentages. The relationship between patient profile and success of PTA was assessed using Chi-square and Mann-Whitney U tests.

Results. One hundred one patients were included in the study. Eighty-two had a first intervention, and 19 had a recurrent first intervention. The mean age was 49.8 years, with forty-six (45.5%) males and fifty-five (54.5%) females. The most common comorbidity was hypertension (59.4%). This was followed by diabetes (35.6%), chronic glomerulonephritis (18.8%), and NSAID nephropathy (4.9%). Other comorbidities include lupus nephritis, urate nephropathy, and polycystic kidney disease. The interval between symptoms and intervention ranged from two weeks to ninety-six weeks. Eleven patients (10.9%) had an arterio-venous fistula (AVF) before initiating dialysis and did not have a history of dialysis catheter use. Temporary catheters comprise most of the central vein catheters (CVC) (84.2%), while tunneled catheters were a minority (8.9%). The overall central line insertions of one hundred one patients were one hundred fifty-five, most via the right internal jugular vein (86%). There was a total of one hundred twenty-seven lesions seen during venography. Most of these lesions were in the left Innominate vein (38.6%, 39/101) and the right innominate vein (32.7%, 33/101). The most common type of lesion was stenosis (47.5%), followed by abrupt occlusions (31.7%) and tapered occlusions (20.8%). The overall success rate of PTA was 74.2%. In the second intervention for recurrence (n=19), the success rate was 78.9% (15/19). Third-time intervention in three patients was all successful. The success rate in stenotic, tapered, and abrupt lesions were 100%, 85.7%, and 28.1%, respectively. Symptom-free intervals ranged from twelve to one hundred ninety-two weeks. After a failed intervention, a new fistula or graft was the most common access option (50%). This was followed by central catheter (38.5%), venous bypass (7.7%), and peritoneal dialysis catheter (3.8%). Morbidity was 0.99%. The in-hospital mortality was zero.

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Conclusion. Overall PTA success rate for non-recurrent and first operation of recurrent patients with CVOD was high (74%). Stenotic type of lesions were the best vessels to dilate. Failure of PTA was directly related to previous right subclavian catheter insertion, multiple central vein catheter insertions, lesions in the right innominate vein, and an abrupt type of central vein occlusion. The current strategy of PTA for CVOD is both safe and effective. Early AVF creation can prevent patients from requiring multiple catheter insertions and developing CVOD. The right internal jugular vein is the optimal choice for access, while subclavian vein access should be avoided.

Keywords: end-stage kidney disease, central vein occlusive disease, percutaneous transluminal angioplasty

INTRODUCTION

Hemodialysis is the most common form of renal replacement therapy in the Philippines. A surgically created arteriovenous fistula (AVF) or a central vein catheter (CVC) dialysis access is necessary for hemodialysis. The following are considered central veins for upper limb vascular access: superior vena cava, bilateral brachiocephalic veins, bilateral internal jugular veins, bilateral external jugular veins, and bilateral subclavian veins. The central veins for lower limb vascular access are the bilateral femoral, common Iliac, external Iliac, and infrarenal inferior vena cava.

A known complication of AV fistula or hemodialysis catheter vascular access is central vein occlusive disease (CVOD), leading to venous hypertension and eventual loss of hemodialysis access.

Diagnosis of the central venous occlusive disease is mainly clinical. Venous hypertension from CVOD can manifest in a spectrum. There can be facial and upper extremity swelling and edema, ipsilateral extremity heaviness, extensive venous collaterals with skin ulcerations, breast swelling, laryngeal edema, exophthalmos, visual and auditory disturbances, and pleural effusion. There is recirculation, high-pressure alarms, and difficult cannulation during hemodialysis.[1,2]

The possible pathology of CVOD is intimal hyperplasia resulting from faster turbulent flow in the previously low-velocity venous system and vessel trauma. As the endothelial cells are denuded due to shear stress on the vein, smooth muscle cell proliferation ensues.[3] This process starts with vessel stenosis and occlusion. Occlusion or stenosis will give rise to venous hypertension and the spectrum of signs and symptoms related to CVOD. Patients without previous history of catheter insertion may develop CVOD. This occurrence is low but supports the theory that the increase in turbulent flow in the central veins from the AVF and the uremic environment may cause inflammation and, subsequently, intimal hyperplasia.

The etiology of these lesions could also be from direct physical damage from the movement of the dialysis catheter tip or body against the vessel wall, resulting in inflammation and thrombus formation.[4] CVOD occurs more frequently following subclavian catheter insertion (42-50%) than right internal jugular catheter insertions (10%). It is also proposed that left-sided cannulations incur a higher incidence of CVOD, likely due to the catheter's significant movement during head and neck rotation. A catheter inserted through the subclavian vein or left internal jugular vein must cross a complex anatomic pathway with angulations, which likely causes more significant endothelial trauma.[5-7] The exact incidence of the pathology is unknown.

A 50% or more luminal diameter stenosis in the central vein is considered significant. Although catheter venography is diagnostic, computerized tomography, magnetic resonance venography, and ultrasound may be used. The latter is less expensive and avoids radiation exposure but is more operator-dependent.[8]

The earliest description of percutaneous balloon angioplasty for CVOD was in 1982. This was done in a patient with recurrent arm edema due to CVOD.[9] Contemporary treatment includes percutaneous transluminal angioplasty (PTA), stenting, access ligation, and venous bypass.[2] Recently, some investigators used the laser to recanalize lesions deemed non-crossable by traditional endovascular techniques.[8] These may effectively alleviate symptoms, but patency rates are still poor.[2]

PTA aims to dilate the stenotic or occluded vein, relieve patient symptoms, and prolong the life of the AVF. PTA of the central vein entails venography through the arteriovenous access or a central vein. Once a map of the lesion is seen, an attempt is made to cross a wire through the lesion. If a wire is successfully crossed over the lesion, an over-the-wire balloon is inserted and inflated to relieve the stenosis or occlusion. The procedure is deemed successful when there is less than 30% residual diameter stenosis and a decrease in engorged tributaries.[10] Stenting is the next option for lesions with significant elastic recoil after balloon PTA. However, these stents are not available in this institution. If the lesion is not crossed with a wire, subsequent alternative access is planned, and the current AVF is ligated.

Procedural complications include venous perforation or rupture requiring stenting or balloon tamponade in 0.39% of cases. Other complications include arterial embolization and venous puncture.[11]

Technical success ranges from 73-90%. Primary patency rates post-intervention at one month are 84%, three months at 55-80%, six months at 42-71%, and 12 months at 17-55%.[12-15]

The first Percutaneous Transluminal Angioplasty (PTA) for CVOD was done in the Philippine General Hospital in 2013.[16] Local studies or data are limited in the Philippines. This study reviewed the ten-year expe-rience in managing CVOD in this institution. Specifically, it is aimed to 1) describe the demographic and clinical profile of patients who underwent PTA for CVOD, 2) report the immediate

outcomes of their treatment, and 3) determine the association between patient factors and success or failure of recanalization from PTA.

METHODS

This retrospective cohort involved a review of patient medical records. The study included hemodialysis patients (age >18 years) admitted to the UP-PGH for symptomatic central vein occlusive disease who underwent venography and PTA from January 1, 2013 to December 31, 2022. Patients who did not undergo venography were excluded. One hundred forty-three patients were initially screened. Twenty patients were excluded due to incomplete records. Data from the remaining 123 patients were collected. Eighty-two had their first episode of CVOD, and 19 experienced a recurrence after a previous PTA, requiring reintervention (1st recurrence). Nineteen had second, and three had third recurrences requiring reintervention. These twenty-two patients with second and third recurrences were omitted in the Chi-square and Mann-Whitney U test analysis to avoid over-representation of recurrent patients' characteristics. One hundred one patients (82 first occurrence and 19 first recurrence) were included in the statistical analysis for success or failure of the angioplasty.

Patients were identified using the Integrated Surgical Information System (ISIS) database of the Department of Surgery and the Philippine General Hospital's Computerized Registry of Admissions and Discharges (RADISH).

Demographic and clinical data were collected, such as age, sex, comorbidities (hypertension, diabetes mellitus, chronic glomerulonephritis, NSAID nephropathy), the time interval from onset of symptoms to intervention, number and type of previous central vein catheter insertions, type of AVF, anatomic location of previous central vein catheter, site of central vein lesions, lesion characteristics, type of occlusion, and the success of recanalization.

Data were also collected on the clinical course, such as the symptom-free period after successful PTA, the complication of intervention (perforation), dialysis access after a failed intervention, and in-hospital mortality.

Continuous descriptive variables like age, the number of previous central vein catheter insertions, duration of central catheter use, and the onset of symptoms to the intervention were expressed as mean and standard deviation. Categorical variables like sex, comorbid conditions, access site of arteriovenous fistula, type of central catheter used, location of central vein lesions, lesion characteristics, and dialysis access after the failed intervention, morbidity, and mortality were summarized as counts and percentages.

Patients' data were made anonymous by assigning a code.

The success rate of PTA was computed as the proportion of successful recanalization from the total number of cases. Statistical analysis comparing categorical variables vs. successful or failed PTA was done using a Chi-square test in patients with first and recurrent first interventions. The variables were: a) sex and comorbidities, b) type of AVF, c) central vein catheter (CVC) access site, d) type of catheter used, e) location of central vein lesion, and f) lesion characteristics. Mann-Whitney U test was used for the number of catheters inserted vs. success or failure of PTA. Patients' data were made anonymous by assigning a code.

The study protocol was approved by the University of the Philippines Manila Research Ethics Board.

Definition of Terms

Lesion characteristics. The lesion could be an occlusion or a stenosis. Stenotic lesions are lesions with a tiny sliver of the venous outflow through which the wire can be guided (Figure 1). Occlusion can be a tapered or abrupt type of lesion. During venography, tapered lesions show some contrast flow but gradually disappear as it approaches the center (Figure 2). The abrupt type of lesion shows immediate contrast cutoff in the occlusion site (Figure 3).

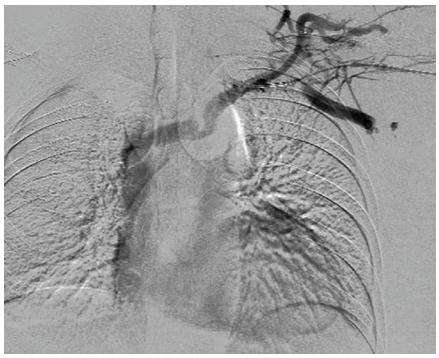

Figure 1. The image shows a stenotic lesion with a tiny sliver of the venous outflow through which the wire can be guided.

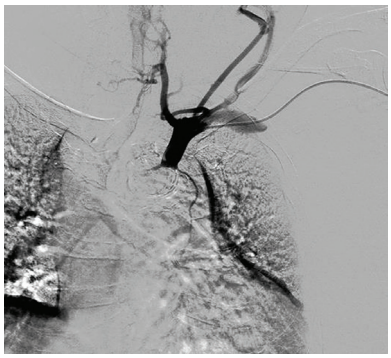

Figure 2. The image shows a tapered occlusion lesion wherein some contrast flow but gradually disappears as it approaches the center.

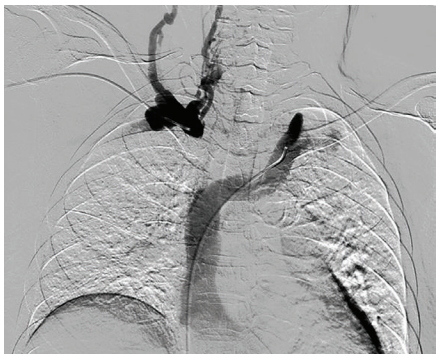

Figure 3. The image shows an abrupt occlusion lesion with immediate contrast cutoff in the occlusion site.

RESULTS

The average age of the patients was 49.8 years, with 46 (45.5%) males and 55 (54.5%) females. Most patients had hypertension (59.4%) and Diabetes Mellitus (34.6%) (Table 1).

The interval between symptoms and intervention ranged from two weeks to ninety-six weeks, with a mean of 18 weeks (Table 2).

Only eleven patients (10.9%) had a fistula before initiating hemodialysis. Almost a third (31.7%) of all patients had one central line insertion for hemodialysis. The others had two insertions (24.7%), three insertions (22.8%), four insertions (8.9%), and five insertions (0.9%) (Table 3).

Temporary catheters comprise the majority of the CVC (84.2%), while tunneled catheters were a minority (8.9%) (Table 4).

The left and right brachiocephalic fistula configurations were the majority. It comprised 40.6% and 33.7%, respectively. Both were followed by the left radio-cephalic at 9.9% and the right radio-cephalic at 5.9%. The most common of the arteriovenous (AV) grafts, was the right brachio-axillary configuration (5%). Only one patient had a basilic vein transposition (Table 5).

Out of 101 patients, 155 central line insertions were performed, with the majority accessed through the right internal jugular vein (86.1% of patients). The left internal jugular vein was accessed in 40.6% of patients, followed by the left common femoral vein (9.9%), the right common femoral vein (7.9%), the right subclavian vein (5.9%), and the left subclavian vein (3%). These details are summarized in Table 6.

Of one hundred one patients, there was a total of one hundred twenty-seven lesions seen during venography. Most of these lesions were in the left Innominate (38.6%, 39/101) and right innominate vein (32.7%, 33/101). Superior vena cava pathology was present in 19.8% (20/101) of patients. The right and left subclavian vein pathology was seen in 16.8% (17/101) and 17.8% (18/101) of patients, respectively (Table 7).

The most commonly observed lesions (Table 8) were stenosis at 47.5%, abrupt at 31.6%, and tapered at 20.7%.

Table 9 shows the different lesion type seen in each Central Vein area. There is more abrupt occlusion seen in the Right (48%,16/33) and Left innominate vein (35.9%, 14/39).

Table 10 shows the outcomes of patients who underwent venography and angioplasty for CVOD. Of the total 101 patients (single and first intervention recurrent patients), 74%

Table 1. Sex and Comorbidities

	All Patients		1st Recurrent Patients	
	n	%	n	%
Sex				
Male	46	45.545	8	42.105
Female	55	54.455	11	57.895
Total	101		19	
Comorbidities				
Hypertension	60	59.406	13	68.421
Diabetes mellitus	35	34.653	7	36.842
Chronic glomerulonephritis	19	18.812	2	10.526
NSAID nephropathy	5	4.950	1	5.263
Others	6	3.960	–	–

Note: Other comorbidities include lupus nephritis (n = 1), polycystic kidney disease (n = 1), and urate nephropathy (n = 4).

Table 2. Interval between Symptoms to Intervention (weeks)

	Mean	SD	Min–Max
All patients, 1st operation (N = 101)	18.158	16.655	2–96
Recurrent patients, 1st operation (N = 19)	14.526	9.045	2–36
Recurrent patients, 2nd operation (N = 19)	7.158	6.466	3–29
Recurrent patients, 3rd operation (N = 3)	7.333	1.155	6–8

Note: Values are in weeks.

Table 3. Number of Central Vein Catheter Insertions

Number of Insertions	All patients 1st operation N = 101 (%)	Recurrent 1st operation N = 19 (%)	Recurrent 2nd operation N = 19 (%)	Recurrent 3rd operation N = 3 (%)
		5 (26.316)	5 (26.316)	–
1	32 (31.683)	4 (21.053)	4 (21.053)	1 (33.333)
2	25 (24.752)	1 (5.263)	1 (5.263)	1 (33.333)
3	23 (22.772)	6 (31.579)	6 (31.579)	1 (33.333)
4	9 (8.911)	3 (15.789)	3 (15.789)	–
5	1 (0.990)	–	–	–

Note: Values in parentheses are percentages.

Table 4. Type of Central Vein Catheter

Number of Insertions	All patients 1st operation N = 94 (%)	Recurrent 1st operation N = 14 (%)	Recurrent 2nd operation N = 14 (%)	Recurrent 3rd operation N = 3 (%)
Temporary	85 (84.158)	13 (68.421)	13 (68.421)	3 (100.000)
Tunneled	9 (8.911)	1 (5.263)	1 (5.263)	–

Note: Values in parentheses are percentages.

(75/101) were successful, while 25.7% (26/101) had failed interventions. For the first operation of the recurrent patients, all 19 (100%) were successful.

Second intervention recurrent patients (n=19) had success in 78.9% (15/19), with failure in 21% (4/19). Third intervention patients (n=3) had all successful (100%) operations.

During the procedure, one patient had a minor complication. A hematoma developed at the puncture site of the cephalic vein, needing evacuation and repair.

Morbidity was 0.99%, and the 30-day mortality was zero.

Symptom-free intervals ranged from 12 to 192 weeks with a mean of 49 weeks (Table 11).

Table 5. Type of Arteriovenous Fistula

Type of AVF	All patients 1st operation N = 101 (%)	Recurrent 1st operation N = 19 (%)	Recurrent 2nd operation N = 19 (%)	Recurrent 3rd operation N = 3 (%)
Right radio-cephalic	6 (5.941)	1 (5.263)	1 (5.263)	–
Left radio-cephalic	10 (9.901)	1 (5.263)	1 (5.263)	1 (33.333)
Right brachiocephalic	34 (33.663)	5 (26.316)	5 (26.316)	–
Left brachiocephalic	41 (40.594)	9 (47.368)	9 (47.368)	2 (66.667)
Right brachio-basilic	–	–	–	–
Left brachio-basilic	1 (0.990)	1 (5.263)	1 (5.263)	–
Right axillo-axillary (graft)	1 (0.990)	–	–	–
Left axillo-axillary (graft)	2 (1.980)	–	–	–
Right brachio-axillary (graft)	5 (4.950)	2 (10.526)	2 (10.526)	–
Left brachio-axillary (graft)	1 (0.990)	–	–	–

Note: Values in parentheses are percentages.

Table 6. Central Vein Catheter Access Sites

CVC Access Sites	All patients 1st operation (%)	Recurrent 1st operation (%)	Recurrent 2nd operation (%)	Recurrent 3rd operation (%)
Right subclavian	6 (5.941)	–	–	–
Left subclavian	3 (2.970)	–	–	–
Right internal jugular	87 (86.139)	14 (73.684)	14 (73.684)	3 (100.000)
Left internal jugular	41 (40.594)	7 (36.842)	7 (36.842)	1 (33.333)
Right common femoral	8 (7.921)	3 (15.789)	2 (10.526)	–
Left common femoral	10 (9.901)	2 (10.526)	2 (10.526)	–

Note: Values in parentheses are percentages.

Table 7. Central Vein Lesions

Central Vein Lesions	All patients 1st operation (%)	Recurrent 1st operation (%)	Recurrent 2nd operation (%)	Recurrent 3rd operation (%)
Right subclavian	17 (16.832)	1 (5.263)	1 (5.263)	–
Right innominate	33 (32.673)	4 (21.053)	4 (21.053)	–
Superior vena cava	20 (19.802)	5 (26.316)	5 (26.316)	–
Left subclavian	18 (17.822)	1 (5.263)	1 (5.263)	–
Left innominate	39 (38.614)	11 (57.895)	11 (57.895)	3 (100.000)

Note: Values in parentheses are percentages.

Table 8. Lesion Characteristics

Number of Insertions	All patients 1st operation N = 101 (%)	Recurrent 1st operation N = 19 (%)	Recurrent 2nd operation N = 19 (%)	Recurrent 3rd operation N = 3 (%)
Tapered	21 (20.792)	7 (36.842)	6 (31.579)	–
Abrupt	32 (31.683)	4 (21.053)	5 (26.316)	–
Stenosis	48 (47.525)	8 (42.105)	8 (42.105)	3 (100.000)

Note: Values in parentheses are percentages.

After a failed intervention, a new fistula or graft was the most common access option (50%). This access option was followed by a central catheter (38.5%), venous bypass (7.7%), and peritoneal dialysis catheter (3.8%) (Table 12).

Table 13 shows the results of the Chi-Square Test of Independence to assess the relationship between successful/failed PTA and sex, comorbidities, type of AV fistula, CVC access site, type of CVC used, location of central vein lesion.

For the number of CVC insertions, the Mann-Whitney U test was used in place of an independent samples t-test because the normality assumption was violated. The results indicate a difference between successful and failed operations, with more insertions being performed in the failed PTA group.

Table 14 shows that there were significant differences between successful and failed operations in terms of the lesion characteristics. The success rate was highest for stenotic lesions followed by tapered lesions. Abrupt lesions had the highest failure rate.

Factors that made a significant difference in the failure of the procedure were: 1) previous Right subclavian access site

Table 9. Central Vein Occlusion and Type

Central vein	Tapered	Abrupt	Stenotic
Right subclavian vein	5/17	4/17	8/17
Right innominate vein	7/33	16/33	10/33
Superior vena cava	6/20	4/20	10/20
Left subclavian vein	4/18	5/18	9/18
Left innominate vein	7/39	14/39	18/39

Table 10. Percutaneous Transluminal Angioplasty Results

Patient Type (N)	Success, N (%)	Failure, N (%)
Non-recurrent Patients and 1st Operation of Recurrent Patients (N = 101)	75 (74.257)	26 (25.743)
1st Operation of the Recurrent Patients (N = 19)	19 (100%)	0 (0)
2nd Operation of the Recurrent Patients (N = 19)	15 (78.947)	4 (21.053)
3rd Operation of the Recurrent Patients (N = 3)	3 (100)	0 (0)

Table 11. Symptom-Free Interval (for recurrent patients only) in weeks

	Mean	SD	Min–Max
Between 1st and 2nd operation (n = 19)	49.167	53.489	12-192
Between 2nd and 3rd operation (n = 3)	23.667	4.041	20–28

Note: Values are in weeks. For most of the patients (83.333%) the interval between the 1st and 2nd operations was within 12–48 weeks.

Table 12. Dialysis Access after Failed Intervention

	All Patients 1st Operation N = 26		Recurrent Patients 2nd Operation N = 4	
	n	%	n	%
New fistula / graft	13	50.000	1	25.000
Venous bypass	2	7.692	–	–
Central line catheter	10	38.462	3	75.000
Peritoneal catheter	1	3.846	–	–

Note: There were no failed interventions among the 1st and 3rd operations of the recurrent patients.

Table 13. Relationship between Failure of PTA with various Factors (Chi-square Test)

Factors	X^2	*P**
Sex	0.280	0.597
Comorbidities		
Hypertension	1.401	0.236
Diabetes mellitus	2.072	0.150
Chronic glomerulonephritis	0.269	0.604
NSAID nephropathy	0.559	0.455
Type of AV Fistula		
R radiocephalic	0.192	0.661
L radiocephalic	0.105	0.746
R brachiocephalic	0.131	0.717
L brachiocephalic	0.519	0.471
R brachiobasilic	–	–
L brachiobasilic	0.350	0.554
R axilloaxillary (graft)	2.913	0.088
L axilliaxillary (graft)	0.628	0.428
R brachioaxillary (graft)	0.091	0.763
L brachioaxillary (graft)	2.913	0.088
CVC access site		
R subclavian	11.068	<0.001*
L subclavian	2.709	0.100
R internal jugular	0.158	0.691
L internal jugular	1.285	0.257
R common femoral	2.674	0.102
L common femoral	3.416	0.065
Type of CVC used		
Temporary	3.779	0.052
Permanent	1.107	0.293
Location of central vein lesion		
R subclavian	0.052	0.819
R innominate	4.778	0.029*
Superior vena cava	1.506	0.220
L subclavian	0.047	0.828
L innominate	0.202	0.653

**Significant*

Table 14. Success of Percutaneous Transluminal Angioplasty and Lesion Type

PTA	Lesion Characteristics		
	Tapered, N (%)	Abrupt, N (%)	Stenosis, N (%)
Success	18 (85.714)	9 (28.125)	48 (100.000)
Failure	3 (14.286)	23 (71.875)	–

2) multiple CVC insertions, 3) Right innominate vein lesions, and 4) abrupt lesions.

DISCUSSION

Demographics

The sex distribution (45.5 % males) was similar to those reported in the literature.[17] However, our study had a younger age group with a mean age of 49.8 years compared to 60 years in other series.[17] Similarly, hypertension was the most common co-morbidity.[17]

Time from symptom to intervention

The time from symptom to intervention was long in our study. The range was two weeks to ninety-six weeks (24 months) with a mean of 18 weeks (4 ½ months). This delay in intervention could be related to local healthcare delivery and the health-seeking behavior of patients, some during the COVID-19 pandemic. This delay may have affected the success rate of recanalization.

No previous history of catheter insertion

In our study, 10.9% (11/101) of patients with CVOD did not have a previous history of CVC insertion. This observation supports the similar findings of Oguzkurt that CVOD may develop even without previous catheter insertion, indicating the turbulent flow in the area, the uremic milieu, and inflammation may cause CVOD.[1] The exact incidence, although low, is unknown.

Catheter Type

Unlike in other centers where tunneled catheters were used, most catheters inserted in this study were temporary, non-tunneled ones. Most patients had temporary catheters placed, suggesting that another long-term vascular access for dialysis like AVF was planned. Temporary catheters are cheaper compared to tunneled ones. Temporary catheters were used to minimize the risk of developing CVOD.

AVF type

The recommended first choice for the location of AV fistulas is the radiocephalic. Most patients in this series had brachiocephalic AV fistulas, the second choice of surgeons when the cephalic vein on the wrist is small or unusable.

CVC access site

Most patients (86%) had the right internal jugular vein catheter access site. Subclavian vein access was avoided and rarely used to avoid long-term complications.

Lesion location

Most lesions were in the left (38.6%) and then the right innominate vein (32.7%). The left brachiocephalic lesions can be due to compressive stenosis and organic stenosis. In particular, the left brachiocephalic vein may be compressed between the sternum and the right brachiocephalic artery causing the lesion.[18]

Success rates in PTA

Success rates in PTA of CVOD procedures can vary widely in the literature, ranging from 50.5% to 60% to 90% due to variability in patient demographics.[17,19,20] The type and severity of lesions encountered, such as stenosis or occlusion, tapered or abrupt, and single or multiple lesions, can result in significant outcome variability. Most studies do not give a breakdown of the types of lesions seen on angiograms. In our study, the overall success rate of recanalization was 74.25%.

Morbidity and mortality

Central vein rupture may occur in 0.39% of patients undergoing PTA for CVOD. All ruptures in the series of Kim occurred in the cases with occlusion. Central vein ruptures were managed by low-pressure balloon tamponade (n = 2), stent/stent-graft (n = 5), and balloon-mediated hemostasis blocking venous inflow followed by the observation (n = 5). There was no mortality in Kim's series.[11]

The complication rate in this series was also low (0.99%). In one patient, a hematoma at the puncture site was corrected by evacuation of clots and suturing of the access vein. Central vein rupture was not seen in our patients. There was no in-hospital mortality in our study. The procedure was safe and effective.

Symptom-free interval

The symptom-free interval can be a surrogate for estimating primary patency rates. The latter is reported in current literature with one month at 84%, three months at 55-80%, six months at 42-71%, and 12 months at 17-55%.[12-15] In our patients (n=19), it ranged from twelve (3 months) to one hundred ninety-two weeks (48 months). Although very wide in range, this data must be interpreted cautiously as we have limited cases of multiple intervention CVOD. Also, patient follow-up in this study could have been better, and the last few years of the study period coincided with the COVID-19 pandemic lockdown.

Dialysis access after failed PTA

For failed PTA, new central vein catheters were inserted, usually in the femoral vein, and AVF was created on the opposite side, depending on the central vein anatomy.

Factors affecting the success or failure of PTA

Sex and comorbidities, AVF type, and dialysis catheter type (temporary or long-term tunneled) did not affect the outcome of PTA.

Age greater than 60 years was a predictor of the success of PTA in Hongkasul's series. The possible explanation was that elderly patients could not tolerate symptoms and came for early treatment.[17] However, in this study, age was not a significant factor.

Four factors significantly contributed to a high PTA failure rate in our study.

Type of lesion

In this study, the overall success rate of recanalization was 74.25%. We divided the type of lesions into three categories to give a better picture (Table 1.8). The majority were stenosis (47%), followed by abrupt (31%) and tapered (20%). The success rate in stenotic lesions was 100%. The tapered type of occlusion followed this at 85.7%, and the abrupt type at 28.1%. These findings are similar to Hongsakul's, where stenotic lesions significantly predict successful angioplasty, and abrupt occlusions had more failed angioplasty.[17] It was inferred that tapered lesions are recent lesions with microchannels not seen on venography. These characteristics make them more crossable with a guidewire and balloon angioplasty than the abrupt occlusion types.[17] This may impact vascular surgery training and radiation safety, as attempts at PTA for lesions less likely to be recanalized may be abandoned earlier, thereby reducing the potential radiation exposure for patients and personnel.

Previous right subclavian catheter insertions

Most dialysis catheters in the study were inserted via the right internal jugular vein (86%). The second choice for catheter access is the left internal jugular vein (40.5%). Subclavian catheter insertions are avoided in our institution and used as a last resort to prevent complications like pneumothorax, hemothorax, and CVOD. Subclavian vein catheter insertion carries the most significant risk of CVOD development. About 50% of subclavian catheter insertion patients had mild to high-grade central venous occlusions compared to the zero incidences of CVOD in those with catheters in the internal jugular vein.[21]

In this study, those with a right subclavian vein catheter insertion had an 83% chance of failing a CVOD intervention. Most of the lesions seen in these patients are abrupt-type occlusions, a factor likely contributing to a high failure rate.

Multiple CVC insertions

Lesions resulting from multiple catheter insertions are associated with occlusive-type lesions.[22] Occlusive lesions, coupled with more events of vessel injury during multiple catheter insertions, may develop lesions that are hard to cross with a guidewire, leading to failed PTA. Our findings corroborate the inferences, where more central line insertions exist in our patients with failed intervention. The majority of failed interventions have abrupt occlusive-type lesions.

The fistula first strategy or early AVF creation must be emphasized to avoid hemodialysis via central vein catheters.

Lesion at the right innominate vein

In the study population, most lesions were in the left (38.6%) and right (32.7%) Innominate veins. In Hongkasul's study, most were in the right (43%) innominate veins.[17] These were also seen in several studies.[14,22] A possible explanation could be inferred from a simulation model of the human central veins with a hemodialysis catheter inserted. In the model, it was found that intravascular catheter disrupts the native flow inside the veins. Spiral flow is reduced in the area of the right innominate vein, which may lead to thrombosis.[23] Decrease in lumen size may decrease oxygen delivery in the vein itself. Hypoxia promotes a cascade of inflammatory processes, which may promote vascular remodeling and pathology.[24]

This study shows a higher failure rate in the right innominate vein. Failure of PTA was 39.4%, higher than in other central vein locations. Results are likely due to the more significant proportion of abrupt-type lesions seen in the right innominate vein. Half of the abrupt-type lesions in the study are seen in this location.

The current approach to hemodialysis worldwide is the 'Fistula First and Catheter Last' paradigm. It entails referring a CKD patient with a creatinine clearance of <25 mL/min to a vascular surgeon for assessment and early construction of an AV fistula.[2] This decreases the risk of catheter-related sepsis and death among CKD patients.[25] The approach often avoids needing a central catheter for hemodialysis initiation, reducing complications such as sepsis and CVOD. In our study population, only 10.9% had a fistula before starting hemodialysis. Although the number is only a small portion of our CKD patients and does not likely represent the exact 'fistula first' rate in the country, effort should be made to promote this paradigm as it may decrease complications and healthcare costs.

Early AVF creation may prevent patients from undergoing multiple dialysis catheter insertions and CVOD. Early kidney transplantation is the next important strategy to avoid complications of hemodialysis access. The right internal jugular vein is the first choice for access. The subclavian vein should be avoided.

Limitations of the Study

The retrospective study covered the single vascular surgery referral center experience. The small population size and poor patient follow-up limit the study.

CONCLUSION

The overall PTA success rate was high (74%). Stenotic type of lesions were the best vessels to dilate. Previous right subclavian catheter insertion, multiple central vein catheter insertions, lesions in the right innominate vein, and an abrupt type of central vein occlusion were directly related to the failure of PTA for CVOD. PTA for CVOD is an effective and safe strategy in the short term. Morbidity is low, and mortality is zero.

Recommendations

Early creation of a native AV fistula is the best way to avoid multiple central vein catheter insertions and CVOD. The right internal jugular vein is the optimal access choice for patients requiring immediate dialysis. Using the right subclavian vein as an access site for dialysis should be avoided as much as possible.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria

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