PERCUTANEOUS TRANSLUMINAL ANGIOPLASTY IN SUBCLAVIAN VEIN STENOSIS CAUSED BY CENTRAL VENOUS CATHETERIZATION FOR HAEMODIALYSIS ACCESS IN CHRONIC KIDNEY DISEASE PATIENTS

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ABSTRACT

Introduction: The increased central vein access for haemodialysis in chronic kidney disease patients has led to an increase in side effects in clinically relevant stenosis of the subclavian vein. One of the therapeutic options to solve stenosis of the subclavian vein is endovascular treatment Percutaneous Transluminal Angioplasty (PTA).
Objectives: To show our experience in treating subclavian vein stenosis using Endovascular treatment Percutaneous Transluminal Angioplasty (PTA).
Materials and Methods: A retrospective study of 62 chronic kidney disease patients who underwent haemodialysis with stenosis of subclavian veins treated with PTA in 3 hospitals in Surabaya from October 2017 to October 2020 with a range of ages 18 to 70 years was conducted.
Results: We performed PTA for subclavian vein stenosis in 62 cases. Partial stenosis was found in 35 cases and total occlusion in 27 cases. For 27 total occlusion cases, 19 cases can still be opened, but 8 cases can't be opened or recanalization and we drop out these patients. 54 cases (87%) were good and 8 cases (13%) can't be open. The result of PTA in treating stenosis of the subclavian vein was good. The results of reduced arm swelling and using Doppler USG follow-up are 100%(54/54) after 1 month, 100%(54/54) after 3 months, and 90.7% (49/54) after 6 months.
Conclusion: Percutaneous Transluminal Angioplasty (PTA) is effective in treating subclavian vein stenosis and relieving its symptoms. The patency rate is 90.7% after 6 months post-procedure of PTA.

Keywords: Endovascular Treatment, Central Venous Stenosis, Haemodialysis

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INTRODUCTION

Central venous stenosis (CVS) is a narrowing of the vessel lumen in a big intrathoracic vein, including the subclavian vein and the superior vena cava [1,2]. Stenosis is considered significant if it causes flow disturbance or obstruction to forward flow, this usually occurs if the diameter of the stenotic side is more than 50% of the adjacent normal side [3]. Subclavian vein stenosis can be caused by previous subclavian vein catheter placement for haemodialysis access in chronic renal disease patients [4]. It can have symptoms such as oedema of the upper extremity and chronic pain caused by the development of venous hypertension.

The fittest therapy for symptomatic subclavian stenosis is not defined. Stenosis and occlusion of the subclavian vein can be treated by both endovascular and open procedures form [2,5]. Although fistula ligation is frequently used as symptomatic relief, functional fistula can be sacrificed in this procedure which is a disadvantage in patients with very limited alternative access sites for AVF creations [6,7]. One alternative minimal invasive therapy to surgery in treating subclavian vein stenosis is Percutaneous Transluminal Angioplasty (PTA). In previous studies, PTA shows a good result with AVF salvage and symptomatic relief reduced in oedema of affected extremity [8,9]. The objective of this study is to show our experience in treating subclavian vein stenosis using PTA.

MATERIALS AND METHODS

A retrospective study with a total of 62 angioplasties in subclavian stenosis with a history of central venous catheterization was performed. The diagnosis of subclavian stenosis was based on clinical presentation, doppler USG, and angiography. The range of age in this study was 18 to 75 years. The angioplasties were performed in 3 hospitals in Surabaya from July 2017 to October 2020 (39 months). Procedural results were evaluated after 1, 3, and 6 months based on clinical presentation and Doppler USG.

The indication for angiographic examination was based on clinical criteria and the result of Doppler USG. The criteria utilized were persistent swelling of the arm with the previous central venous catheter insertion in the subclavian vein.

Venous puncture using a 21 gauge needle is employed in all cases as an angiographic technique. The contrast was injected followed by obtaining digital angiographic images from the arteriovenous fistula up to the subclavian veins. Angioplasty was performed immediately in patients with the presence of significant stenosis (>50%).

For subclavian venous stenosis and occlusive, inflations with systemic heparinization previous to balloon inflation were performed two times in 2 to 3 minutes. The access vein was punctured with an 18 gauge needle. Manual injection of 12 mL of contrast medium with iodine 150 mg/ml was obtained as venography, which revealed stenosis of the subclavian vein. The adjacent vein diameter was approximately 12 mm. Then, a 3000 U (50 U/kg) intravenous heparin was injected into the patient before the procedure. After the insertion of a 7-French sheath introducer from the puncture site, a hydrophilic 0.035-inch guidewire (®Terumo) and a 5-French catheter through the sheath introducer were traversed to the stenosis site. As pre-dilatation, insertion of a balloon catheter with 10-12 mm in diameter (®Powerflex) was performed through the sheath introducer and inflated over the stenotic lesion at 10 atm (varying from 6 to 20 ATM) for 1 minute. Technical success of PTA has severe criteria such as venography with two views representing residual stenosis less than 30%. 1,3 and 6 months follow-up in reduced arm swelling after the procedure was performed to evaluate the clinical effects and results of PTA.

RESULT

A total of 62 angioplasties for subclavian vein stenosis were performed. From 62 cases of subclavian vein angioplasty, 35 partial stenosis cases and 27 total occlusion cases were found. For 27 total occlusion cases, 19 cases can still be opened, but 8 cases with total occlusion can't be opened or recanalization. The initial result of PTA was good in all cases and reduced in arm swelling. For these 62 angioplasties, 54 cases (87%) were good and 8 cases (13%) couldn't be opened or recanalization. For these 8 cases, the AV shunt was ligated, after that we used chronic double lumen and we dropped these patients from the study.

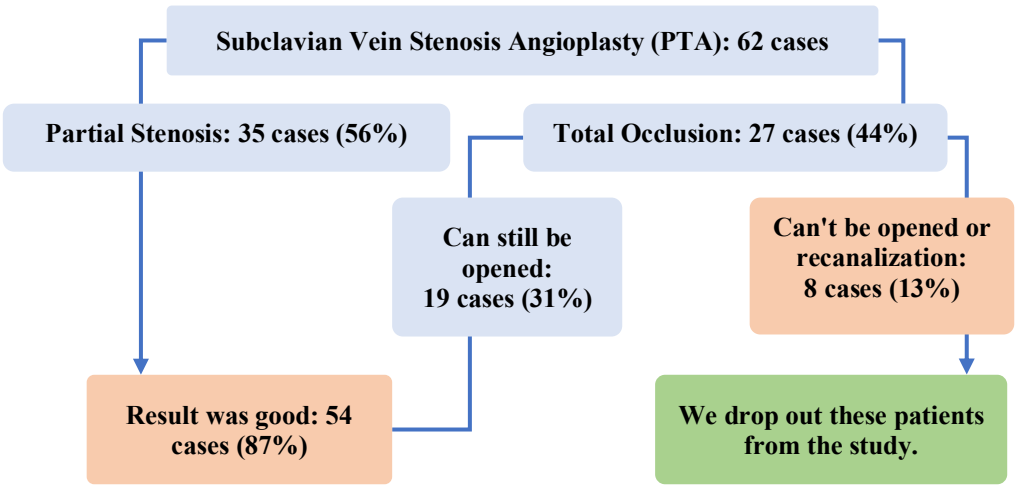

Figure 1. Total Angioplasty for Subclavian vein stenosis

More than 50% degrees of stenosis were found in all patients. In this study, initial percutaneous transluminal angioplasty as symptomatic relief was technically successful in 54 (87%) of 62 cases and dialysis can be continued in the affected extremity. There were no complications related to the procedure in this study such as vein perforation and deaths.

A total of 54 angioplasties were evaluated after the procedure with 1, 3, and 6 months follow-up. All of the patients had reduced arm swelling within 24 hours after the procedure with total resolution in 1-2 weeks. The result of follow-up reduced arm swelling and using Doppler USG revealed a patency rate of 100%(54/54) after 1 month, 100% (54/54) after 3 months, and 90.7% (49/54) after 6 months. There were 5 patients with restenosis and slight arm swelling after 6 months of follow-up

Table 1. Result of Follow-up Subclavian Venous Stenosis After Procedure

Total Subclavian Vein Stenosis Angioplasty	**Follow Up Period** (Based on clinical presentation and evaluation using Doppler USG)		
	After 1 month	After 3 months	After 6 months
54 Cases	100% (54/54)	100% (54/54)	90.7% (49/54)

Notes: All of the patients had reduced arm swelling within 24 hours after the procedure with total resolution in 1-2 weeks.

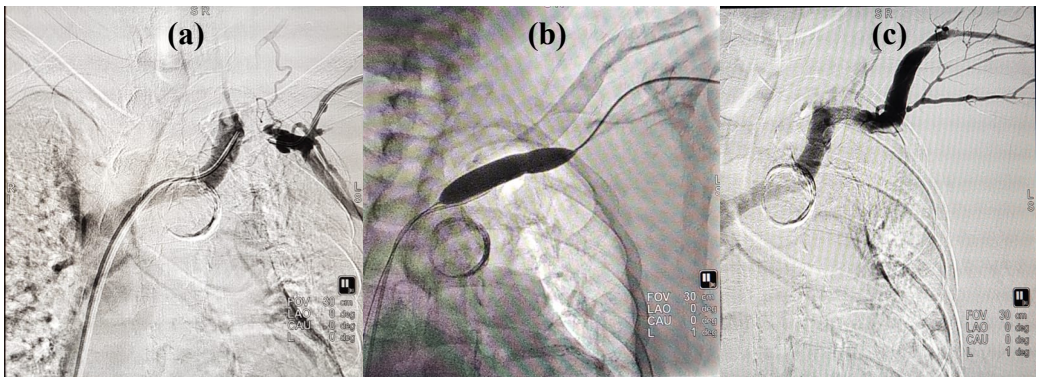

Figure 2. (a) Stenosis of Subclavian Vein and (b) Angioplasty Procedure (c) After Angioplasty

Female patient, 45 years old with diagnoses of chronic renal disease and left subclavian vein stenosis

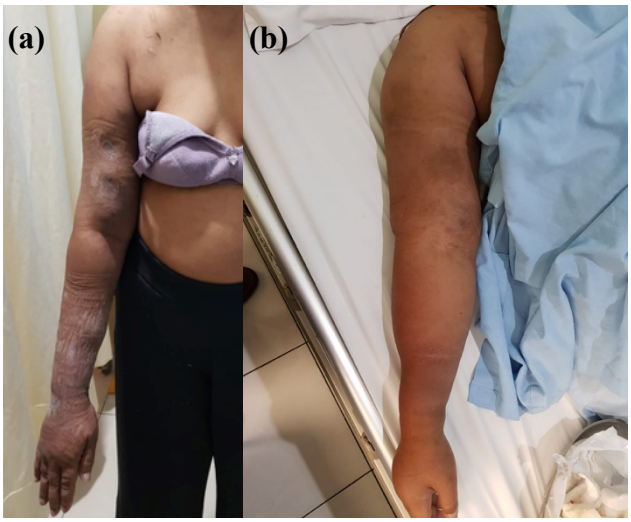

Figure 3. Clinical presentation (a) Before PTA (b) After PTA
Female patient, 49 years old with diagnoses of chronic renal disease and right subclavian vein stenosis

DISCUSSION

Subclavian vein stenosis is a serious problem for patients on chronic haemodialysis. The effect of stenosis is affected by the flow of the vein. The symptoms may not show until an arteriovenous fistula (AVF) or graft is made in the affected arm or forearm for haemodialysis. Additionally, if the stenosis is not critical or there is development of adequate collateral flow, it may remain asymptomatic. Clinical signs may be subtle, and the only indication of access dysfunction may be inadequate dialysis [2,10].

Subclavian vein stenosis due to previous subclavian venous catheter placement is most likely caused by high inflammation, oxidative stress, activation of leukocytes, release of myeloperoxidase, and coagulation. Initial trauma from vein cannulation causes endothelial damage that is perpetuated by an indwelling foreign body that is not biocompatible. The constant movement of the catheter due to postural change and respiration followed by the increased flow and turbulence from the AV access, alters the shear stress and causes altered shear stress that leads to platelet deposition and venous wall thickening. Infection associated with venous catheters may aggravate inflammation and predispose to the development of subclavian stenosis. Clinical problems were issued due to this problem such as increased use of long-term central venous catheterization/chronic double lumen and proximal/another site AVF surgery in chronic kidney disease

patients that increased parallelly with subclavian vein stenosis [11].

Subclavian stenosis may be very disserve in a patient with chronic kidney disease and requires routine haemodialysis. First, a swollen arm is very uncomfortable and disturbing for the patient, the oedematous skin is easily injured and wound healing is a problem, especially in a patient with an immunocompromised condition. The swollen skin and subcutaneous soft tissue also make vein puncture for haemodialysis difficult. The venous pressure is high and it is difficult to maintain adequate haemodialysis. Aneurysmal dilatation of veins, prolonged bleeding after dialysis, and thrombosis of vascular access can occur. The worst of all is that stenosis is usually near the final common pathway; the amount of collaterals formed around the mediastinum and chest wall is usually insufficient to maintain adequate dialysis or to let the arm swelling subside [4,5,10].

In patients with chronic kidney disease who require haemodialysis with AVF, oedema of the arm caused by stenosis or occlusion of the subclavian vein is a serious problem that needs to be treated immediately. Poor adequacy of dialysis and its consequences, such as recurrent hyperkalaemia can develop if the stenosis is left untreated. Symptomatic relief for the patient was the primary goal while maintaining the life and function of the present AVF which might improve the patient's life quality [12].

In the period when endovascular therapy for vascular diseases was not popular, the patient used to be put on an anticoagulant, hoping that enough collaterals would form with time, and the patient might still use the ipsilateral limb for haemodialysis. The AVF or graft has to be ligated, and another AVF or graft is fashioned in the opposite limb, hoping that there are good peripheral and central veins in it. After the AVF is ligated, the collaterals are usually enough for venous drainage from an upper limb and the swelling will subside readily. The other option is the surgical creation of a nonanatomic route to bypass the stricture [6,13].

Currently, endovascular treatment for vascular diseases is widely available; hence, thoracotomy for the creation of such a bypass is rarely performed. This endovascular technique has been widely used because open surgical techniques increase morbidity rates. In several previous studies, PTA as an alternative procedure has been seen to be quite effective and safe procedure compared to an open procedure [12,14,15]. The two most important endovascular means for the treatment of subclavian stenosis are balloon

angioplasty and endovascular stenting. Balloon angioplasty should be the first choice. If there is recurrent stenosis, it can be repeated. Interestingly, a recent meta-analysis study by Wu *et al* showed that there was no significant difference in primary patency, between PTA group compared to stent group [2]. The metallic stent is used only when there is immediate elastic recoil after angioplasty or there is a rapid recurrence of stenosis [3,9,16]. The National Kidney Foundation suggests the use of metallic stent for subclavian stenosis if there is significant residual stenosis after PTA or recurrence of stenosis within three months [11,17].

The previous studies showed that PTA shows good results for initial therapy as a symptomatic relief in subclavian vein stenosis a very high success rates ranging from 70%-90%.[7]. This result same as our study, where PTA success rates reached 87%, but we only used regular balloon angioplasty without stent placement. The initial result of PTA was good in all cases and reduced in arm swelling. For these 62 angioplasties, 54 cases (87%) were good and 8 cases (13%) couldn't be opened or recanalization. For these 8 cases, the AVF was ligated, we used chronic double lumen, and we dropped these patients from our study. There were no major complications or death due to the endovascular procedures it same as our study [18].

Reduced arm swelling after PTA was found in many of our patients and dialysis can be continued in the affected extremity. In some cases when the clinician finds limited alternative access sites for AVF, maintaining the life and function of present AVF is important which increases patient life quality [2,8,19]. In our study, we evaluated 54 angioplasties with 1, 3, and 6 months follow-up. All of the patients had reduced arm swelling within 24 hours after the procedure with total resolution in 1-2 weeks.

A study by Barret *et al* showed that the primary patency rate 1, 3, and 6 months after PTA consecutively 90%, 83%, and 77% [20]. In our study, the result of follow-up reduction in arm swelling was 100%(54/54) after 1 month, 100%(54/54) after 3 months, and 90.7% (49/54) after 6 months. There were 5 patients with restenosis and slight arm swelling after 6 months of follow-up. For these patients, we do reintervention (second angioplasty) resulting reduced in arm swelling.

However, there are several other studies Kovalik et al reported that there where 7% failed angioplasty, 50% or more had luminal diameter improvement and 23% showed no improvement of stenosis and occlusion symptoms caused by elastic lesions. In our study, there are 8 cases (13%)

with total occlusion that can't be opened. Subsequently, Glanz et al reported, that recurrent stenosis was found in 81% of those patients with a successful angioplasty with an average restenosis duration of 7.6 months; 100% of those with elastic lesions occlude in an average of 2.9 months. [12]. In our study restenosis was found in 9.3% of patients in 6 months follow-up.

The mechanism of restenosis after angioplasty or stenting is likely related to intimal hyperplasia. The action may be accelerated due to the high flow and turbulence. After angioplasty, the stenosis usually recurs at the same site [21]. A recent study by Cui *et al* showed that patient with high-pressure balloons has a higher patency rate than patients with low-pressure balloons. This technique can be considered as prevention of restenosis. The destruction of fibrotic tissue by the high-pressure balloon may delay the fibroblastic proliferation of venous, which may explain the reason for the reduction of symptomatic restenosis after the high-pressure balloon PTA[22].

PTA can be used to treat recurrent lesions as a definitive or palliative therapy. The clinical and procedural factors associated with the success of PTA have not been previously identified. Despite the overall poor long-term outcome of PTA for controlling oedema and improving the patency of CVC for haemodialysis, it will be interesting to see whether future studies confirm our observation that the initial response to PTA is predictive of long-term success.

There are some limitations of this study such as the retrospective nature of our research method. Despite these limitations, these results can be used as an accurate reflection of good results in clinical situations.

CONCLUSION

Percutaneous Transluminal Angioplasty (PTA) is effective in the treatment of subclavian vein stenosis in chronic kidney disease patients who require haemodialysis and can provide symptomatic relief in patients who present swelling of the upper extremity.

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